Hungary´s Seventh National Communication and Third Biennial Report





Under the United Nations Framework Convention on Climate Change

Ministry of National Development, Department for Climate Policy 2017

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1. EXECUTIVE SUMMARY

Basic characteristics of the country

Hungary is located in Central Europe; the neighbouring countries are Austria, Croatia, Romania, Serbia, Slovakia, Slovenia and Ukraine. Geographically Hungary is mostly flat terrain, with some hills and low mountains. Danube and Tisza are the two main rivers of the country; the largest lake is Lake Balaton. The capital city of Hungary is Budapest, with approximately 1.7 million inhabitants. Other major cities are Debrecen, Miskolc, Pécs, Szeged, Győr with around 100-200 thousand inhabitants. Hungarian is the official language. The area of the country is 93,033 km2, of which 57, 4% is agricultural area (46, 5% arable land, 2,5% garden, orchard and vineyard, 8,4% grassland), 20.9% forest, 0.9% reed and fish-pond, and 20,7% is uncultivated land area. The recent micro-census concluded in 2016 shows that the population dropped under 10 million souls (9.803M in 2016) with a life expectancy of 72.2 years for males, and 79.8 years for females.
The density of population was 105,4 inhabitants/km2. The climate is characterised as temperate, with cold, humid winters and warm summers. The average annual temperature is between 10 and 11 °C (50-52 °F).

Hungary is administratively subdivided into 20 regions, which are the 19 counties and the capital city of Budapest (independent of any county government). There are 3,154 municipalities in Hungary which are responsible for the provision of most local services, including the operation of schools, kindergartens, welfare and healthcare facilities, some office buildings and museums. Of the 3,154 municipalities, only 23 are considered to be major metropolitan areas and over 2,800 are villages. Outside Budapest, the largest municipality in Hungary is Debrecen, with a population of 200,000 inhabitants.

Hungary is a long standing parliamentary democracy, one of the leaders of political and economic transition in the region. Hungary became a member state of the European Union in 2004 and is pursuing economic stability and prosperity.

Hungary is a market economy; it has a highly internationalised and export-oriented business sector and a stable macroeconomic situation. The global economic crisis hit hard the Hungarian economy in 2009 but the recovery started soon and the economy is now on a path of sustainable growth. Hungary's macroeconomic situation is stable, and the economy has been on a sound path: the government debt declines, the inflation is moderate and the country shows a positive balance of trade since 2009.

Hungary's GDP per capita in Purchasing Power Standards (PPS) was more than 68.3% of the EU-28 average in 2016. The private sector accounts for more than 80% of GDP. Foreign ownership and investment in Hungarian firms are widespread, with foreign direct investment stock totalling more than $75 billion in 2016

The employment rate is constantly rising; it was 71.5% in 2016 regarding the population aged 20-64. The trend is in line with the headline objective of the Europe 2020 strategy, according to which the employment rate in the EU member states should reach 75 percent.

Industry is the most significant sector of the Hungarian national economy, its share in GDP was 26% in 2016. Despite the fact that the volume of investments in the whole national economy decreased by 20% in 2016, the volume of investments in the field of industry performed much better by reaching 4.1% increase. The Government has approved the Irinyi Plan in February 2016. The strategy is a frame for further manufacturing industrial strategies

In the 27 years since the fall of Communism, the Hungarian economy has undergone a fundamental structural change, resulting in marked decline in the GHG intensity (-40%) accompanied by increasing energy efficiency and GDP between 1990 and 2015. As a result, economic growth and energy consumption is successfully decoupled in Hungary. The cumulated drop in the gross inland consumption of energy was 12.5%, while the cumulated GDP growth was 36.7% in this 25 years-time frame.

At the same time, Hungary is still heavily dependent on energy imports. The oil and gas dependency is 93% and 70% respectively. However, the import dependency is still increasing. It is not only the import dependency, which causes vulnerability for Hungary, but also the unilateral character of it. The major part of the import, and practically all the gas originates from Russia, even if a part of it is transported to Hungary through the European network. Then it is not surprising that the key message of the Hungarian energy policy is seeking ways out of our energy dependency. The five means to achieve the above goal include energy savings, increasing the share of renewable energy sources to the greatest possible level, the maintenance of our nuclear energy capacity, and diversification of source countries and transit routes safeguarding Hungary's natural gas and oil import; and the renewal of the government's energy institution system.

Energy savings - The two most important elements of the energy efficiency improvement plans are the following: thermo retrofitting of buildings and the modernisation of heating and cooling systems; installation of high efficiency new-, and modernisation of existing electric power stations;

Renewables - Thanks to the targeted supporting schemes (METÁR, Environmental and Energy Efficiency OP, etc.) and measures, the recent share (2015) of RES in the gross inland energy consumption is 14.47%, close to our EU2020 commitment that is to 14.65% share in primary energy consumption by 2020.

Nuclear energy - Maintenance of the nuclear capacity in the electricity mix is one of the key factors in securing the Hungarian energy independence. Besides energy security issues, replacing Paks Nuclear Power Plant that is nearly 30 years in service, with the modern Paks-2 Power Plant.

Energy Union – As an EU Member State, Hungary is part of the implementation of the EU's Energy Union Strategy aiming a transformation of European energy supply through the establishment of a fully integrated energy market. This will certainly give the opportunity for Hungary to diversify its energy import sources and transport routes providing secure, sustainable and affordable energy supply.

Domestic energy reserves – In longer term, depending on the speed of the innovation, domestic fossil energy reserves (coal, lignite, unconventional natural gas) also mean

strategic backup for a future eco-friendly utilization involving BATs and R&D in the field of clean coal technologies (zero carbon power plants, carbon capture and reuse) for power generation. Hungary's central location in Europe and the accordingly dense motorway network are one of its most important competitive advantages. Three vital European TEN-T core network corridors (Orient – East-Med, Mediterranean, Rhine-Danube) pass through Hungary, providing unparalleled access to all parts of Europe. As a result of intensive construction works along main transport corridors, major motorways and trunk roads reach national borders, ensuring faster and safer transportation.

7712 km-long railway network covers the whole country and it is an integral part of the international network (Hungary has 3000 km-long TEN-T railway line), thus providing easy access by international express trains from the neighbouring and numerous other European countries. Around 18% of freight is transported by rail in Hungary, well above the EU average. Hungary is a landlocked country but it has access to the Black Sea and the North Sea via the river Danube.

Within less than a year after the demise of the Hungarian national airlines, the market reinvigorated again. Both passenger numbers and cargo volumes soon reached and even exceeded the prior peaks.

The stock of cars is increasing constantly in the last 5 years. Numbers of other fuel driven vehicles (hybrid, electric and mixed combustion) are five times higher than in 2010, but their share of total vehicle stock is only 1,2%.

The natural and climatic conditions of Hungary are very favourable for agricultural production. Thanks to its favourable natural endowments, Hungary has had a significant and internationally appreciated agricultural sector for centuries. Since Hungary’s accession to the EU, its agriculture has developed considerably and its efficiency, competitiveness and profitability have begun to catch up with the EU15. As a result, the significance of Hungarian agriculture has increased in terms of production and income indicators. Nevertheless, there are still many reserves in the agriculture of the country; its role in the EU’s agriculture can be further increased in the future, with a better utilization of its capabilities.

Vegetable and fruit production has a long tradition in Hungary, thanks to the favourable natural conditions. Hungary’s agricultural production decreased dramatically between 1990 and 2000 and the drop of livestock reached 50% which has been continued after the EU accession as well. In recent years, due to Government’s aims to reverse these trends, several measures were introduced which has resulted slight positive changes in the animal husbandry sector. In the next years further increase of the livestock is expected.

In general, forests in Hungary have been managed sustainably for about a century, and, overall, have continued to be carbon sinks. The new forests have added much to the services of the forests, including the sink capacity. The sink of the biomass of the forests established since 1990 have been 1.1-1.2 million tCO_2 a year in this decade. The share of private forests amounts to 42.5%, whereas forests owned by local governments only amount to 1%. Most forests (56.5%) are thus still state owned.

Greenhouse gas inventory information

In 2015, total emissions of greenhouse gases in Hungary were 61.2 million tons carbon dioxide equivalents (CO_2-eq) excluding the LULUCF sector. Taking into account also the mostly carbon absorbing processes in the LULUCF sector, the net emissions of Hungary were 54.7 million tons CO_2-eq in 2015. Being about 6 tons, the Hungarian per capita emissions are below the European average.

Now, our emissions are 44% lower than in the base year (average of 1985-87). For the most part, this significant reduction was mainly a consequence of the regime change in Hungary (1989-90) which brought in its train radical decline in the output of the national economy. The production decreased in almost every economic sector including also the GHG relevant sectors like energy, industry and agriculture. Then, between 2005 and 2013, after a period of about 14 years of relatively stagnant emission level (1992-2005), GHG emissions fell again quite significantly by 24 per cent. The global financial and economic crises exerted a major impact on the output of the Hungarian economy, consequently on the level of GHG emissions as well resulting in a quite significant drop of 9% between 2008 and 2009. Then, after a smaller increase in 2010, emissions decreased further in the following four years. In contrast, the decline in economic output stopped in the first quarter of 2010, and Hungary not only reached the pre-crisis level of GDP again in 2014 but exceeded it even in 2015.

The decreasing trend of emissions stopped in 2014. Moreover, an increase of 6% could be detected in 2015. About 74% of this growth was realized in the energy sector, whereas industrial processes contributed by a further 24%. Despite the 3.2 million tons increase in 2015, current emissions remained by 19% far below the emission level of 2005.

The most important greenhouse gas is carbon dioxide accounting for 77% of total GHG emissions. The main source of CO_2 emissions is burning of fossil fuels for energy purposes, including transport. CO_2 emissions have decreased by 45% since the middle of the 80's. Methane represents 12% in the GHG inventory. Methane is generated mainly at waste disposal sites and in animal farms, but the fugitive emissions of natural gas are also important sources. CH_4 emissions are by 39% lower than in the base year. Nitrous oxide contributes 7% to the total GHG emissions. Its main sources are agricultural soils, and manure management. N_2O emissions are 61% lower compared to base year. The total emissions of fluorinated gases amount to 4% and due their steadily growing tendency special attention is needed as their applications in the cooling industry and the use of SF_6 in electrical equipment are still popular

Policies and measures on climate change

Hungary's mitigation actions, as a Member State of the European Union, are determined to a great extent by the policies and regulations of the EU.

In 2009 the EU established internal rules under its "2020 climate and energy package" - these underpin the EU implementation of the target under the Convention. The package introduced a clear approach to achieve a 20% reduction of total GHG emissions from 1990 levels, which is equivalent to a 14% reduction compared to 2005 levels. This 14% reduction objective is divided between the ETS and ESD sectors. The target for the ETS is 21% reduction, while the target for the ESD is 10% reduction compared to 2005. The latter is

shared between the 28 Member States through individual national GHG targets. Under the ESD Hungary can increase its emissions by 10%.

Beyond the EU legislation the National Climate Change Strategy gives a framework to the country's climate policy. The strategy was reviewed in 2013. The updated NCCS II for 2017-2030 (NCCS II) was published and opened to public consultation in the spring of 2017. It was accepted by the Government and submitted to the Parliament in May 2017. It includes a decarbonisation roadmap and gives a framework for national adaptation. Moreover it provides a target system of awareness-raising activities and an analysis of expected effects of climate change in Hungary.

Hungary has adopted several measures that serve the mitigation of GHG emissions and help achieving its climate policy targets. As these measures affect many territories of the economy several institutions are taking part of their implementation. The Ministry of National Development, the Ministry of Agriculture, the Ministry for National Economy, the Ministry of Interior and the Prime Minister's Office are the major policy makers.

Projections

For the report two scenarios were constructed. The "with existing measures scenario" (WEM) encompasses implemented and adopted policies and measures, while the "with additional measures scenario" (WAM) takes into account planned measures.

Total GHG emissions without LULUCF have been decreasing from 2007 until 2013 almost continuously, but it increased again in the last two years. According to our "with existing measures" scenario this will turn again into a downward trend with total emissions without LULUCF reaching 3.8% lower level in 2020 and then mainly because many of the existing measures don't span out until 2030 it will rise slowly reaching a level 1.2% below the 2015 level. In this scenario emissions will be 35.6% and 33.8% lower than they were in 1990. According to the "with additional measures" scenario emissions will decrease by 4% until 2020 and by 2% until 2030. This compared to the 1990 level equals 35.7% and 34.4% respectively.

The residential sector will be a major contributor to GHG emissions reduction. The sector is expected to emit 18% and 41% less in 2020 and 2030 respectively mainly due to the new regulations on energy performance of buildings.

The largest increase is expected in the transport sector. The demand for transport and most of all for road transportation will most certainly continue to rise in the coming decades. The penetration of alternative fuels in road transportation won't be able to counterbalance this effect. Altogether in the "with existing measures" scenario we project emissions from transport to be 22% higher in 2030 than they were in 2015. In the "with additional measures" scenario we expect emissions to be 20% higher in 2030 than in 2015.

Climate change vulnerability and adaptation

Knowledge of the direction and quantified degree of the changes are indispensable for the preparation in terms of the effects of climate change, during the mapping of which it can rely basically on two sources: on the one hand, one can draw consequences regarding the

climatic situation of the recent past and the present using collected and available measurements; on the other hand, one can quantify the expected, future changes of the 21st century applying model simulations. The trend analyses basing on the controlled and homogenised measurement data recorded in the climatology database of the Hungarian Meteorological Service (OMSZ).

Like on a global level, average temperature will undoubtedly increase in Hungary as well in the future.

Based on the model calculation results shown for the 21st century, we have to expect a further increase in temperature with an extent that reaches 1°C in almost the entire country and in every season by 2021–2050, and will exceed even 4°C in the summer months, compared to the reference period of 1961–1990. It is obvious that temperature extremities are shifting significantly towards warming up: the number of frosty days will decrease and the number of summer days and heatwave days will increase, and will add up to a whole month by the end of the century.

The evolution of extremities has a characteristic spatial distribution and has a negative effect primarily on the central, southern and eastern parts of Hungary, signifying the importance of territorial vulnerability assessments.

The territorial differences of Hungary are attributable to various reasons (West–East, and recently Northwest–South economic division, inequalities between urban and rural areas, serious social, and income differences) and may become aggravated by the impacts of climate change, as the vulnerability to the prognosticated mid- and long-term climatic changes is different for each area. A regional vulnerability comparison would therefore be quite urgent. Appropriate regional level climate vulnerability assessments are to integrate the challenges and tasks related to climate change into regional strategic planning and decision-making and reinforce the practical means. The aim of vulnerability assessment is to explore and detect the extent each region and settlement is vulnerable to the expected impacts of climate change. The aim of vulnerability assessment is not to determine absolute vulnerability but to compare regions and to determine relative differences.

The potential instrument for adaptation and the systemisation opportunities for action lines has quite a wide range. A specific set of adaptation instruments forms a heterogeneous group. Its basic pillars are the development of human resources and consciousness, application of experiences from traditional farming methods, the proper selection of technological, technical innovations, management tools and complying with the external regulatory environment. All these presume the direct and indirect flow of necessary information, horizontal and vertical integration at a regional and country level, and the joining of individual adaptation activities into a larger, community system.

It should be emphasised that in certain cases the goals of adaptation, emission-regulation, and the specific measures to achieve them and the indirect effects of these measures are interconnected. This is particularly true for agriculture and forestry, and – to a limited extent – to energy management.

The Hungarian climate protection developments have two sources basically. On the one hand, incomes from international quota sales ensure the encouraging of household energy efficiency and building energy investments, on the other hand, Hungarian operational programmes ensure funds for supporting public (state, municipal, church and civil) and private energy efficiency, renewable energy developments from the EU budget. The Hungarian framework and utilisation rules regarding EU funds is laid down by the Partnership Agreement, the fields of each development funded by each Fund are laid down in the operational programmes. The utilisation of incomes from quota sales is governed by Act XCV of 2015[1].

In the New Széchenyi Plan, the different policies execute their support policy through the operational programmes, and this is supplemented by the environmental protection and climate protection aids of agricultural and rural development programmes. The fact that prevention and mitigation of climate change effects was not a horizontal criterion during OP planning did significantly reduce the indirect, synergic, climate change-related impact of operational programmes during 2007–13. Identification of adaptation measures did not play any decisive role during planning at that time. Renewable energy and energy efficiency schemes were in turn often over applied for (e.g. priorities 4 and 5 of the EEOP, which required a subsequent reallocation of additional funds from other operational programmes).

Assistance to developing countries

Hungary is dedicated to contribute to the commitment of developed countries to jointly mobilize USD 100 billion per year by 2020 from a wide variety of sources. Public finance has been provided through bilateral and multilateral channels. Assistance to developing country Parties that are particularly vulnerable to climate change is ensured by continuously providing financial support through bilateral channels in forms of grant and tied aid. Hungary's public climate finance is expected to remain at a similar level in the coming years, around 35 million EUR annually.

Striving to the mobilization effect of public financial resources Hungary works closely with actors of the national private sector. Planning of green growth activities partly in collaboration with the Global Green Growth Institute will multiply the financial resources and their effect on the green economy. The Balkan Regional Trust Fund, a regional financial vehicle is being developed in collaboration with the Global Green Growth Institute, to be launched over the course of 2019.

Hungary is active in the transfer of adaptive water management technologies. For this purpose the Ministry of Foreign Affairs and Trade (MFA) organized an expo of water technologies in conjunction with the Budapest Water Summit in 2016. Specifically, the MFA also established a dedicated Department for Water Diplomacy, Export and the Danube Region Strategy. Hungary is also supporting technology development and transfer through the UNFCCC Technology Mechanism, and the activities of the Climate Technology Center and Network.

[1] Act XCV of 2015 on the amendment of the distribution and targeted utilisation rules of quota incomes accorded to the Hungarian state from the emission trading system

Research and development

Regarding climate and environment related research, the main priorities are set by the National Climate Change Strategies and the National Environmental Programmes. As of 2017, the most up to date documents are the second National Climate Change Strategy for 2017-2030 and the fourth National Environmental Programme for 2015-2020.

Although, a significant part of all research in Hungary is carried out or coordinated by the Hungarian Academy of Sciences, several institutions, namely the Hungarian Meteorological Service, the Mining and Geological Survey of Hungary and the Hungarian Forest Research Institute, along with Hungarian higher education institutions (Szent István University, Eötvös Loránd University, University of Sopron, Budapest University of Technology and Economics, Central European University) must be noted.

The most important governmental institute dealing with climate change and the implementation of the NCCSs is the Department for Climate Policy at the Ministry of National Development, which also manages the so-called National IPCC Committee. The Hungarian Government continuously encourages scientists to participate in as many IPCC activities as possible, including the preparation of various IPCC reports.

As for the funding of research, it mainly stems from European Union sources and the National Research, Development and Innovation Fund. The total funding available for research, development and innovation until 2020 is 1 200 billion HUF, provided from both EU and domestic sources in the framework of calls announced in cooperation with the National Research Development and Innovation Office.

One of the most relevant projects is the creation of the National Adaptation Geo-information System (NAGiS). The aim is to continuously operate a geoinformational data system based on Hungarian research and the results of Earth observation, which is capable of multipurpose use, such as supporting decision preparation and decision making.

The majority observation activities are still carried out by the Hungarian Meteorological Service (OMSZ) and the Department of Meteorology at Eötvös Loránd University (ELTE). Besides short-range, medium-range, and monthly weather forecasts, OMSZ provides climate projections into future with the help of two regional climate models. Other two regional climate models were adopted by ELTE. The results of the projections have been applied in many national and international projects, such as the NAGiS project in which climate model results of OMSZ and ELTE were utilised for impact studies of hydrology, agriculture, tourism and critical infrastructure

Education, public awareness, trainings

Besides remarkable mitigation and adaptation actions, the newly updated National Climate Change Strategy (NCCS II) for 2017-2030 contains a "*Partnership for Climate*" Awareness-Raising Plan, with the aim of integrating climate awareness and sustainability into decision-making and actions on all levels of society. The Plan primarily focuses on public and higher education, civil and private organizations and the media. Climate Change education in *primary and secondary schools* is still embedded into the National Base Curriculum, furthermore, it tends to appear in many other school activities: the Hungarian Ecoschool

Network and the Green Kindergarten Network operate with approximately 1000 schools and 900 kindergartens and a new, complex series of Green Study Competitions and Programmes was also launched in 2016. Aspects of climate change are more and more widely taught at Hungarian *universities and colleges*, as well, either as part of degree programmes on broader subjects such as environmental science, environmental engineering, earth sciences etc., or as elective courses freely available to students of any subject. One university offers Climate Research as a possible area of specialization in its MSc Meteorology programme.

Churches have always played an important role in the education of the society and in forming its approach and way of life. The perspective of religious communities is characterized by a long-term, broad-minded and responsible thinking of our goals and actions. The churches have recognised that nature on its own is a value worth respecting, and raise the attention to the importance of respecting life and the role of caution and love in our dealings with nature. Therefore, the Hungarian Government aims to collaborate with the churches in Hungary on the issue of climate change and environmental protection. Churches may play a direct role in awareness-raising. Congregations, religious communities may initiate and participate in local mitigation (e.g. awareness-raising about energy) or adaptation (e.g. afforestation, habitat protection) programmes, in cooperation with NGOs, municipalities. The base provided by governmental background institutes should be used to create the network of NGOs, academic and ecclesiastical organisations, institutes, networks dealing with sustainability and climate change. The positive effects of such a network should be systematically channelled to the various levels of society and also into legislation.

The efficient use of the press and the innovative channels of mass communication is unavoidable, therefore the Government aims to establish a partnership with the media in the field of awareness-raising on climate change. The forming of the legal regulations, training of programme-makers should be used to achieve that the issues of climate change and sustainability are not put into a separate "green box" in the media, but appear regularly and are integrated into the daily flow of information and entertainment. Complex campaigns for climate-consciousness are needed to encourage active participation of citizens, therefore a Climate-Friendly Hungarian Decade campaign should be launched. Complex awareness-raising should be done in the priority areas of adaptation and mitigation (reduction of energy consumption and the use of renewable energy, environmentally conscious consumption, preparation of households and workplaces to the negative effects of climate change, agriculture, use of land, nature conservation). The long-term goal is to represent climate change as a boundary condition, in every governmental campaign activity.

Several organisations in Hungary offer trainings related to climate change and a large number of conferences and expert workshops are taking place to address such topics. These are geared towards the general public (Energy Club, Association for Sustainable Economies), professionals (Hungarian Green Buildings Council, Climate Policy Thematic Trainings – LIFE Capacity Building in Hungary) and members of local authorities (Mining and Geological Survey of Hungary).

2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Geographical conditions

Hungary is located in Central Europe; the neighbouring countries are Austria, Croatia, Romania, Serbia, Slovakia, Slovenia and Ukraine. Geographically Hungary is mostly flat terrain, with some hills and low mountains. The Danube and the Tisza are the two main rivers of the country; the largest lake is Lake Balaton. The capital city of Hungary is Budapest, with approximately 1.7 million inhabitants. Other major cities are Debrecen, Miskolc, Pécs, Szeged, Győr with around 100-200 thousand inhabitants. Hungarian is the official language.

The area of the country is 93,033 km2, of which 57, 4% is agricultural area (46, 5% arable land, 2,5% garden, orchard and vineyard, 8,4% grassland), 20.9% forest, 0.9% reed and fish-pond, 20,7% uncultivated land area.

Hungary is a longstanding parliamentary democracy, one of the leaders of political and economic transition in the region. Hungary became the member state of the European Union in 2014.

The administration is based on a regional system of 19 counties (each subdivided into subregions) and the capital city; there are 20 NUTS third-level units of Hungary, and 7 regions qualifying as NUTS second-level units of Hungary.

There are also 23 towns with county rights, the local authorities of these towns have extended powers, but these towns belong to the territory of the respective county instead of being independent territorial units. Figure 2.1. provides an administrative map of Hungary.

Figure 2.1. Map of Hungary
Source: ezilon.com

Approximately half of Hungary's landscape consists of flat to rolling plains of the Carpathian Basin: the most important plain regions include the Kisalföld (Little Plain) in the west and the Alföld (Great Plain) in the southeast. The highest elevation of the latter is only 183 meters above sea level (Hoportyó).

Transdanubia is a primarily hilly region with a terrain varied by low mountains. These include the very eastern stretch of the Alps (Alpokalja) in the west of the country, the Transdanubian Mountains, in the central region of Transdanubia and the Mecsek Mountains and Villány Mountains in the south.

The highest mountains of the country are located in the Carpathians: these lie in the northern parts; in a wide band along the Slovakian border (highest point is the Kékes at 1,014 metres).

Hungary's main river, the Danube ("Duna") divides the country into two parts, other large rivers are the Tisza and Dráva, while Lake Balaton is located in Transdanubia, which is a major body of water. Lake Hévíz, one of the largest thermal lake globally, is also located in Hungary. The second largest lake in the Carpathian Basin is the artificial Lake Tisza ("Tisza-tó").

2.2. Climatic conditions

The climate is characterised as temperate, with cold, humid winters and warm summers. Three climatic zones: continental, oceanic and mediterranean climates affect the country's conditions. Hungary is Greenwich Mean Time plus one hour.

Hungary has a continental climate, with hot summers with low overall humidity levels but frequent showers and frigid to cold snowy winters. The average annual temperature is between 10 and 11 °C (50-52 °F). Recorded temperature extremes are about 42 °C (107.6 °F) in the summer and −34 °C (−20.2 °F) in the winter. The average temperature in the summer falls between 27 °C (80.6 °F) and 35 °C (95 °F) and in the winter it varies from 0 °C (32 °F) to −15 °C (5.0 °F). The average yearly rainfall is approximately 600 mm (23.6 in).

Due to climate characteristics, the primary foreseen impact of climate change is precipitation change, floods and drought.

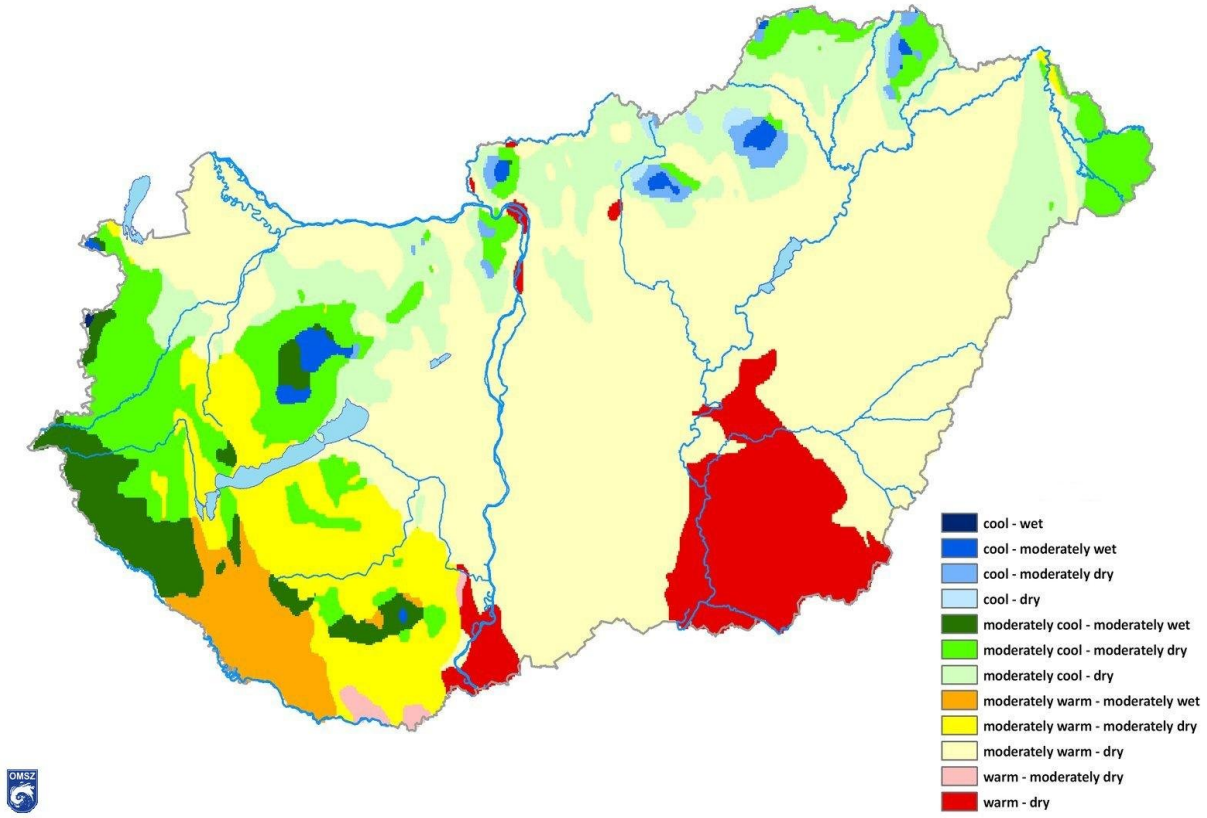


Figure 2.2. Climatic conditions of Hungary
Source: Hungarian Meteorological Service
http://www.met.hu/en/eghajlat/magyarorszag_eghajlata/altalanos_eghajlati_jellemzes/altalanos_leiras/

2.3. Population

At the beginning of 2009, the population of the country was 10.028 million, of which 6.81 million people lived in urban areas. The recent micro-census concluded in 2016 shows that the population dropped under 10 million souls (9.804M in 2016) with an expected lifetime of 72.2 years for males, and 79.8 years for females.

The density of population was 105,4 inhabitants/km^2 in 2016. Between 1970 and 2009 the population decreased by about 300 thousand people. The population peak was in 1980, with 10,7 million inhabitants, since then a uniform decreasing tendency is showing. The age structure of the population is shown on Figure 2.3. This shows that there is a definite aging process in the Hungarian society stemming from decreased childbirths and marriages.

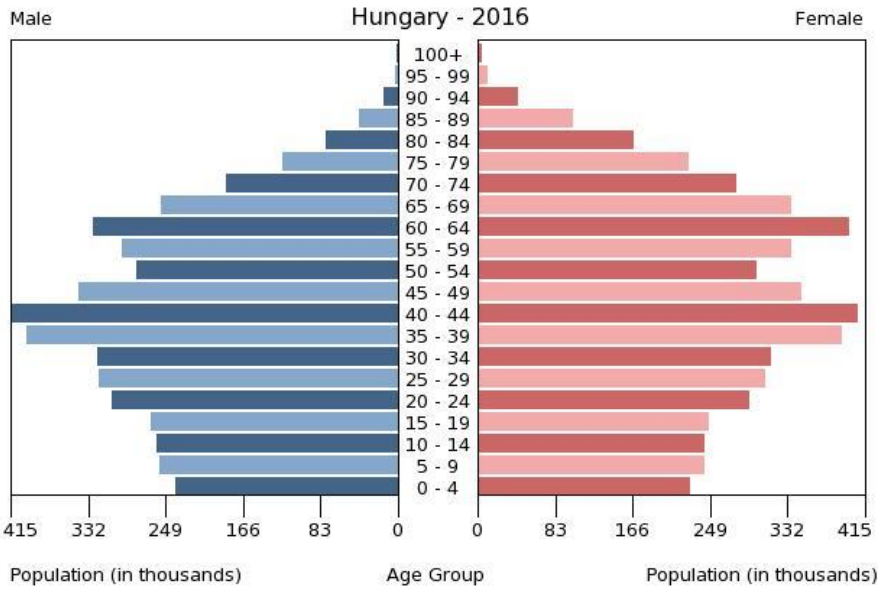


Figure 2.3. Population pyramid of Hungary, 2016
Source: CIA World Factbook, 2017

Figure 2.4. shows the changes of population between 1870 and 2016. The population number in the present territory of Hungary has doubled since 1870. During the Second World War, the population declined, but, due to the significantly increasing number of births in the 1950s, more than 10 million people were enumerated at the 1970 population census. The population number peaked in 1980, and has been decreasing since that time. In 2016, 9.8 million people lived in Hungary.

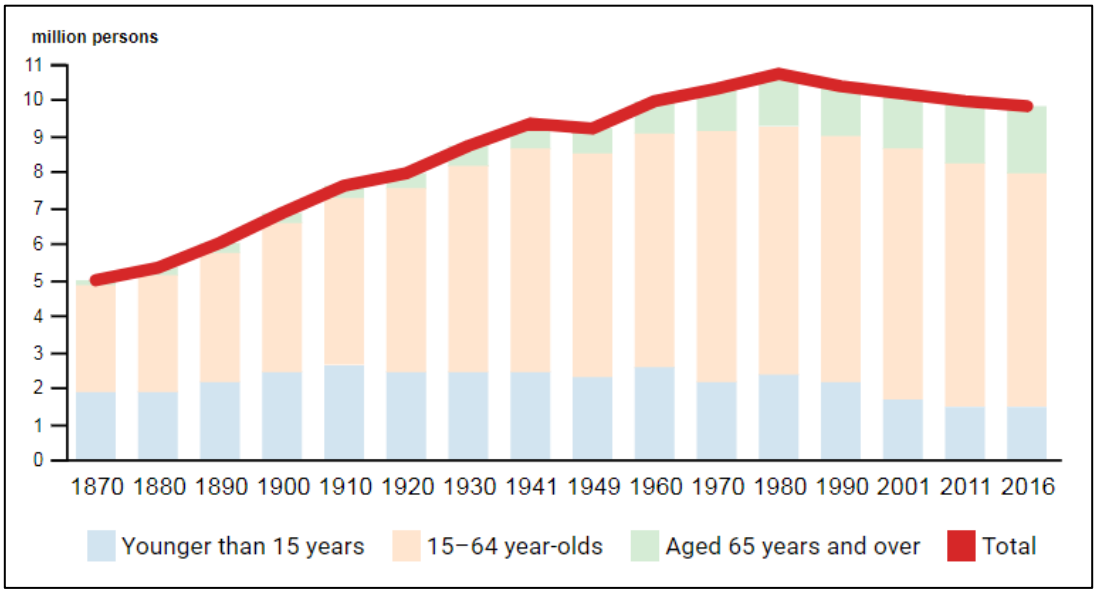


Figure 2.4. Population dynamics in Hungary, 1870-2016
Source: Hungarian Central Statistical Office (KSH)

In Hungary, the number of the child population in 2016 was the lowest since the first census of 1870. The number of children younger than 15 years was more than 2.6 million in 1910 and nearly 2.3 million after the Second World War, which, following the population policy

measures of the 1950s, rose again to over 2.5 million by 1960. The number of births fell significantly from the 1970s until 2011, so the number of the child population was only slightly more than 1.4 million in 2016. The government is trying with full effort to turn this harmful tendency but strong economic incentives would be required.

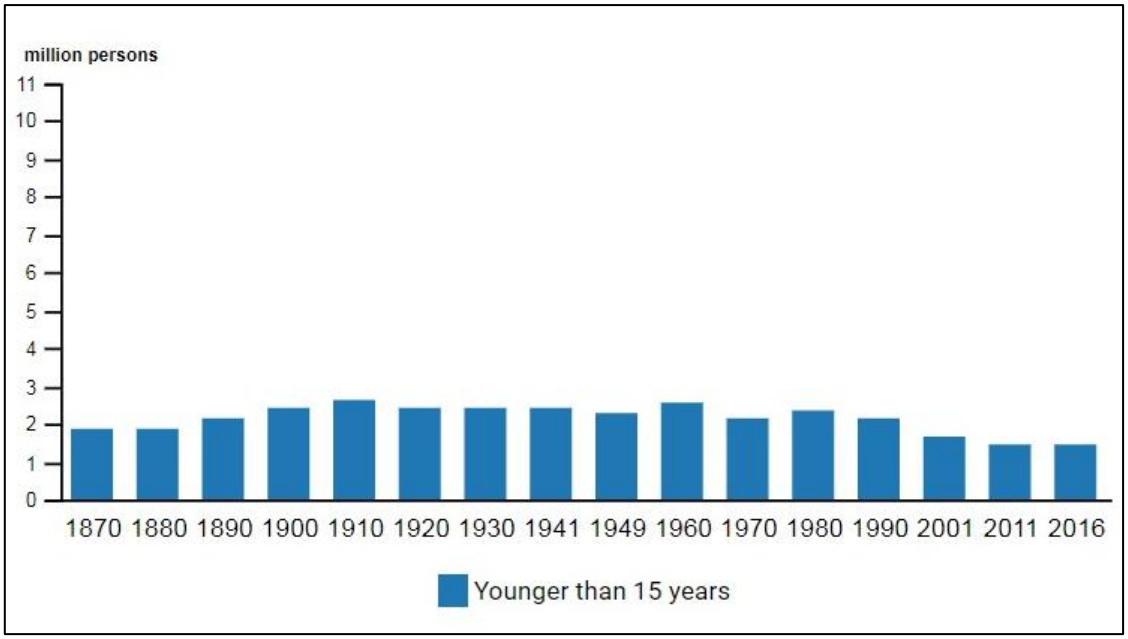


Figure 2.5. Ageing index
Source: Hungarian Central Statistical Office (KSH)

The ageing index shows the number of old-age people per hundred children (people aged 65 years and over per hundred 0–14 year-olds). The ageing age structure of the population is indicated by the steep upward curve of the indicator. The number of old-age people per hundred children was 8 in 1870 and 128 in 2016.

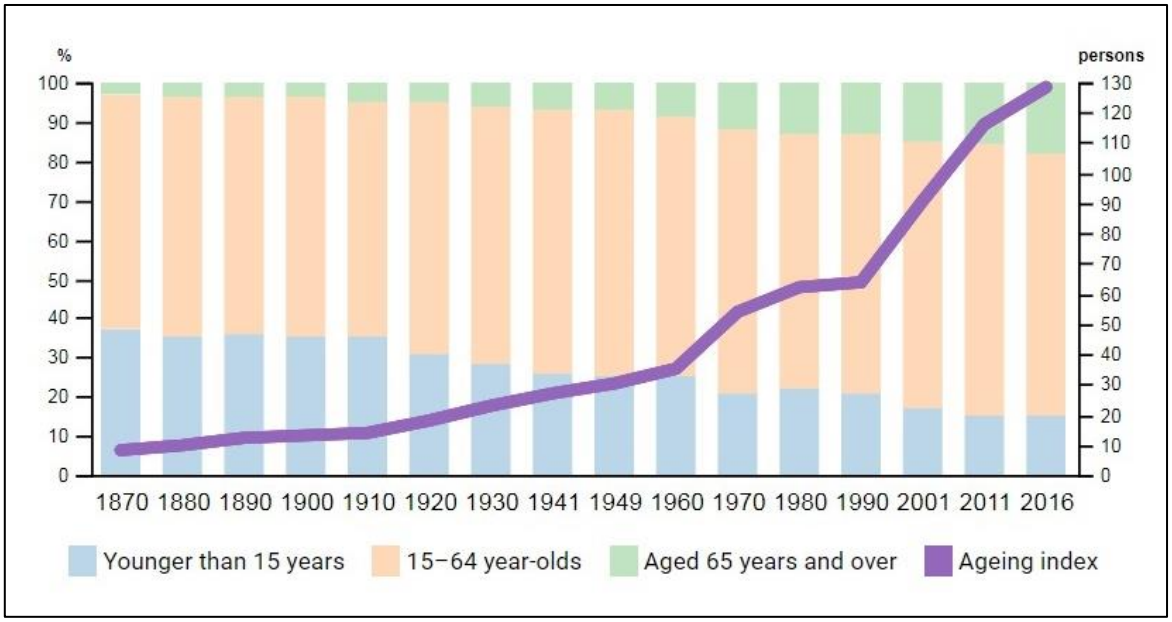


Figure 2.6. Ageing index
Source: Hungarian Central Statistical Office (KSH)

For historical reasons, significant Hungarian minority populations can be found in the surrounding countries, most of them in Romania (in Transylvania), Slovakia, Serbia (in Vojvodina). Sizable minorities live also in Ukraine (in Transcarpathia), Croatia (mainly Slavonia) and Austria (in Burgenland). Slovenia is also host to a number of ethnic Hungarians and Hungarian language has an official status in parts of the Prekmurje region. Today, more than two million ethnic Hungarians live in the neighbouring countries.

2.4. Governmental structure

The President of the Republic, elected by the members of the Parliament has mostly a formal role, but he is nominally the Commander-in-Chief of the armed forces and his powers include the nomination of the Prime Minister who is to be elected by the majority of the votes of the Members of Parliament, based on the recommendation made by the President of the Republic.

Due to the Hungarian Constitution the Prime Minister has the executive power as he appoints Cabinet ministers and has the exclusive right to dismiss them (similarly to the competences of the German federal chancellor). Each cabinet nominee appears before one or more parliamentary committees in consultative open hearings, come through a vote by the Parliament and must be formally approved by the President.

The unicameral 199-member National Assembly ("Országgyűlés") is the highest organ of state authority, it initiates and approves legislation sponsored by the Prime Minister. Its members are elected for a four year term. The election threshold is 5%, but it only applies to the multi-seat constituencies and the compensation seats, not the single-seat constituencies.

A 15-member Constitutional Court has power to challenge legislation on grounds of unconstitutionality.

Hungary has undertaken significant government restructuring including the creation of a sovereign State Secretariat of Development, Climate Change and Key Public Services, established under the Ministry of National Development. Two aides of the State secretary, the Deputy State Secretary for Green Economy, Climate Policy and Key Public Services and the Deputy State Secretary for Environment and Energy Efficiency Operational Programmes work within this State Secretariat.

Climate change policy is underpinned by the National Climate Change Strategy for 2008 – 2025 (NCCS I), superseded by the Second National Climate Change Strategy (NCSS II) in 2013. The energy sector is governed by the long-term National Energy Strategy of Hungary for 2030, the National Action Plan for Renewable Energy for 2020 and the National Energy Efficiency Action Plan for 2020 and the National Strategy for the Energy Performance of Buildings (2015).

2.5. Settlement structure and building stock

Hungary is administratively subdivided into 20 regions, which are the 19 counties and the capital city of Budapest (independent of any county government). There are 3,154 municipalities in Hungary[2], which are responsible for the provision of most local services, including the operation of schools, kindergartens, welfare and healthcare facilities, some office buildings and museums. The operation of these institutions includes supplying energy, except for some hospitals where the running costs are paid for by the central social security fund. Many of Hungary's district heating systems are also owned by municipalities.

Of the 3,154 municipalities, only 23 are considered to be major metropolitan areas and over 2,800 are villages. Outside Budapest, the largest municipality in Hungary is Debrecen, with a population of 200,000 inhabitants. The type and number of public buildings is shown in Table 2.1**.**

Type	**Total** *2016*	**Pre 1900** *(%)*	**1901-1959** *(%)*	**1960-1989** *(%)*	**After 1989** *(%)*
Educational	12485	9,7	31,8	48,0	10,5
Cultural	5169	13,7	36,8	40,0	9,6
Sport	2454	na	na	na	na
Health Service	3771	4,2	28,0	54,2	13,6
Social	2313	8,9	35,7	42,2	13,1
Health + social service	6084	6,0	31,0	49,7	13,4
Trade, Service and Administration	8495	9,3	33,2	47,3	10,2

Table 2.1. Type and age of public buildings
Source: Hungarian Central Statistical Office (KSH), 2015

Residential flats

The data available on the residential housing stock is from the Housing Survey census undertaken in 2015 by the Central Statistical Office of Hungary.

The number of inhabited flats in dwellings was 3.9 million, of which approximately 20-20% were found in the capital cities and the larger urban areas, 33% in other smaller cities and 26% in villages and smaller settlements. Proportion of flats in houses was 63%, in block houses 20% and 17% in building associations 17%, respectively. 27% of the dwellings were built before 1960, 7% originates from before World War I. The major part of the present dwellings, approximately 1.5 million flats were built between 1960 and 1980. Privately owned dwellings ratio is 92%, the number of municipality owned flats is decreasing, around 500,000 flats are in mixed ownership (private-municipal building management). More than 2/3 of the families live in individual buildings (family houses, conventional rural houses).

The decreasing population and the receding number of newly built dwellings result in the decrease of inhabitation intensity, which is reflected in the number of dwellers per 100 flats.

[2] Magyarország településhálózata 2., Városok – falvak, KSH, 2015

This indicator decreased from 274 in 1990 to 226 in 2012. The share of flats built in new family houses decreased to 47.1% by the end of 2004 from 69.3% in 1990 and the share of dwellings in new multi-storey buildings increased to 33.7% by the end of 2004 from 13.9% in 1999. Further data is shown in Table 2.2.

(in 1000 units)	**1999**	**2003**	**2005**	**2012**	**2015**
Total dwellings	3980	4134	4209	4402	4428
Municipality owned dwellings	213	181	117	106	123
Privately rented	119	113	129	129	233
Dwellings inhabited by owner	3494	3450	3641	3582	3431
Empty private dwellings	135	313	212	354	545
Empty municipal dwellings	19	14	14	11	15
Other		91	38	37	61
Population (1000 souls)		10117	10077	9909	9830
Number of inhabitants/dwellings		2,45	**2,39**	**2,26**	**2,21**
Total flats in dwellings		4134	4209	4402	4428

Table 2.2. Flats and dwellings structure in Hungary from 1999 to 2015
Source: Hungarian Central Statistical Office (KSH), 2015

The construction of new dwellings and the widespread appearance of modern household appliances (air-conditioning, dryer-washers, plasma TVs, etc.) are important factors towards increasing energy consumption.

2.6. Economy

Hungary is a market economy; it has a highly internationalised and export-oriented business sector and a stable macroeconomic situation. A structural economic crisis began in the second half of the 1980s, which was followed by the transformation of the whole economic and political system in 1990. This process towards market economy resulted in transformational recession and the economic depression that lasted till 1995. Since then the economy began to develop and the growth rate of the Hungarian economy exceeded the EU average. In 2004 Hungary became the member of the EU. The crisis hit hard the Hungarian economy in 2009 but the recovery started soon and the economy is now on a path of sustainable growth.

Hungary's GDP per capita in Purchasing Power Standards (PPS) was more than 68.3% of the EU-28 average in 2016. The private sector accounts for more than 80% of GDP. Foreign ownership and investment in Hungarian firms are widespread, with foreign direct investment stock totalling more than $75 billion in 2016.

	2008	2009	2010	2011	2012	2013	2014	2015	2016
GDP volume index (previous year = 100%)	100.9	93.4	100.7	101.7	98.4	102.1	104.2	103.4	102.2
Unemployment rate (%)	7.8	10.0	11.2	11	11	10.2	7.7	6.8	5.1
Inflation rate (%)	6.1	4.2	4.9	3.9	5.7	1.7	-0.2	-0.1	0.4
Balance of general government /GDP (%)	-3.6	-4.6	-4.5	-5.5	-2.3	-2.6	-2.1	-1.6	-1.8

Table 2.3. Main economic indicators of Hungary in 2008-2016
Source: Hungarian Central Statistical Office (KSH), 2017

Macroeconomic environment

Considering macroeconomic trends it can be stated that the recession experienced in 2009 hit hard the Hungarian economy: economic activity and production plummeted in 2009 reaching its low in the middle of the same year. The recession turned to a slow growth in 2010 and 2011 however the crisis of the Eurozone inferred a highly unfavourable international economic environment significantly decreasing the growth rate of the Hungarian economy and turning it into a minor recession by 2012. From 2013 the economy has been on a healthy track, the external and internal conditions are improving.

Hungary's macroeconomic situation is stable, and the economy has been on a sound path: the government debt declines, the inflation is moderate and the country shows a positive balance of trade since 2009. Hungary showed robust GDP growth in recent years: in 2016, GDP was up by 2.2%, which growth rate was similar to the OECD average. The main economic indicators of the last years are shown in Table 2.3.

Employment

Since the peak of unemployment in 2010 Hungary's labour market has been characterised by positive trends. In 2017 Q2 the unemployment rate (in the age group of 15-64 years) was down to 4.3% and it is much lower than the EU average (which is 7.6%).

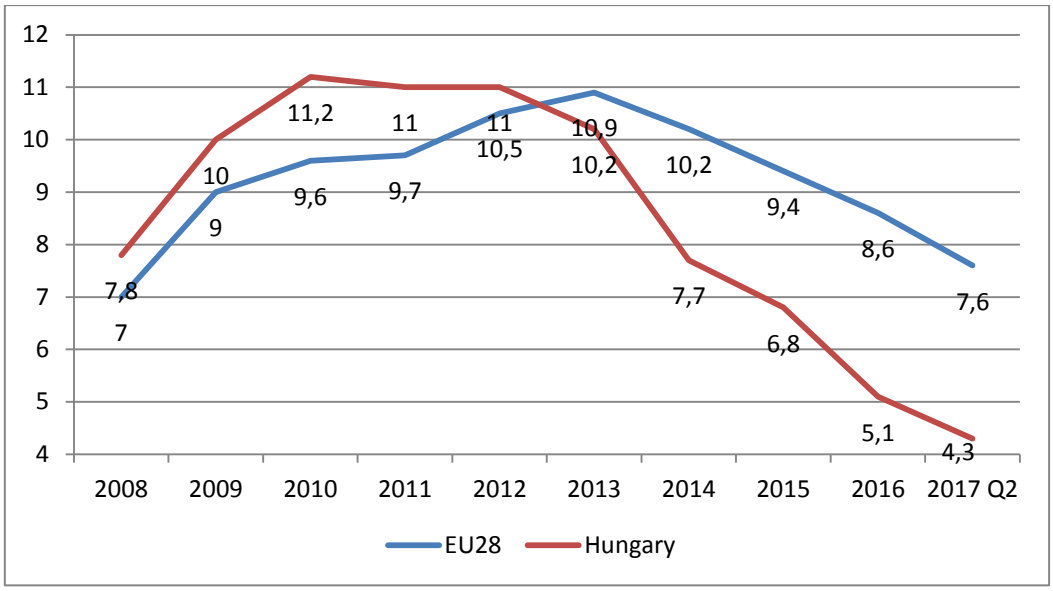


Figure 2.7. Unemployment rate in Hungary and in EU28
Source: Eurostat, 2017

The employment rate is constantly rising; it was 71.5% in 2016 regarding the population aged 20-64. The trend is in line with the headline objective of the Europe 2020 strategy, according to which the employment rate in the EU member states should reach 75 percent.

Financial assets and wealth of households

The gross wealth of households has increased steadily since 2008. Household savings are potential financial resources for other economic actors and thus they also underpin the macro-economic stability.

Year	Annual terminal figures (billion HUF)	Annual terminal figures (billion EUR)
2008	15 459.5	61.5
2009	17 472.4	62.3
2010	18 392.8	66.8
2011	19 822.7	71,0
2012	22 453.8	77.6
2013	25 019.7	84.3
2014	28 312.2	91.7
2015	32 561.8	105.1
2016	35 851.7	115.1
2017 Q1	36 725,4	118,97
2017 Q2	37 476.8	121.3

Table 2.4. Net financial assets of households
Source: Central Bank of Hungary (MNB), 2017

The rising value of financial assets is partly attributable to the upward wage trend. In 2017 Q2 gross monthly wages in Hungary averaged 967.3 euro up by 50% since 2008. This

growth was caused partly by the 15% minimum wage and the 25% guaranteed minimum wage hikes, as well as further wage increases in the public sector.

Inflation

Hungary's inflation was traditionally high until the beginning of the 2010s, when the effects of Government measures and a couple of positive global economic trends (such as declining raw materials prices) had kicked in and fundamentally changed the situation. In the recent years the rate of inflation remained moderate.

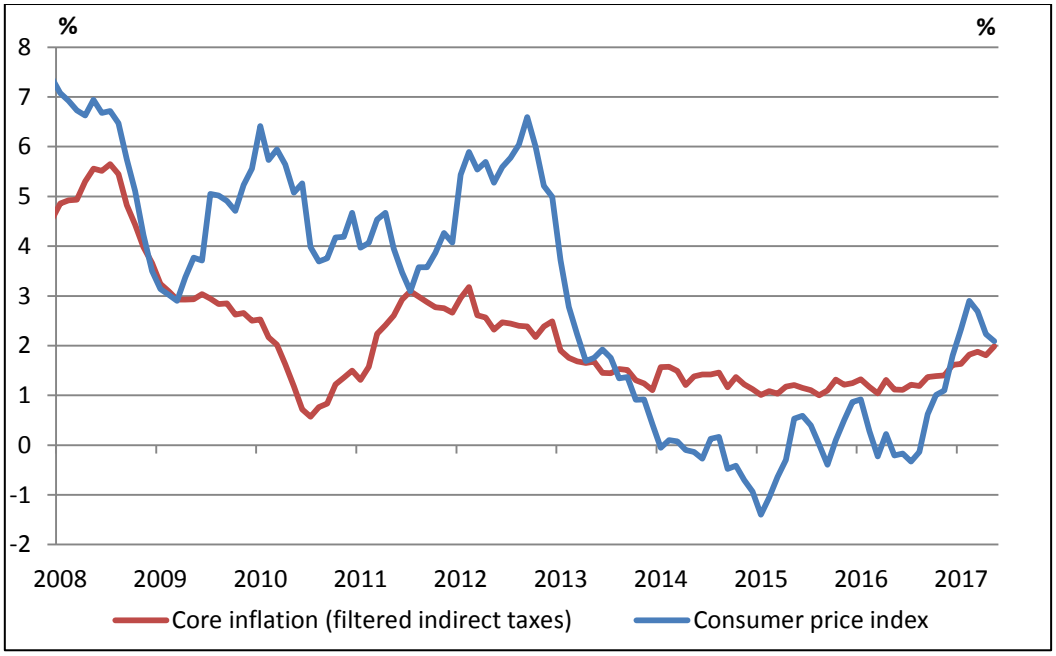


Figure 2.8. Inflation trends in Hungary
(monthly core inflation and consumer price index, year-on-year)
Source: Central Bank of Hungary (MNB), 2017

In a small and open economy like Hungary, international trends typically influence inflation level. Within the European Union, the rate of inflation has been also low and it helps to maintain the modest Hungarian level. On the other hand, the domestic environment is also favourable. In spite of the accelerating wages (which typically translate into consumption growth and turn lifting inflation) the rate of inflation is going to be moderated as the savings rate of households also soars.

Entrepreneurial sector

In 2015 the number of active enterprises was 669 thousand of which 290 thousand were private entrepreneurs and 379 thousand companies with legal entity. The proportion of SMEs in Hungary is 99.9% of total enterprises and the remaining 0.1% (898 units) consists of enterprises with more than 250 employees. Despite this, 27.2% of employment and 45.3% of total added value come from large enterprises.

Current account balance and financing

The current account balance had turned positive in 2009 and it continued to improve ever since.

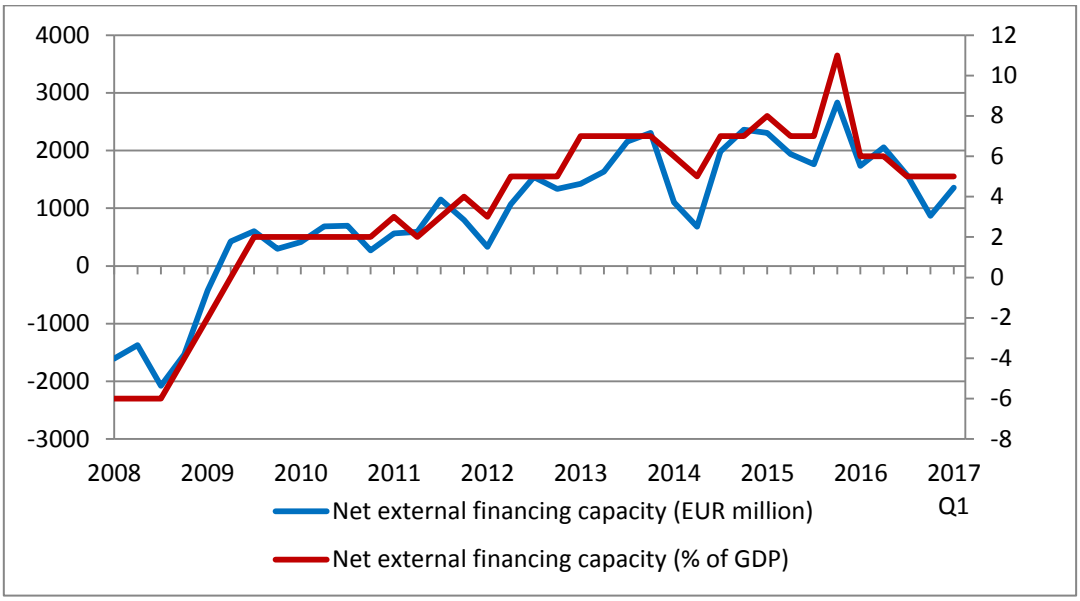


Figure 2.9. Net external financing capacity
(left-hand side axis: EUR million, right hand side axis: % of GDP)
Source: Central Bank of Hungary (MNB), 2017

The declining state debt trend prevalent in recent years resulted in a gross government debt-to-GDP ratio of 74% (2017 Q2) from 84% in 2010. Hungary's net external debt decreased by some EUR 0.75 billion in the first quarter of 2017, thanks mainly to the ongoing downward trend concerning the Hungarian government securities holdings of non-residents and to the concurrent high demand for these assets by resident investors. Data from the past years show that the Hungarian economy has been financially stable; it has been growing dynamically and has a massive savings surplus. The country's position is also favourable from a regional aspect, and the exposure to external risks has been decreasing. The main factors behind this phenomenon are household savings and tight caps on the expenditure side of the state budget.

External trade

Due to its export orientation Hungary's economy is characterised by an increasing openness to the global economic system. The improvement of trade balance that started in 2009 resulted in record high surpluses in the last two years: in 2016 the total external trade balance accounted for 10.3% of the Hungarian GDP. The key driving forces of external trade are basically the transport equipment and related industries. In 2016 79% of Hungary's export was conducted with EU member states and 78% of the import came from the single market. The German economy has an outstanding role in this circle: in last year 27% of our exports and imports were transacted with Germany. Our other important export partners are Romania, Slovakia, France and Italy, while on the import side Germany is followed by Austria, Poland, Slovakia, and China. Following the global economic crisis that brought about

a significant drop in our exports and imports, from 2010 there has been a continuous increase in the volume of our external trade.

The figures for 2016 show a moderate increase with year-on-year growth rates of 4.4% and 4.9% for the exports and imports, respectively. Import volume of energy carriers decreased by 2.9%, accompanied with an 18.8% drop in energy prices which significantly decreased the value traded in this commodity subset. Export of energy carriers decreased by 4.2% over the previous year (although on a much smaller basis). Services show a stable growth: between 2010 and 2016 value of traded services grew by 53%.

Industry

Industry is in the focus of the Hungarian economic policy. The Irinyi Plan (published in 2016) aims to raise the Hungarian industrial sector's contribution to the annual GDP from 26.0% (in 2016) to 30% by 2020. According to this Plan Hungary wants to be among the EU countries with the most highly developed industrial sectors by 2020. Manufacturing sector constituted 24% of GDP in 2016. It has seen massive output growth in recent years (by 42% compared to 2008) – the rate of growth exceeded the EU average (13.5%).
The bulk (95%) of Hungary's industrial sector output is generated by the manufacturing sub-sectors. The energy sector and mining accounts for 5% and 0.2% regarding the total economy. In terms of output value, the output of the transport equipment sector is 29% of total industrial output. Companies with the largest incomes are operating in the following manufacturing sectors: transport equipment, computer, electronic and optical products and food, beverages and tobacco products.

Meanwhile the value of gross value added in agriculture, forestry and fishing sector was 4.4%, the proportion of market services was 44.2% and the non-market services was 21% in 2016.

Sectors	Share in total
Manufacturing	31.7%
Real estate activities*	15.4%
Transportation and storage	13.3%
Wholesale and retail trade, repair of motor vehicles and motorcycles	6.7%
Agriculture, forestry and fishing	5.2%
Public administration and defence, compulsory social security	4.4%
Information and communication	3.8%
Electricity, gas, steam and air-conditioning supply	3.5%
Administrative and support service activities	2.8%
Arts, entertainment and recreation	2.2%
Professional, scientific and technical activities	2.1%
Water supply, sewerage, waste management and remediation	1.8%
Education	1.7%
Construction	1.6%
Accommodation and Food service activities	1.0%
Human health and social work activities	1.0%
Other services	0.8%
Financial and insurance activities	0.8%
Mining and quarrying	0.2%

Table 2.5: Investments of national economy by sector in 2016 (industrial sectors with italic)
Source: Hungarian Central Statistical Office (KSH), 2017

The share of industrial sectors in total investments accounted for 37% in 2016. 31.7% of the investment was materialised in manufacturing; electricity, gas, steam and air-conditioning supply accounted for 3.5%; the share of construction was 1.6% and the role of mining and quarrying was even minor. The high share of industrial sectors in total investments (which is much more than its value in the GDP) predicts an advanced growth of industrial sectors which is in line with the objectives of the Government.

Future prospects

The following table summarises the fundamental indicators of the Hungarian economy and a forecast based on the Convergence Programme. The outlook is highly promising as in the next years the growth is predicted to be around 4%, fuelled by accelerating productivity, investments and private consumption, while governmental consumption and net lending is expected to remain modest – thanks to which the governmental debt is on a decreasing path.

	2017	2018	2019	2020	2021
	% change				
Real GDP (constant prices)	4.1	4.3	3.8	3.7	3.6
Gross fixed capital formation	10.2	12.9	7.8	6.8	6.1
Private consumption expenditure	6.1	5.4	4.4	4.3	4.1
Government consumption expenditure	0.8	1.0	0.7	0.0	0.0
Exports of goods and services	5.4	6.5	6.0	6.2	6.9
Imports of goods and services	6.8	8.2	6.7	6.6	7.1
Employment (15-74)	2.5	1.8	1.2	0.8	0.4
Labour productivity	1.5	2.4	2.6	2.9	3.2
Compensation per employee (HUF million)	6.6	6.9	5.8	6	5.0
	% of GDP				
Gross debt	72.0	70.5	67.3	64.0	61.2
General government net lending	-2.4	-2.4	-1.8	-1.5	-1.2
General government primary balance	0.5	0.2	0.8	1.0	1.2
Balance of goods and services	8.4	6.9	6.3	6.1	5.9
Balance of primary incomes and transfers	-4.1	-3.9	-3.9	-3.7	-3.5
Capital account	3.1	4.2	3.5	1.8	1.7
	%				
Harmonised Index of Consumer Prices	1.6	3.0	3.0	3.0	3.0

Table 2.6. Macroeconomic prospects 2017-2021

Source: Convergence Programme of Hungary, 2017–2021 April 2017

According to trends employment rate is expected to increase gradually and is going to reach the EU 2020 target of 75%. Higher employment is associated with higher wages which further increase household savings too. Regarding the external trade, in the next few years more dynamic annual growth rates of exports and imports can be expected stimulated by new export-oriented investments and favourable global economic environment. Due to higher increase in imports, a lower balance of goods and services can be foreseen.

2.7. Energy

Country-specific trends

Security of supply - Hungary is heavily dependent on energy imports. The gas dependency is close to 80%, and is increasing, because the domestic production decreases more rapidly than the demand. Similarly, the oil dependency is also high, 82-84%, and the domestic production is falling. It is not only the import dependency, which causes vulnerability for Hungary, but also the unilateral character of it. The major part of the import, and practically all the gas originates from Russia, even if a part of it is transported to Hungary through the

European network. Then it is not surprising that the key message of the Hungarian energy policy is seeking ways out of our energy dependency, in particular natural gas and petroleum dependency. The five means to achieve the above goal include energy savings, increasing the share of renewable energy sources to the greatest possible level, safe nuclear energy and the electrification of transport on the basis of the former, diversification of source countries and transite routes safeguarding Hungary's natural gas and oil import, and last but not at least, utilising domestic fossil energy reserves (coal, lignite, unconventional natural gas) in an eco-friendly manner involving BATs and R&D in the field of clean coal technologies (zero carbon power plants, carbon capture and reuse) for future power generation.

Energy and carbon intensity - In the 27 years since the fall of Communism, the Hungarian economy has undergone a fundamental structural change, resulting in a rapid decline of energy-intensive industries and the setback of material and energy utilisation to the level of the 1970's. At the same time, because of the commissioning of Paks Nuclear Power Plant in the late 80's, the decommissioning of nearly all coal-fired power plants, and because of the fast spread of natural gas in the residential and public heating, replacing coal, the GHG intensity (-40% from 1990 to 2015) and the environmental pollution of the energy sector decreased markedly up to the present day. At the same time, the energy efficiency has increased because of the need for increasing cost-efficiency in the market-driven economical environment. Compared to 1990, the gross inland consumption of energy declined until 2013 by 18% then a slight increase could be observed during the subsequent two years resulting in a 12.5% cumulated drop within this time period. Examining data of gross domestic product (GDP) along the same time period shows that economic growth and energy consumption is successfully decoupled in Hungary (Figure 2.10.).

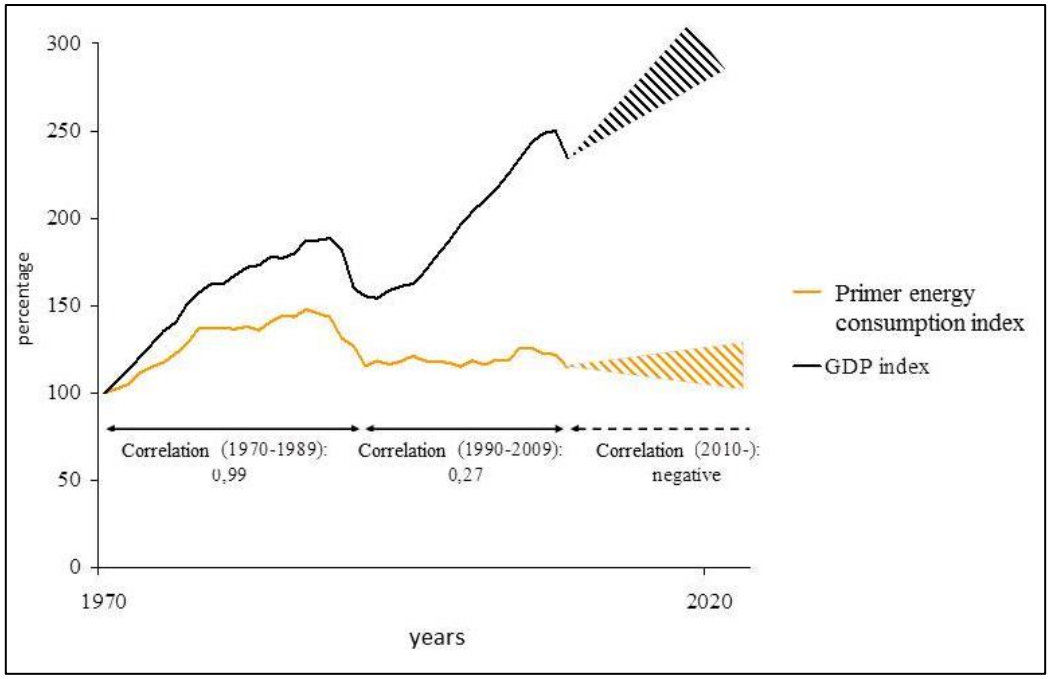


Figure 2.10. The economic growth and energy consumption is successfully decoupled in Hungary
Source: National Energy Strategy 2030

The decreasing tendency of energy consumption is accompanied by a 36.7% increase in GDP between 1990 and 2015, resulting in a decrease in energy- and carbon intensity (-20.8% between 2000 and 2015) that are now roughly equivalent to the IEA average.
Due to the nature of the Hungarian energy sector, the improvement of energy saving and energy efficiency should be treated as a priority, as it holds the greatest potential for maintaining the level of primary energy demand and reducing import dependency. The entire supply chain must be taken into consideration in order that the level of primary energy use can be maintained through the improvement of energy efficiency, as the collective result of technological solutions, economic incentives and social awareness-raising. The three most important elements of the energy efficiency improvement plans are the following:

- Thermo retrofitting of buildings and the modernisation of heating and cooling systems;
- Installing high efficiency new-, and modernisation of existing electric power stations;
- Implementation of Ányos Jedlik Plan targeting a modal shift towards an ambitious electrification of the transport sector;

Renewables – As an EU Member State, Hungary is subject to a binding target of 13% of energy from RES by 2020. However, in its National Renewable Energy Action Plan (NREAP), approved in December 2010, the Hungarian Government set an even more ambitious target of 14.65%. The 2010 target of 3.6% was actually achieved in 2007, mainly due to biomass, which accounts for around 80% of the country's renewable energy. Thanks to the targeted supporting schemes (METÁR, Environmental and Energy Efficiency OP, etc.) and measures, the recent share (2015) of RES in the gross inland energy consumption is 14.47%, close to our commitment. Nevertheless, further efforts are needed to reach Hungary's 2030 targets in spreading RES applications. Therefore time has come finding the path for a further growth involving alternative renewable energy sources other than biomass. Various estimates have been published in recent years concerning the size of the Hungarian renewable energy potential and the exploitable supply. One of the most comprehensive studies was conducted by the Renewable Energy Subcommittee of the Hungarian Academy of Sciences in 2005 and 2006. It should be noted that the results of the survey concerned the total or theoretical potential of Hungary. On that basis, the total domestic renewable potential is estimated to amount to 2,600-2,700 PJ/year, approximately 2.5 times our current primary energy use. The potential assessed by the study is a theoretical figure, indicative of the country's renewable energy potential (Table 2.7.).

Renewable energy sources	Potential (PJ)
Solar energy	1,838
Hydro energy	14.4
Geothermal	63.5
Biomass	203-328
Wind energy	532.8
Total	**2,600-2,700**

Table 2.7. – Hungary's renewable energy potential

Source: GKM 2008 – Strategy for increasing the utilisation of renewable energy sources in Hungary, 2008 to 2020

Compared to the theoretical potential, the realistically exploitable potential is considerable lower, depending on the actual technology and economy considerations. The theoretical maximum figures demonstrate that in Hungary, solar energy can potentially yield the highest amount of renewable energy. Knowing the limited flexibility of the Hungarian electricity system (the electricity production is dominated by base-load providing big central power plants, the regulatory options are based on smaller gas-fired units) solar energy holds the potential for higher prevalence, because its decentralized or family-level application does not necessarily requires grid connections like wind turbines do. Recognizing these benefits, the future expansion of renewable energy applications will be based on solar energy rather than the actual biomass-dominated renewable energy landscape.

Key data

Energy use per capita: 2.5 toe (OECD average: 4.5), -1.7% since 2000

Energy intensity: 0.16 toe per 1000 USD (OECD average: 0.16), -20.8% since 2000

Total Final Consumption: residential sector 31%, industry 26%, transport 25%, commercial and agriculture 18% (OECD average: transport 32%, industry 32%, residential 19%, other 16%)

The Built-in Capacity: the built-in capacity of the Hungarian power plants generating interoperable electricity in the electricity system was 8,558 MW. The available capacity was 7,263 MW, including 2,966 MW and 4,297 MW controllable and non-controllable capacities respectively. Of the 8,558 MW built-in capacity, 7,006 MW was provided by 20 large power plants, whereas the remaining 1,552 MW was provided by small power plants of a capacity below 50 MW, powered mostly by gas or, to a smaller extent, by renewable energy sources.

Supply and demand

Domestic energy production accounts for 42% of the total primary energy supply (TPES) and the country is becoming more import dependent (Figure 2.11). Natural gas and oil are the largest primary energy sources and nuclear power accounts for the greatest share of electricity generation. Oil is used largely in the transport sector and natural gas represents the largest share of energy consumption in the residential and commercial sectors.

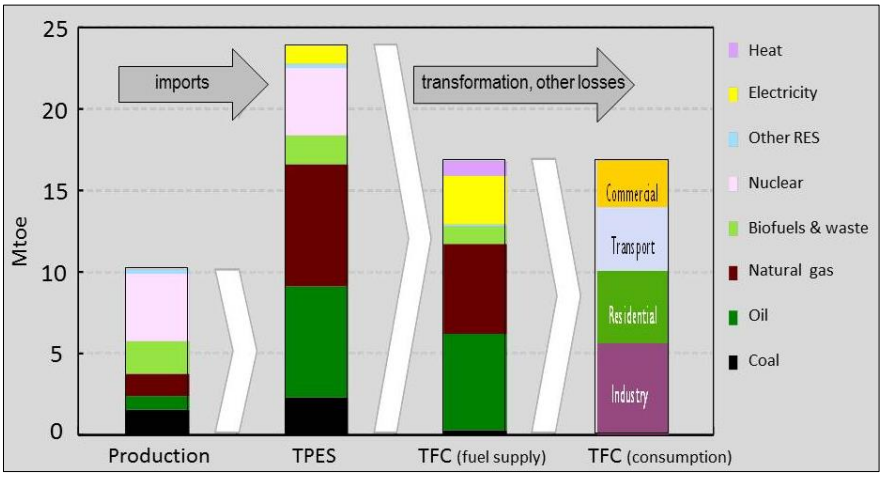


Figure 2.11. - Overview of energy production, TPES and TFC in 2014
Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

* Other renewables constitutes of small shares of wind, hydro, solar and geothermal

Supply

TPES has been slowly declining in Hungary since a 1987 peak of 31 Mtoe (Figure 2.12.), to 24 Mtoe in 2015. Between 2005 and 2015, TPES has fallen by 13%, despite a 6.5% rebound in the last two years. Natural gas and oil account for almost one-third of TPES each, with the remaining energy supply coming mainly from nuclear, coal and biomass.

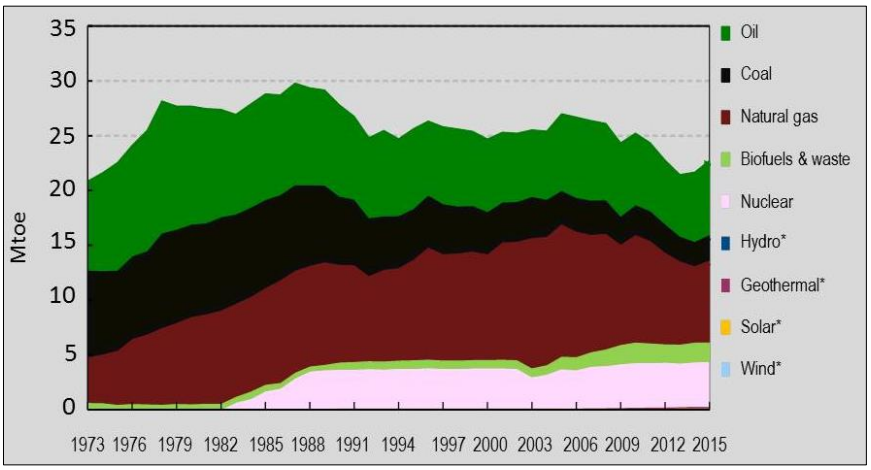


Figure 2.12. TPES, 1973-2015

Source: IEA (2016a), Energy Balances of OECD Countries 2016, www.iea.org/statistics/

Note: Data are estimated for 2015.
** Negligible*

Energy production peaked at 16.8 Mtoe in 1987 and has declined by 40% (Figure 2.13.) since. A major change to the production balance was the introduction of nuclear energy in the late 1980's. It has been the largest domestic energy source since 1996 and accounted for 41% of total production in 2015. As a result of capacity improvements in the nuclear power plants, nuclear energy output increased by 14% from 2005 to 2015.

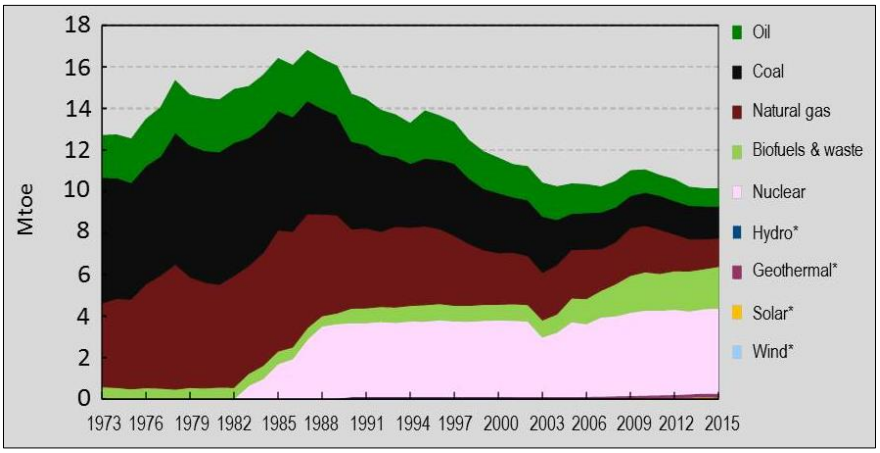


Figure 2.13. Energy production by source, 1973-2015

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Note: Data are estimated for 2015.
** Negligible*

Fossil fuel production has declined significantly over 40 years, from 15 Mtoe in 1978 to below 4 Mtoe in recent years. Coal production was 1.5 Mtoe in 2015, representing a decline of 12% since 2005. Natural gas and oil production both dropped by 41% over the same period to record lows of 1.4 Mtoe for natural gas and 0.8 Mtoe for oil. In 2015, biofuel and waste production was 2.0 Mtoe, an increase of 75% compared to 2005. Other renewable energy production is much smaller, with a total production of 0.25 Mtoe from geothermal, wind, solar and hydro in 2015. Energy production has declined faster than energy demand in Hungary, which has led to increased import dependency, especially for oil and natural gas. In 40 years, Hungary has gone from being almost self-sufficient in natural gas production to importing around 80% of its needs. Oil import dependency was higher in the past but has increased in the last decade from 80% in 2005 to 88% in 2015. Domestic coal production still meets about two-thirds of demand.

Demand

Total final consumption (TFC) of energy experienced a slight increase from the early 1990's until 2005 but has declined since. Between 2004 and 2014, TFC fell by 10%, despite a small increase in 2013 and 2014. The decline was a result of a fall in consumption in the residential and commercial sectors of approximately 30%. Industry accounts for one-third of TFC and has been the largest energy consuming sector since 2013 (Figure 2.14.) It increased its consumption by 18% in 2004-14. The transport sector accounts for almost one-quarter of TFC and consumption in this sector has been stable in the last decade.

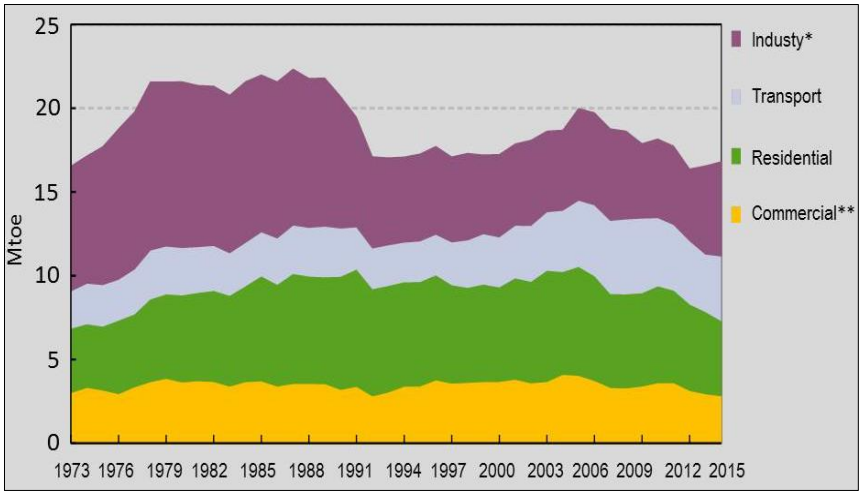


Figure 2.14. TFC by sector, 1973-2014

Source: IEA (2016a), Energy Balances of OECD Countries 2016, www.iea.org/statistics/.

* *Industry* includes non-energy use.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

Oil and natural gas are the largest sources of energy in final consumption, accounting for roughly one-third of TFC each. The transport sector is the largest oil consumer accounting for 61% of oil in terms of TFC in 2014, followed by the industry sector, which uses oil as a fuel and as a feed stock (Figure 2.15.). Natural gas and electricity are the main energy sources consumed in the residential, commercial and industry sectors.

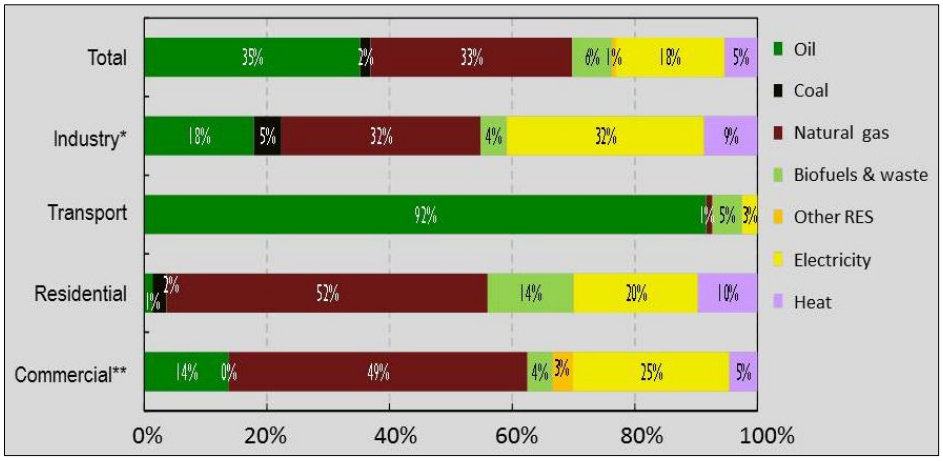


Figure 2.15. Fuel share of TFC by sector, 2014
Source: IEA (2016a), Energy Balances of OECD Countries 2016, www.iea.org/statistics/.

* *Industry* includes non-energy use.
** *Commercial* includes commercial and public services, agriculture, fishing and forestry.
*** Other renewables constitutes of small shares of wind, hydro, solar and geothermal.

Institutions

In Hungary, only central governmental organisations are involved in energy-related tasks. The Ministry of National Development is the lead energy policy institution. It is responsible for conventional energy resources (crude oil, natural gas, and coal), electricity and nuclear energy (except for the capacity maintenance at Paks Nuclear Power Plant). The Ministry is also responsible for renewable energy, climate policy and energy efficiency.

The Ministry for National Economy provides input to energy efficiency plans and handling the greenhouse gas (GHG) emissions rights. It is also responsible for electro-mobility plans and for energy efficiency in buildings.

In 2017, a Minister Without Portfolio was nominated for the capacity maintenance of the Paks Nuclear Power Plant also known as the Paks 2 project. The First National Public Utility Holding Company operates under the supervision of the Prime Minister's Office.

The Ministry of Foreign Affairs and Trade is responsible for energy security and diplomacy. The Hungarian Energy and Public Utility Regulatory Authority is responsible for reporting of statistics (energy, climate, and stocks), exercise regulatory oversight in the sectors and issuing relevant permits.

The Hungarian Atomic Energy Authority has regulatory oversight of nuclear facilities.

Hungarian Energy and Public Utility Regulatory Authority (HEA) is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. HEA's responsibility covers licensing, supervision, price regulation, tariff-and fee preparatory tasks in the fields of electricity, natural gas, district heating as well as in water utility supply, besides pricing of public waste management services. As the official statistical body, HEA also performs standard national energy-statistics related tasks and complies with the data reporting obligations to various national and international bodies and organisations.

The Hungarian Central Statistical Office is responsible for reporting of statistics. The National Research, Development and Innovation Office manages and supports public research, development and innovation funds and is responsible for Horizon 2020 planning. It also provides statistics on energy research expenditures. Mining and Geological Survey of Hungary manages a list of entities involved in geothermal activities and a list of natural gas/crude oil producers.

Policies and measures

European Union policies - Hungary's energy efficiency policies are guided by several EU regulations and directives. The Directive on Energy End-use Efficiency and Energy Services (2006/32/EC) seeks to encourage energy efficiency through the development of a market for energy services and the delivery of energy efficiency programmes and measures to end-users. The Directive requires member countries to create action plans and meet an indicative target to reduce final energy use in the sectors outside of the EU ETS by 9% from the early 2000s to 2016. The EU has also adopted a non-binding target for 2020 to reduce primary energy use in the Union by 20% from baseline projections. The Directive also sets the framework for measures such as financing, metering, billing, promotion of energy services, and obligations for the public sector. In addition, it requires member countries to place energy efficiency obligations on energy distributors or retailers.

The Directive on the Energy Performance of Buildings (EPBD, 2002/91/EC) sets requirements for energy efficiency in building codes, including minimum energy performance standards and energy certificates. A recast of the EPBD (2010/31/EU) was adopted in May 2010 to strengthen the energy performance requirements and to clarify and streamline some provisions.

Requirements for energy labelling of household appliances are based on several directives adopted over the past 15 years which also include compulsory minimum energy efficiency requirements (2009/125/EC). The recast Directive Establishing a Framework for Setting Ecodesign Requirements for Energy-related Products (Ecodesign, 2009/125/EC) aims to improve energy efficiency throughout a product's lifecycle. It applies to products that use energy and to products that have an impact on energy use, such as building components.

Recent EU transport policies aim to reduce CO_2 emissions from new passenger cars. In May 2009, the EU adopted Regulation EC/443/2009 to reduce CO_2 emissions from new passenger cars to reach a fleet average of 130 grams (g) CO_2/km by 2015. From 2020 on, this limit will be 95 g CO_2/km. The regulation will be complemented by measures to further cut emissions by 10 g CO_2/km. Complementary measures include efficiency improvements for car components with the highest impact on fuel consumption, and a gradual reduction in the carbon content of road fuels.

Another EU transport development is related to tyre labelling requirements. Regulation EC/1222/2009 seeks to harmonise information on the energy performance of tyres, wet braking and external rolling noise. It will apply to EU member countries from November 2012.

National policies

National Energy Strategy 2030

The current National Energy Strategy was adopted by the Parliament in 2011 (Parliamentary resolution 77/2011. (X.14.) OGY) and the final document was published in 2012. The fundamental goal of National Energy Strategy 2030 (NES 2030) is to seek ways out of Hungary's energy dependency. NES 2030 identifies five means to achieve this goal including greater energy savings and energy efficiency, increasing the share of renewable energy sources, maintaining existing nuclear energy capacity, closer integration with the Central European electricity and natural gas networks and construction of the required cross-border connections, and renew the government's energy institution system. NES 2030 also recognises that, for the time being, the country cannot afford to give up fossil fuels.

On this basis, NES 2030 presents a 'joint effort vision', which the government considers to be the most realistic objective to be implemented. It is represented by the 'Nuclear-Coal-Green' scenario of NES 2030 in terms of electricity generation. Its most important elements are as follows:

- the long-term preservation of nuclear energy in the electricity mix
- the maintenance of the current level of coal-based electricity generation
    - the extension of Hungary's National Renewable Energy Action Plan (NREAP) after 2020

The implementation of the Nuclear-Coal-Green scenario is expected to increase electricity supply security which is an important objective for Hungary.

Nonetheless, if certain external and internal economic policy conditions are met, the government may change its energy preferences, and a different scenario might deliver a more reliable guarantee for the safety of energy supply under the changed conditions. A biennial review of NES 2030 is therefore an important element of the strategy.

Targets and goals:

- Energy savings: NES 2030 targets 189 PJ or 23% of total primary energy savings by 2030 compared to the "Sitting and Waiting" scenario.
- Increase the use of renewable and low-carbon energy: the share of renewable energy in TPES will rise from 7% in 2012 to approximately 20% by 2030; due to the objective of long term use of nuclear energy in the electricity mix, nuclear will remain a clear contribution to the country's climate change mitigation efforts.
- Power plant modernisation: In order to ensure the reliable supply of electric power, detailed proposals will be drawn up for the replacement of soon to be closed-down power plants. Electricity generation-related CO_2-intensity will be reduced from 370g CO_2/kWh in 2012 to about 200g CO_2/ kWh by 2030.
- Modernisation of community district heating and private heat generation: The share of generation of heat from renewable energy sources will increase to 25% by 2030 from 10% in 2012.

- Increasing energy efficiency and reducing the CO_2 intensity of transport: increase the share of electric and hydrogen-based transport to 9% and the share of biofuels in transport to 14% by 2030 in order reduce both the sector's oil dependence and CO_2 emissions.
- Green industry and renewing agriculture: Agriculture is responsible for 13% to 15% of total GHG emissions. Promotion of agricultural technologies and organic farming will help reduce GHG emissions. Energy efficiency in agriculture may also be improved by supporting greenhouse cultivation based on the utilisation of sustainable geothermal energy.
- Waste-to-energy: Since municipal organic waste qualifies as biomass, its energy utilisation is added to the share of renewable energy sources. The utilisation of up to 60% of municipal waste in incineration plants, in strict adherence to environmental standards.

- Strengthening the role of the state: in 2012, government participation was moderate. While the government has a strong presence in the electricity sector, a similar presence should be established in the natural gas and oil sectors.

National Renewable Energy Utilization Action Plan (NREAP)

Hungary's Action Plan for the Utilisation of Renewable Energies 2010-2020, (hereinafter referred to as "NREAP) was published early 2011. The key points and targets are the followings.
The NREAP reconfirms Hungary's overall target for the share of renewable energies and identifies the key areas of intervention, stating individual quantitative targets. It sets more ambitious targets than the ones set by the European Union in order to support the overall economic objectives (job creation, improving competitiveness, reducing energy import dependency) through boosting "green" economy. While the RED Directive (2009/28/EC) of the EU set the renewable target for Hungary as minimum 13% of the total gross final energy consumption, the objective defined by NREAP is 14.65%.

Hungary's 3rd National Energy Efficiency Action Plan (NEEAP)

Article 24 (2) of the Energy Efficiency Directive (2012/27/EU) of the European Parliament and Council requires EU Member States to prepare National Energy Efficiency Action Plans (hereinafter referred to as "NEAP") in every 3 years and submit them to the European Commission. The III. NEAP of Hungary was adopted by the Governmental Decision 1601/2015. (IX.8.). The energy efficiency targets of the III. NEAP had been created by calculating with the national energy data of 2012, the current energy trends and GDP forecasts, as well as taking into account the planned energy efficiency measures and by the Governmental Decree 1160/2015, dealing with national energy consumption forecasts.

The 2020 target for primary energy consumption is 1009 PJ (according to the "joint effort" plan). The target for final energy consumption (primary energy consumption minus losses caused by transformation, conversion, distribution of energy, as well as non-energy uses) is 693 PJ. The scenarios entitled "Ölbe tett kéz / Sitting and Waiting" and "Közös erőfeszítés / Joint Effort" of the National Energy Strategy 2030 are calculating with primary energy use difference of 92 PJ, while the difference of final energy use is 73 PJ until 2020.

In order to fulfil the energy efficiency targets on the basis of the Climate- and Energy Consciousness Action Plan, the District Heating Development Action Plan, National Building Energy Strategy, as well as the planned Transportation Energy Efficiency Action Plan, NEAP describe the planned energy efficiency measures for each economic sector. NEAP also describes in detail the issues of implementation of practical applications and measures of the EU Directive on Energy Efficiency 2012/27/EU, as well as the supporting programs for better energy efficiency. Measures related to better energy efficiency of buildings, including new buildings with low energy consumption levels, as well as reconstruction of existing buildings, are having the most significant effects on fulfilling the energy efficiency targets. On this basis the National Building Energy Strategy (Governmental Decision 1073/2015. (II.25)) is part of NEAP.

Financial regulatory tools

European Cohesion Fund - European Structural and Investment Funds include the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund, the European Maritime and Fisheries Fund (EMFF), the European Agricultural Fund for Rural Development (EAFRD) provides Hungary with a total of 21.9 billion euro under the cohesion policy for the period 2014-2020. In addition, Hungary will also receive a grant of € 3.45 billion for rural development and a budget of 39 million euro will be available for the maritime sector and fishing.

The financial breakdown is as follows:

- 15 billion EUR for less developed regions (Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain and Southern Great Plain)
- 436.7 million EUR for more developed regions
- 6 billion EUR through the Cohesion Fund
- 361.8 million EUR for European Territorial Cooperation
- 49.8 million EUR for Youth Employment initiative

The relevant priorities of the cohesion policy:

- Promoting employment through economic development, employment, education and social inclusion policies
- Tackling social and demographic challenges
- Improving the competitiveness and global performance of the business sector
- Implementation of local and territorial development aimed at promoting economic growth.
- Trans-European transport (TEN-T) networks, notably priority projects of European interest as identified by the EU. The Cohesion Fund will support infrastructure projects also under the Connecting Europe Facility;
- Increasing energy and resource efficiency

- Here, the Cohesion Fund can also support projects related to energy or transport, as long as they clearly benefit the environment in terms of energy efficiency, use of renewable energy, developing rail transport, supporting intermodality, strengthening public transport, etc.

Environmental and Energy Efficiency OP (Környezet- és Energetikai Hatékonysági Operatív Program - KEHOP)

Programme description:
The programme aims to support sustainable growth and contribute to achieving the Europe 2020 targets for smart, sustainable and inclusive growth. It should improve flood protection, provide better waste and wastewater management services and good quality drinking water to more residents, help protect natural habitats and species, and it should improve energy efficiency and the use of renewable energy sources.

Territorial and settlement development OP (Terület- és Településfejlesztési Operatív Program - TOP)
Programme description:
The programme aims to support regional, decentralised economic development and an increase in employment based on local resources. The programme allocates more than EUR 1 billion to integrated sustainable urban development actions in the framework of a dedicated priority.

Economic Development and Innovation Operational Programme (Gazdaságfejlesztési és Innovatív Operatív Program - GINOP)

Programme description:
The programme aims to stimulate the economies of the less developed regions in Hungary. Its most important priorities are the competitiveness of small-and medium sized enterprises, research and innovation, and employment. The programme also aims to develop the tourism industry, enterprises' energy efficiency, and information and communication technologies. Moreover it will stimulate the use of financial instruments to cover other objectives, like increasing renewable energy production and improving the energy efficiency of households and public buildings.

Integrated Transport Development Operational Programme (Integrált Közlekedésfejlesztési Operatív Program - IKOP)

Programme description:
The Operational Programme will support the development of transport infrastructure, which is seen as essential to increase economic competitiveness and stimulate job creation – the two key objectives of the EU's Lisbon Strategy for growth and jobs.
Good quality transport links make it easier for people to commute to and from work. The better the links the greater distances people can travel efficiently, which in itself can enable more people to enter the jobs market. What's more, improving transport links can also strengthen social and territorial cohesion.

Rural Development Program (Vidékfejlesztési Program – VP2)

Programme description:
The EU's rural development policy helps the rural areas of the EU to meet the wide range of economic, environmental and social challenges of the 21st century. The Rural Development Programme (RDP) for Hungary was formally adopted by the European Commission on 10 August 2015, outlining the Hungarian priorities for using the EUR 4.2 billion of public money that is available for the 7-year period 2014-2020 (EUR 3.4 billion from the EU budget and EUR 740 million of national co-funding).

EU CO_2 quota-based financial programs

In order to support the overall economic objectives (job creation, improving competitiveness, reducing energy import dependency) through boosting green economy including innovations in climate change mitigation/adaptation, different supporting schemes were launched from the time of the last IDR:
According to Article 8 paragraph (3) of Act C of 2015 on Hungary's central government budget in 2016, 50% of the income originated from revenues from the EU Allowance (hereinafter referred to as "EUA") type of EU ETS quotas (allowances for stationary installation) is to be spent on greening activities and the other 50% is to support the state's budget. Also the 50% of the revenues, to be spent on greening activities, is divided equally between the Ministry for National Economics and the Ministry of National Development. Therefore 25% of the income originated from EUA unit quota revenues is to be spent (on the implementation of Green Economy Financing Scheme (hereinafter referred to as "GEFS") subprograms), by the Ministry of National Development, while the other 25% is spent by the Ministry for National Economics (on the implementation of Economy Greening Scheme (hereinafter referred to as "EGS") programs). The revenues from auctions to aircraft operators under EU ETS (European Union Aviation Allowance units) and the Effort Sharing Decision (AEA units – no transaction was accomplished by now) are shared 50%-50% between the two ministries (GEFS and EGS schemes). Concerning international units under the Kyoto protocol, the revenues from a theoretical new contract should be halved between the two ministries (Green Investment Scheme (hereinafter referred to as "GIS") and EGS schemes). Due to the recent low prices of the international credits, Hungary did not enter into any new contract on international credits since 2012.

Economy Greening Scheme (EGS)

EGS is a separated scheme operated by the Ministry for National Economy. The funding of this scheme is partly financed by the auction revenues of EUA and EUAA allowances (as ruled by the amended Act CCXVII of 2012) and partly by the incomes from the trading of allowances under the Kyoto Protocol (when applicable; as ruled by the amended Act LX of 2007 on the implementation framework for the United Nations Framework Convention on climate change and its Kyoto Protocol).
As the rules of what the revenues from emission trading can be used for is strongly restricted by the international, EU-wide and national law, similar rules have to be applied as in the GIS and GEFS, in accordance with the goals of the National Climate Change Strategy. As ruled by the Minister for National Economy in the Ministerial Order 16/2015 (V. 29.) NGM, the scheme can offer funding for the following purposes:

a) research, innovation and demonstration projects in the field of emission reduction and adaptation for the consequences of climate change;

b) energy production from renewable energy sources and the improvement of energy efficiency;

c) support of transition for low emission transport and public transport;

d) fund the 50% of the national contribution to the Green Climate Fund;

e) costs of the operation of the scheme.

Since the start of its operation in 2015, the scheme focuses on the support of electro-mobility through the implementation of the "Jedlik Ányos" Plan. Furthermore, a geothermal plant for district heating has also been supported in 2016.

Green Investment Scheme (GIS)

GIS is aimed to foster green economic development in Hungary by implementing environmental programs related to energy efficiency and renewable energy sources using revenues from selling the country's emission units under the Kyoto Protocol.
The continuous functioning of the GIS is assured by funding from the sale of Kyoto units. Hungary, represented by the Ministry of National Development at the time when these transactions took place, has signed several contracts for the sale of CO_2 allocation units (Assigned Amount Units and Removal Units) since the launch of the quota trade regime, until 2012.

The basic idea of GIS is that only projects with direct effects on greenhouse gas emissions and energy efficiency can be supported. In order to ensure the proper implementation of GIS, the emission reduction realized by the funded projects is accountable towards the partners purchasing the Kyoto units. Monitoring and Implementation Reports of GIS and its programmes are prepared each year, which verify and quantify the amount of direct greenhouse gas emission reduction realized through each programme. No projects can be implemented from the financial support of GIS, if the emission reduction and energy efficiency aspects of the projects are not verifiable and quantifiable.

Reduction of CO_2 is the main benefit of the GIS Programmes. The other benefits include direct environmental benefits of lower emissions and use of less energy, lower energy costs, heat savings in district heating, increased renewable heat production and reduced pollution by dust particles. The GIS Programmes are also expected to create new job opportunities and foster green economic development.

Besides the environmental benefits of the reduction of CO_2 emissions and fostering the use of renewable energy sources, the GIS Programmes also aim to help green economic development and to benefit the related industries and economic sectors by creating new job opportunities.

GIS and its programmes have been primary focused on increasing energy-efficiency and use of renewable energy sources in the building energy sector, as well as reducing greenhouse gas emissions. This is because emissions related to buildings account for 30% of total national CO_2 emissions. Over three-fourths of total quota revenues collected so far have been allocated to the funding of energy efficient buildings. For this reason, the main

emphasis of the previous and current GIS Programmes is energy efficient reconstruction of private apartments and apartment complexes, namely reconstruction or replacement of old heating systems, use of renewable energy sources, heat insulation of buildings, replacement of old windows and doors, installations of low-emission biomass-fired sources or efficient heat pumps, furthermore to support the use of renewable energy sources, as heat pumps or solar collectors.

The Hungarian GIS was regulated by the Act LX of 2007 on the implementation framework for the United Nations Framework Convention on climate change and its Kyoto Protocol, while detailed aims could be found in the Governmental Decree 323/2007. (XII. 11.). However, the GEFS scheme had been established in 2013, therefore the legislation of GIS changed and accordingly the use of support for both green schemes was regulated within the Ministerial Decree of the Minister for National Development 7/2016. (IV. 8.). According to the legislation, support from GIS can be used for the following purposes:

f) improvement of building energy efficiency;

g) increasing the utilization of renewable energies;

h) improvement of efficiency of district heating systems;

i) promotion of the construction of low- energy consumption buildings;

j) energy efficient modernization of indoor and outdoor lighting systems;

k) promotion of creating carbon sinks;

l) emission reduction in the transport sector;

m) replacement of old inefficient household appliances and electronic devices with new certified low energy consumption equipment;

n) other emission reduction purposes.

Besides the above mentioned supports, it is possible to provide interest rate subsidy for applicants of GIS projects, in order to cover the cost of credits or loans to realize GIS projects. The interest rate subsidy could be up to 100%.
Also, maximum 5% of GIS revenues can be used for administrative support and monitoring purposes of GIS Subprogrammes.
As since 2012 Hungary accomplished no new transactions under the Kyoto Protocol, no new revenues are available in GIS, only revenues from the previous contracts are being used in the current programmes.

Green Economy Financing Scheme (GEFS)

GEFS is an important nationally funded program, which is financed from ETS quota revenues. The first GEFS Subprogramme was launched in September 2014 similarly to the GIS. Direct and accountable energy consumption- and emission reduction is the governing idea behind the GEFS subprogrammes.

Annex 1 of the Ministerial Decree 7/2016. (IV. 8.) NFM, regulates the main aims and possible uses of GEFS Subprogrammes. According to the legislation, support from GEFS can be used for reduction of GHG gases, for the creation of GHG sinks, or for measures aimed to reduce the effects of climate change in case of international cooperation.

I. GEFS support can be used for the following purposes on international levels:

o) contributions for the Global Energy Efficiency and Renewable Energy Fund;

p) contributions to the European Globalisation Adjustment Fund (EGF), launched at the Poznan Climate Change Conference (COP 4 and COP/MOP 4);

q) measures to avoid deforestation and help afforestation and reforestation in developing countries, which have ratified the international agreement on climate change;

r) transfer of technologies and to help adaptation to climate change in developing countries, which have ratified the international agreement on climate change;

s) safe capture and geological storage of CO_2 originated from solid fossil fuel power plants or industrial activities in developing countries.

II. For developments realized within the European Union, GEFS Supports can be used for the following purposes:

t) development of energy production from renewable energy sources;

u) measures aimed to help energy efficiency;

v) measures or investments to reduce GHG emissions;

w) capture of CO_2 through reforestation;

x) support for the participation in the initiatives of the European Strategic Energy Technology Plan and the European Technology Platforms;

y) safe capture and geological storage of CO_2, originated from solid fossil based power plants or industrial activities;

z) measures helping the shift to low-GHG-emission transportation methods and to encourage the use low GHG emission public transportation methods and tools;

aa) support for research and development related to energy efficiency and clean technologies, in case of industries, which need permissions for emitting GHG gases and mentioned in the GHG Emission Act. (Act LX of 2007 on the implementation framework for the United Nations Framework Convention on climate change and its Kyoto Protocol);

bb) research and development aimed at the adaptation to climate change and GHG emission reduction, as well as implementation of demonstration projects;

cc) support for the development of new technologies aimed to help the shift to low carbon economy;

dd) financial support for social measures of lower and middle income households to help their energy efficiency.

Energy taxation

The European Union (EU) Energy Tax Directive (2003/96/EC) sets the EU framework for the taxation of energy products and electricity. The Directive sets minimum tax rates for all energy products including coal, natural gas and electricity. For each, it sets a minimum level of tax expressed in terms of the volume, weight, or energy content of the fuel. The Directive is also intended to reduce distortions of competition, both between member states as a result from divergent rates of tax on energy products, and between mineral oils and the other energy products (OECD, 2016c).

In 2015, excise and VAT together accounted for 57.2% of the final price of a litre of premium unleaded gasoline, 54% of the final price of a litre of automotive diesel and 61.9% of the final price of litre of light fuel oil for households.

Motor car purchases are also taxed and VAT is payable at 27% alongside a registration tax. The registration tax varies from HUF 45 000 to HUF 400 000 on new passenger cars according to engine type (diesel or petrol) and engine cylinder capacity, and from HUF 20 000 to HUF 230 000 on motorcycles according to engine cylinder capacity. For cars generating great levels of emissions, higher rates are levied (400%, 600%, 800% or 1 200%), but the rate is reduced according to a scale based on age (until 90%). A reduced rate is levied to hybrid cars and HUF 0 is levied on electric vehicles.

The transfer of motor vehicles is also liable to tax: the rate of duty is determined on the basis of vehicle's engine capacity (in kW). The tax rate varies from HUF 300/kW to HUF 850/kW depending on the age of the vehicle (the older the vehicle, the lower the liability). Reduced rates apply to cars with hybrid engines or with gas-powered engines (HUF 76 000) and for cars with electric engines (HUF 0).

Based on the rules set in Governmental Decree 176/2017., companies can receive reduction of their corporation tax if they execute investments in their energy efficiency.

Electric vehicles enjoy a distinguished treatment compared to other cars concerning the environmental product fee.

Energy security

Hungary produces small volumes of oil and gas but for the most part relies on imports to meet its needs. The Russian Federation is major source for both oil and gas but significant efforts have been made to diversify supply routes both along the north-south and east-west axes. Increasingly, greater diversity can be seen in the country's portfolio of crude oil sources. As a land-locked country, Hungary is supplied by several crude, product and gas pipelines.

Getting more involved in the common European oil and gas market, building new cross-border connections and/or amplification of the existing ones could mean a safer energy supply in the middle term. As an EU Member State, Hungary is part of the implementation of the EU's Energy Union Strategy aiming a transformation of European energy supply through the establishment of a fully integrated energy market. This will certainly give the opportunity

for Hungary to diversify its energy import sources and transport routes providing secure, sustainable and affordable energy supply.

Oil represents roughly one-quarter of TPES and is expected to remain at this level until at least 2020. Domestic oil production, which was 0.86 Mt in 2015, is expected to continue to decline thereby increasing dependence on imports. Oil consumption increased from 6.6 Mt in 2014 to 7.1 Mt in 2015. The transportation sector dominated oil consumption accounting for 60% of demand in 2015.

Natural gas demand has declined significantly since its 2005 peak of 15 billion cubic metres (bcm) but it retains the largest share of Hungary's TPES accounting for 31.3% in 2015. Gas demand dropped to 9.0 bcm in 2014. Hungary produced 1.8 bcm or 20% of its demand in 2015 but domestic production has been in steady decline, a trend that is likely to continue.

The use of publicly held stocks is central to Hungary's emergency response policy for both oil and gas. The Hungarian Hydrocarbon Stockpiling Association (HUSA) is entrusted with public stockpiling of both oil and gas. HUSA was founded and is operated and financed by the domestic oil and gas industry and government exercises special control rights over the association. Its public oil stocks are composed of gasoline, diesel and crude oil and remain comfortably above the IEA's 90-day requirement. The stored quantity was 105 days of net imports in September 2016. According to the Stockpiling Act, a minimum of one-third of the strategic stocks shall consist of petroleum products i.e. diesel and/or gasoline and the present ratio of petroleum products to crude is 60:40. When counted together with industry stocks, the total puts Hungary well beyond the IEA minimum stockholding obligation of 90 days of net imports with total stock levels standing at 176 days. In an IEA co-ordinated response to a supply disruption, Hungary can respond with the release of public stocks.

Hungary has also developed strategic gas reserves, which are under government control. These were created in the aftermath of the January 2006 Russia-Ukraine gas crisis. Although these stocks reached the planned level of 1.2 bcm in early 2010, matching decreasing demand, stocks have since been reduced to 915 mcm. The level of stocks is determined by a ministerial decree.

Electricity production was 30.1 TWh in 2015, while total electricity consumption was 43.75 TWh. These amounts are expected to continue to grow in the future as electricity consumption per capita is still relatively low compared to the OECD average. Hungary is a net electricity importer and also a major transit country, mostly to its southern neighbours. Little more than half of the country's generation is ensured by the nuclear power plant in Paks, with most of the remaining generation depending on coal, natural gas and about 10% of renewables. Hungary is part of the electricity system of Central Eastern Europe, and its wholesale electricity market has been coupled with the Czech Republic, Slovakia and Romania since 2014. The Hungarian electricity system is directly connected to all of the country's neighbours with the exception of Slovenia, where the interconnector is planned to be built in the forthcoming years under a Project of Common Interest (PCI). In 2016 the electricity interconnection level of Hungary was 37%, having increased from 29% in 2014 and being well above the 2020 EU target of 10%. However, the current national arrangements for congestion management and bidding zone definition in Central Europe do not necessarily accurately reflect actual congestion, and this is leading to increasing

limitations of cross-border flows of electricity. The country's TSO, MAVIR, is responsible for grid management and system security, under the supervision of HEA, the energy regulator. MAVIR has contracts for mutual assistance with neighbouring TSOs. Every power plant over 50 MW is required to keep an equivalent of 16 days of stocks of alternative fuel. In case of under-frequency in the grid, the TSO can make use of automatic or manual load shedding. Regulated electricity prices mean that voluntary load shedding (interruptible contracts) or smart metering are not measures available to the TSO in a disruption. The response system was well tested during two major weather-related disturbances in recent years.

Nuclear energy was the source of 51.3% of domestically generated electricity in 2016 and will continue to play a major role in the power sector into the foreseeable future. NES 2030 states that the long-term preservation of nuclear energy in the energy mix is an important objective of long-term energy policy.

This objective ensured on the medium run by the lifetime extension of Paks Nuclear Power Plant (the lifetime extension process was completed at the fourth and last unit at the end of 2017); sustaining high capacity utilisation; responsible management of nuclear waste. On the long term, the objective will be reached by the construction of two additional units at Paks (called Paks 2 capacity replacement project). The construction of Paks 2 would be the largest investment in the Hungarian energy sector for several decades, and therefore considered a flagship project by the government.

The four units of the Paks Nuclear Power Plant are planned to close down in sequence between 2032 and 2037, after 50 years of operation. To ensure the timely replacement by new nuclear units, the Hungarian Parliament adopted a decision in principle for the start of the preparatory works for Paks 2 in 2009.

In January 2014, Hungary signed an Inter-Governmental Agreement with the Russian Federation for the construction of two new nuclear units at Paks. The new units with a nominal electrical capacity of 1200 MWe each should start operation in 2026 and 2027. In 2014, Hungary and the Russian Federation signed a financial agreement providing for a EUR 10 billion credit line from Russia to cover 80% of the costs of the two new units. The Hungarian State will be financing the remaining 20%

2.8. Industry

Industry is the most significant sector of the Hungarian national economy, its share in GDP was 26% in 2016. Despite the fact that the volume of investments in the whole national economy decreased by 20% in 2016, the volume of investments in the field of industry performed much better by reaching 4.1% increase. The volume of the Hungarian industrial production has had a more moderate growth following a strong increase of 7.4% in 2015, the volume of output increased by 0.9% compared to the previous year. The cause of the latter is the outstanding performance of the manufacturing industry.

The Government has approved the Irinyi Plan in February 2016. The strategy is a frame for further manufacturing industrial strategies, including also several provisions on the improvement of green economy It has identified five pillars and seven focus areas based on

global industry trends, our opportunities, current experience, recent and potential export destinations, state of domestic business environment, FDI attracting ability, and the ability to dissolve regional disparities.

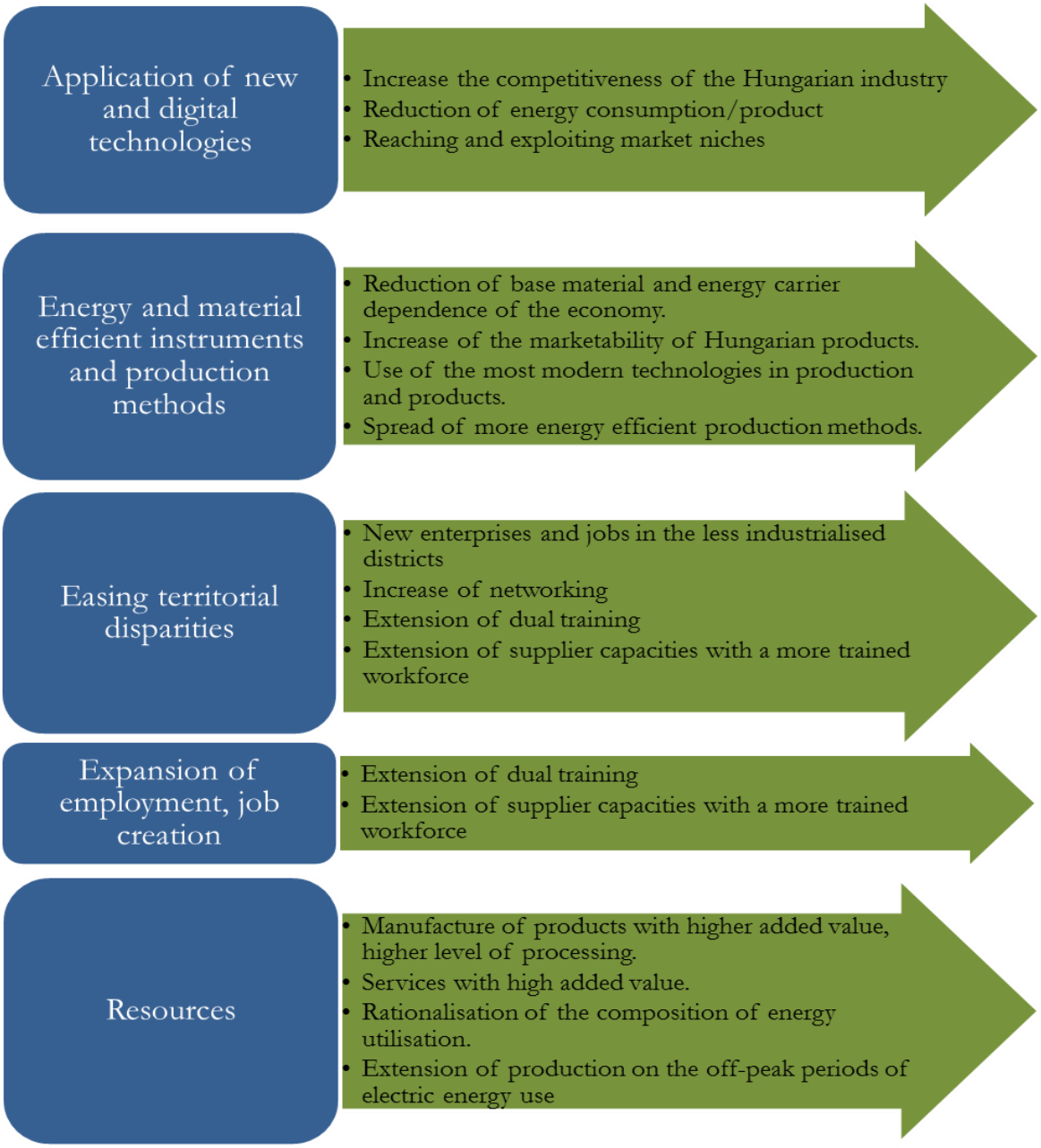


Figure 2.16. Five pillars of manufacturing industrial strategy, 2016
Source: Irinyi Plan, Ministry for National Economy, 2017

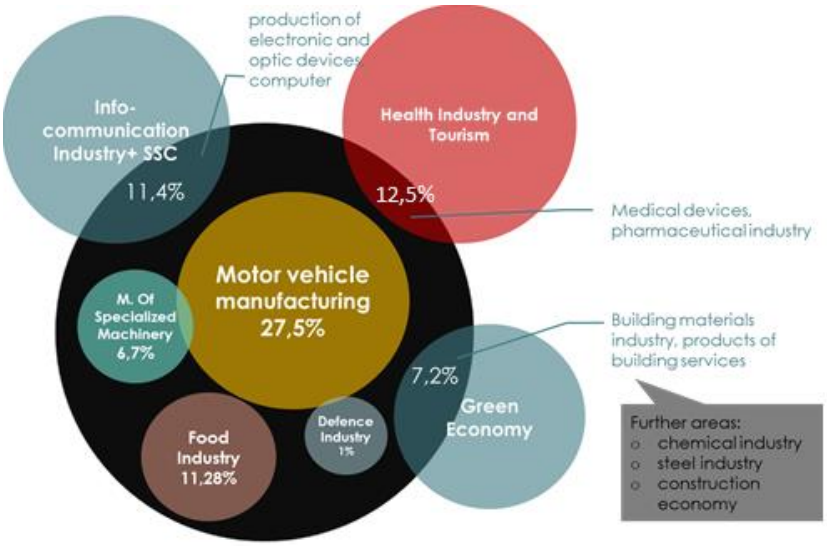


Figure 2.17. Connection between the priority sectors of Irinyi Plan and the manufacturing industry
Source: Ministry for National Economy, 2017

The aim of Irinyi Plan is to strengthen the share of industry in GDP from 23% to 30%, as well as to ease the national economic dependence on automotive industry.

The influence of Irinyi Plan is not yet measurable, however the manufacturing industry, which is the most significant industrial segment in Hungary with its 1/3 share in the total industrial investment, has increased by 7% even without the effect of the Plan. According to recent data, small and medium sized enterprises of manufacturing industry were also more likely to invest besides the specific investments. Regarding manufacturing industry, investments increased in 2016, and as a result, more greenfield projects were concluded which had a positive effect on the expansion and development of the supplier network too.

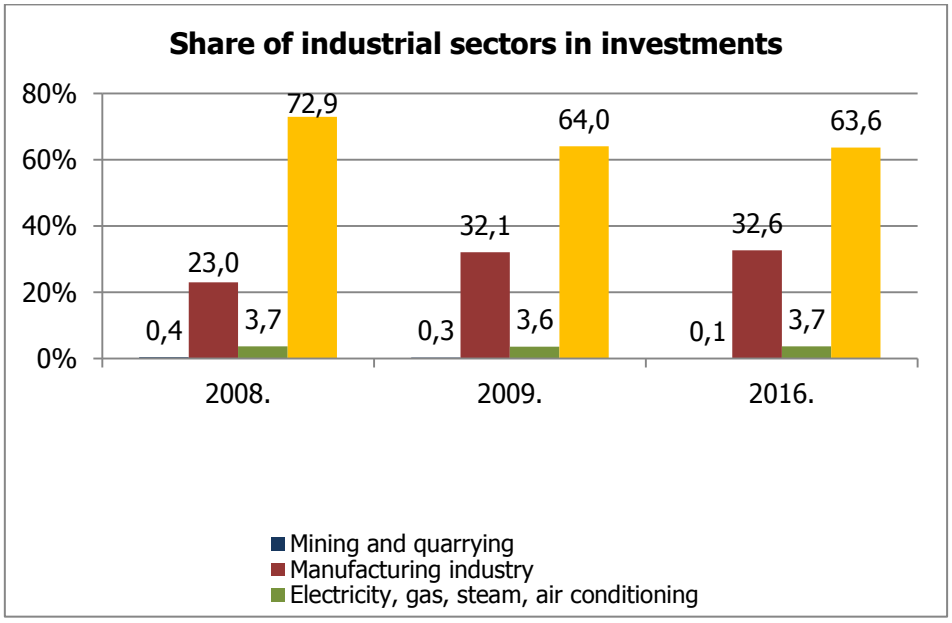


Figure 2.18. Share of industrial sectors in investments, 2016
Source: Hungarian Central Statistical Office (KSH), 2017

Regarding the changes in the investments, it had a negative trend due to the economic crisis. However after year 2013 a positive change occurred: the index showed a growth in mining, in manufacturing industry and in electricity, gas, steam and air conditioning. Following this year a continuous decrease was observed: in 2016 the decrease of the indices of mining and electricity, gas, steam and air conditioning were 70.3% and 35.7% respectively. Regarding the key national economic sectors, only the manufacturing industry showed a growth in index by 16% because of the increasing investments of businesses.

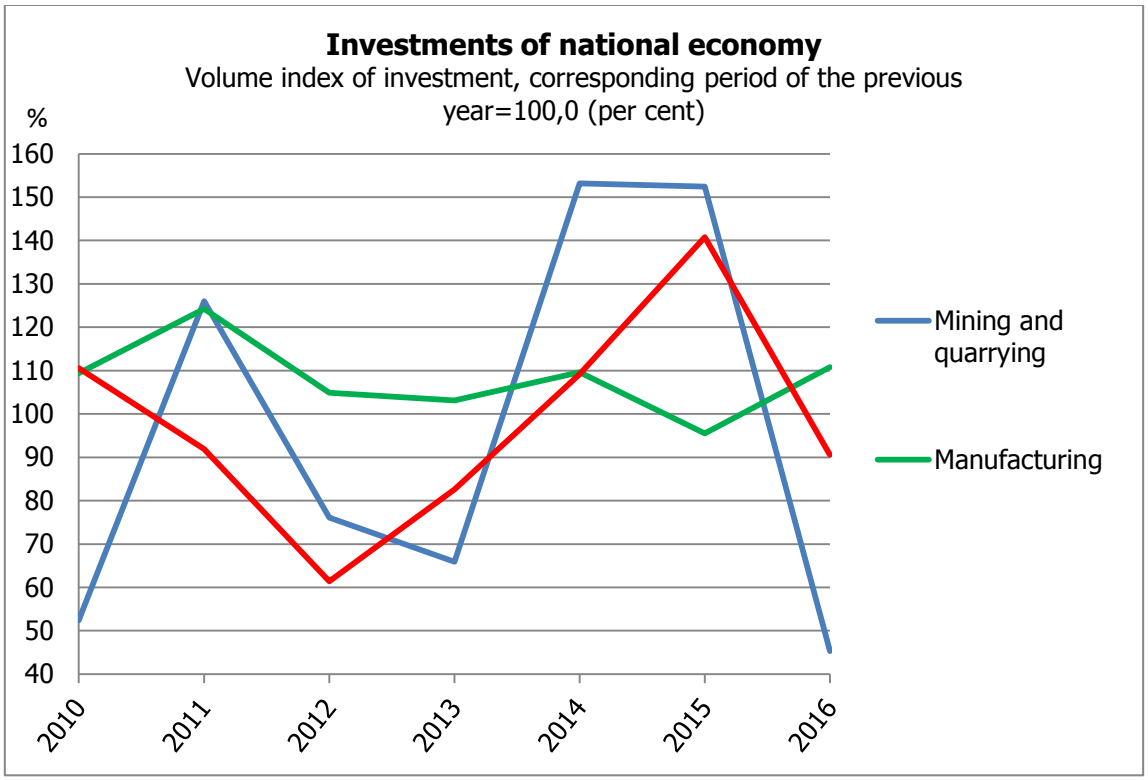


Figure 2.19. Investments of national economy, 2016
Source: Hungarian Central Statistical Office (KSH), 2017

Other segments of industry showed a decreasing trend in 2016. Investments decreased by 9.9% in the field of electricity, gas, steam and air conditioning. Investments in the energy sector decreased because of the completion of specific great volume investments.

Mining decreased by 69% in 2016 following a 75% growth in 2015. Most probably the cause of the decreasing trend was low investments by the hydrocarbon producing enterprises, due to the decline of the prices of hydrocarbon raw material. Despite all of the above, small investments and developments occurred in the of gravel, sand and clay mining sectors.

Growth of industrial production fell, the output increased only by 0.9% in 2016. Export sales increased by 0.4%, domestic sales decreased by 1.2%. The production of manufacturing industry, representing 95% of the industry sector, increased by 1.4% in parallel with the expansion of export.

Financial processes of the world economy, as well as the EU determine the production and sales of local industry. The dependence is strengthened by the fact that a determining factor is export sales. Domestic demand increased slowly in 2014 and 2015 after a longer decrease, but in 2016 it lowered again. 65% of the total sales of industry and 75% of that of manufacturing industry were export sales. The growth of export slowed down to 0.4%.

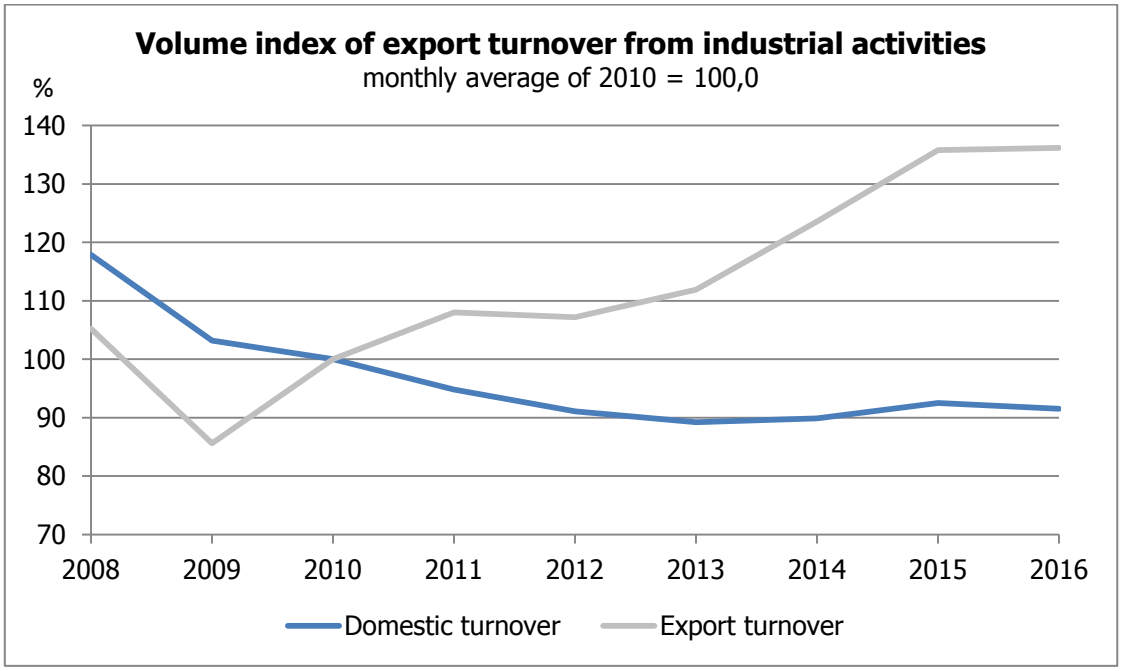


Figure 2.20. Volume index of export turnover from industrial activities, 2016
Source: Hungarian Central Statistical Office (KSH), 2017

If we consider production output of sectors we could note dramatic changes in the performance of mining. Only crude oil exploitation increased. Also there was stagnation in electricity, gas, steam and air-conditioning supply in 2016 compared to the previous year. A 2.9% increase was measured in electricity production, while gas supply dropped by 8,4%.

In 2015 the growth rate of processing industry, covering 95% of total industry production, was 8,0%, in 2016, after a considerable fall, it was only 1,6%.

Total industry output (26 000 billion HUF) was higher across 7 months compared with the same period of the previous year. The volume of export went up by 1,3%, while domestic trade was higher by 1,7%.

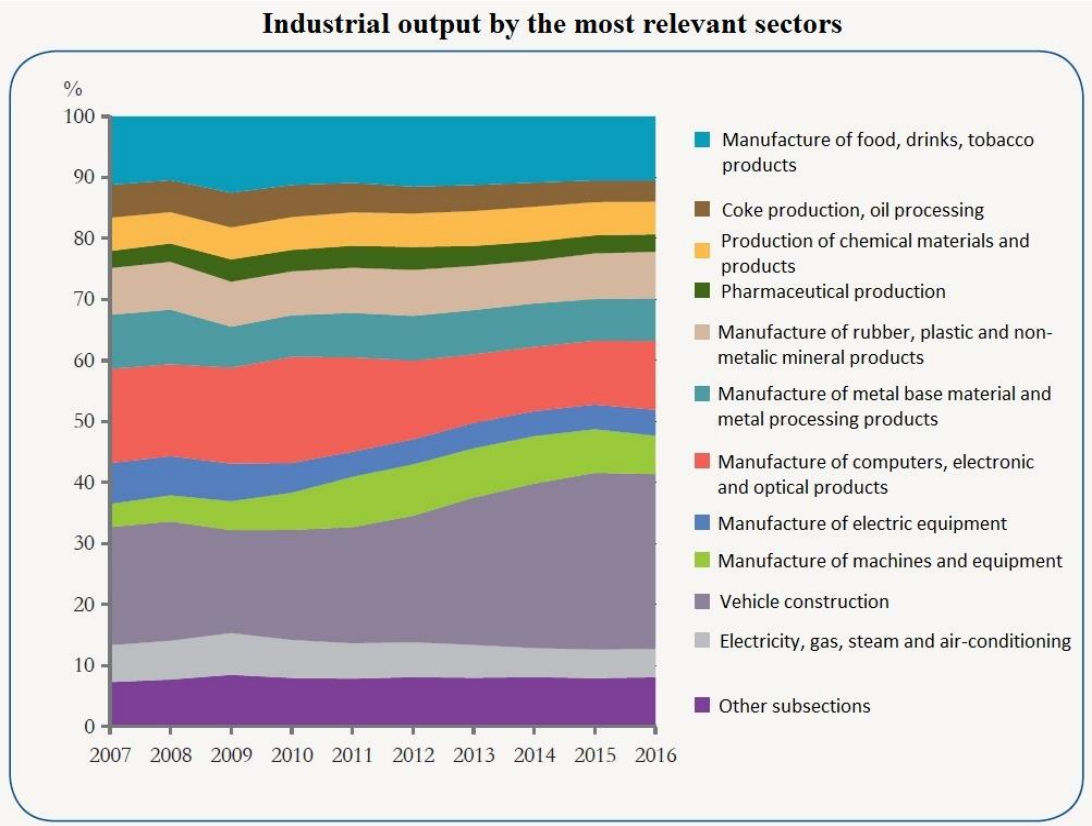


Figure 2.21. Industrial output by the most relevant sectors
Source: Report on industry performance in 2016, Hungarian Central Statistical Office (KSH)

Between 2007 and 2013 the volume of internal trade in processing industry suffered a downturn year by year. However it has been growing since 2014in 2015 the growth rate was 6,7% and perceptible setback in domestic demand was only visible in 4 sectors out of 13. The rate of domestic trade within aggregate trade is gradually decreasing. In the year of 2000 the rate of domestic trade regarding to manufacturing industry was 40%, while in 2016 it was less than 25%.

The sectoral composition of the industry is changing continuously. Not only the proportion of processing industry is increasing, but also the manufacture of machines is growing and in parallel with that the inner structure of the machinery industry and its export is also changing. Since 2008 the ratio of machinery has been increasing appreciably by 5,2%. In 2016 the sector contributed to the industrial production by more than 50% compared with the ratio of 45% in 2008. Within the sector the vehicle construction has increased its share by the highest degree, 9,1% in the period in question. The proportion of manufacture of machines and equipment rose by 2% during the last 8 years, while manufacture of computers, electronical and optical products decreased by 3,8% and the output declined by 2,2% in manufacture of electric equipment. Chemical industry had a share of 19,3% in 2016, this proportion is lower by 1,9% compared with the previous year.

Industry sector structure based on the distribution of production value

(at the price level of 2016) (%)

Sector	2008	2012	2016
Mining and quarrying	0,5	0,5	0,3
Manufacture of food, drinks, tobacco products	10,5	11,5	10,5
Manufacture of textile, clothing, leather and leather products	1,7	1,6	1,5
Timber processing, manufacture of paper products, printing activity	3,1	3,3	3,2
Coke production, oil processing	5,2	4,4	3,5
Production of chemical materials and products	5,1	5,5	5,3
Pharmaceutical production	3,0	3,8	2,9
Manufacture of rubber, plastic and non-metalic mineral products	7,8	7,5	7,6
Manufacture of metal base material and metal processing products	9,0	7,3	7,0
Manufacture of computers, electronic and optical products	15,1	12,9	11,3
Manufacture of electric equipment	6,4	4,1	4,2
Manufacture of machines and equipment	4,3	8,4	6,3
Vehicle construction	19,5	20,7	28,7
Other processing industry; commissioning and repair of industrial machines and equipment	2,4	2,8	3,1
Processing industry	93,1	93,8	95,1
Electricity, gas, steam and air-conditioning	6,4	5,7	4,6
Industry without water and waste management, enterprises employing at least 5 people	*100,0*	*100,0*	*100,0*

Table 2.8. Industry sector structure based on the distribution of production value

Source: Report on industry performance in 2016, Hungarian Central Statistical Office (KSH)

Proportion of manufacture of food, drinks and tobacco products has been showing the tendency of decrease for years. There is no change compare to the year 2008, and in spite its share decreased by 1% between 2012 and 2016, it remained the third largest sector of processing industry. Fraction of coke production and oil processing (1,7%) as well as manufacture of metal base material and metal processing products (2%) are decreasing within the Hungarian industry. The share of light industry changed moderately, only by 0,1% compared to 2008.

Additionally two sectors show declines from 2008 to 2016: mining (by 0,3%) and energy sector (1,7%).

Industrial structure transformation has effect on production of industry by regions. In 2016 the highest expansion (15,4%) was in one of the smallest regions named South-Transdanubia (Dél-Dunántúl) thanks to the communication engineering sector and manifacture of electronic equipment. Both have significant importance. The second was

Middle-Transdanubia (Közép-Dunántúl) among the fastest growing regions owing to the expansion of electronic products and growing achievements of vehicle construction. Northern Hungary (Észak-Magyarország) region was the third most productive one with dynamic growth rate of 6,4%. in consequence of growing selling of electronic, vehicle and motor equipment.

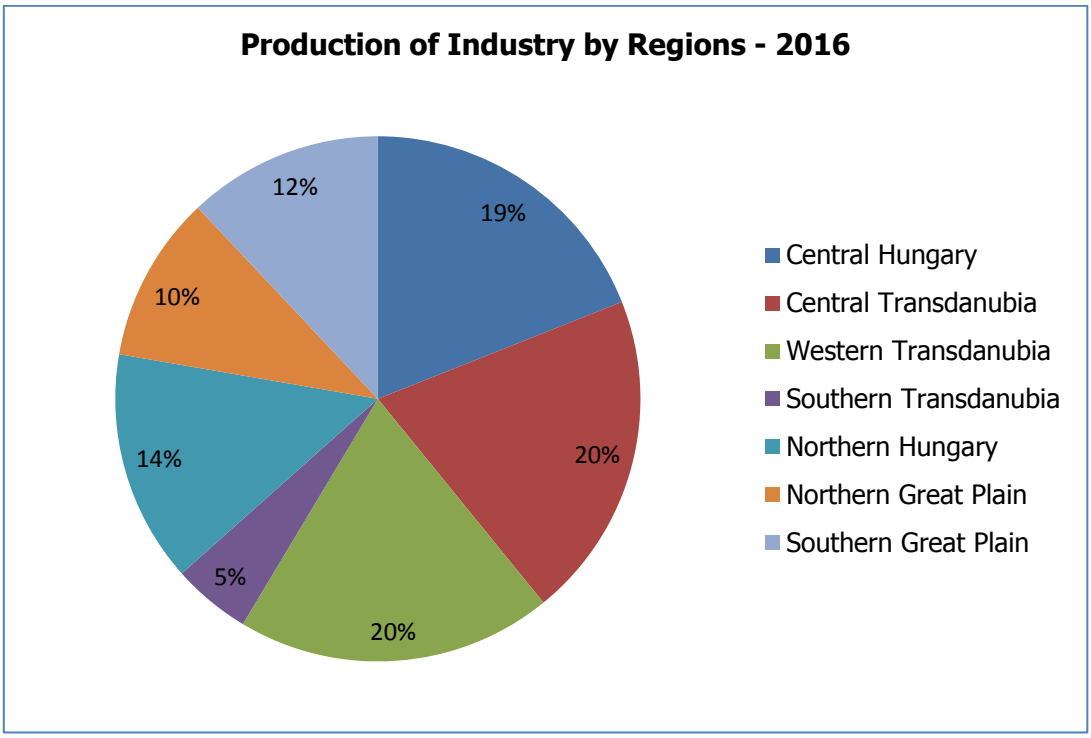


Figure 2.22. Production of Industry by Regions - 2016
Source: Irinyi Plan, Ministry for National Economy, 2017

2.9. Transport

Infrastructure

Hungary's central location in Europe and the accordingly dense motorway network are one of its most important competitive advantages. Three vital European TEN-T core network corridors (Orient – East-Med, Mediterranean, Rhine-Danube) pass through Hungary, providing unparalleled access to all parts of Europe, including major European ports and the fast-growing CIS market. In order to exploit these benefits, Hungary is determined not only to preserve, but also to enhance its infrastructural network and to improve its integration into the European network.

Road Network

As a result of intensive construction works along main transport corridors, major motorways and trunk roads reach national borders, ensuring faster and safer transportation. Hungary has an extensive road system, centred in Budapest, and the most developed highway network among new EU member states. Seven of the nine main roads start from Budapest

(designated by single digit numbers, running clockwise from the Vienna motorway M1) and all of them link up with the European road network.

The road network is divided into roads and private roads. Roads are state-owned national roads and local public roads. The length of national roads is 31 805 km. Local roads have a total length of 167 407 km. The national road network accounts for about 75% of the country's total road traffic (Figure. 2.23.).

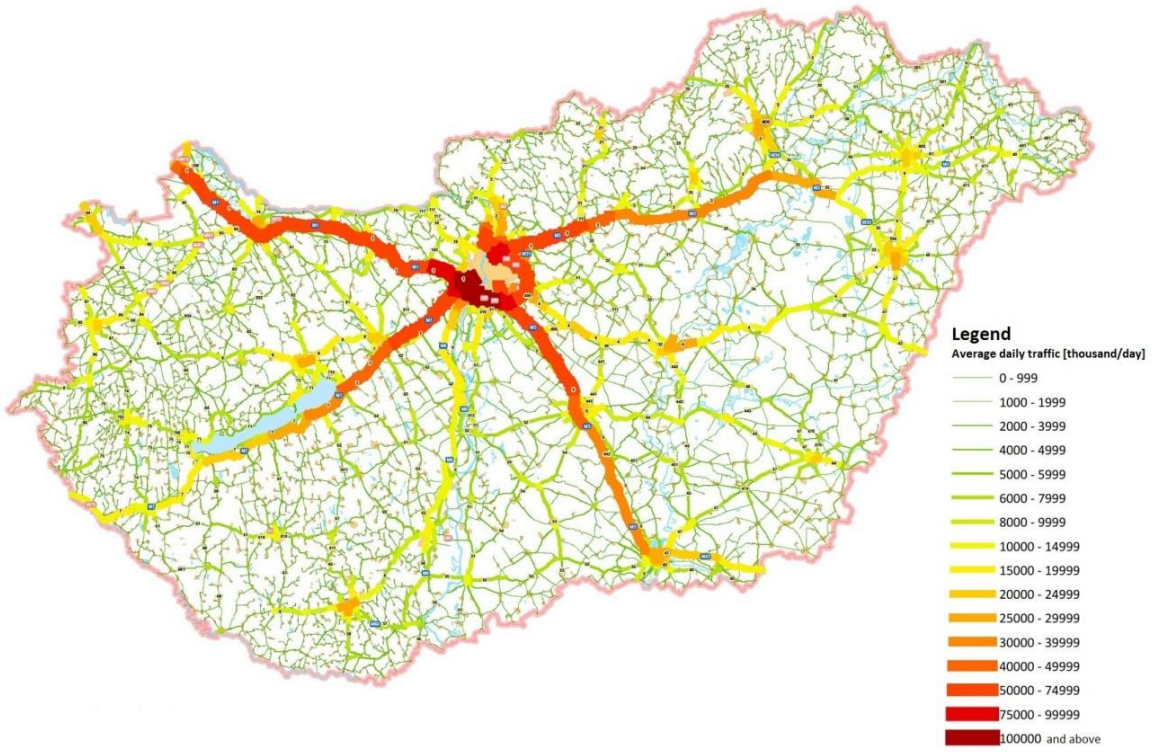


Figure 2.23. Traffic volumes (average daily traffic) on the Hungarian Sate Road network
Source: Hungarian Public Road Non-profit Plc. (based on data from 2016)

8745 km of national roads are the main network, of which 2 347 km are part of the European road network. The length of the expressway network (motorways, motor roads) is 1 366 km, and the length of motorways with node branches is 1 804 km. 27% of the length of the national roads pass through settlements, so they play a significant role in the local traffic. There are 7,529 bridges on the national roads, 1,793 road-rail crossings (of which 1 448 are level crossings, of which 63 are insured), 8,715 road junctions and 5 503 level pedestrian crossings.

The improvement of the highway network and four-lane motorways linking all the major cities in Hungary will result in an approximately 40% decrease of driving times on the main intercity routes. A top priority of the Hungarian government is to further extend and reconstruct the road network in Hungary. Figure 2.23 shows the present and planned roads in Hungary (double lines are expressways).

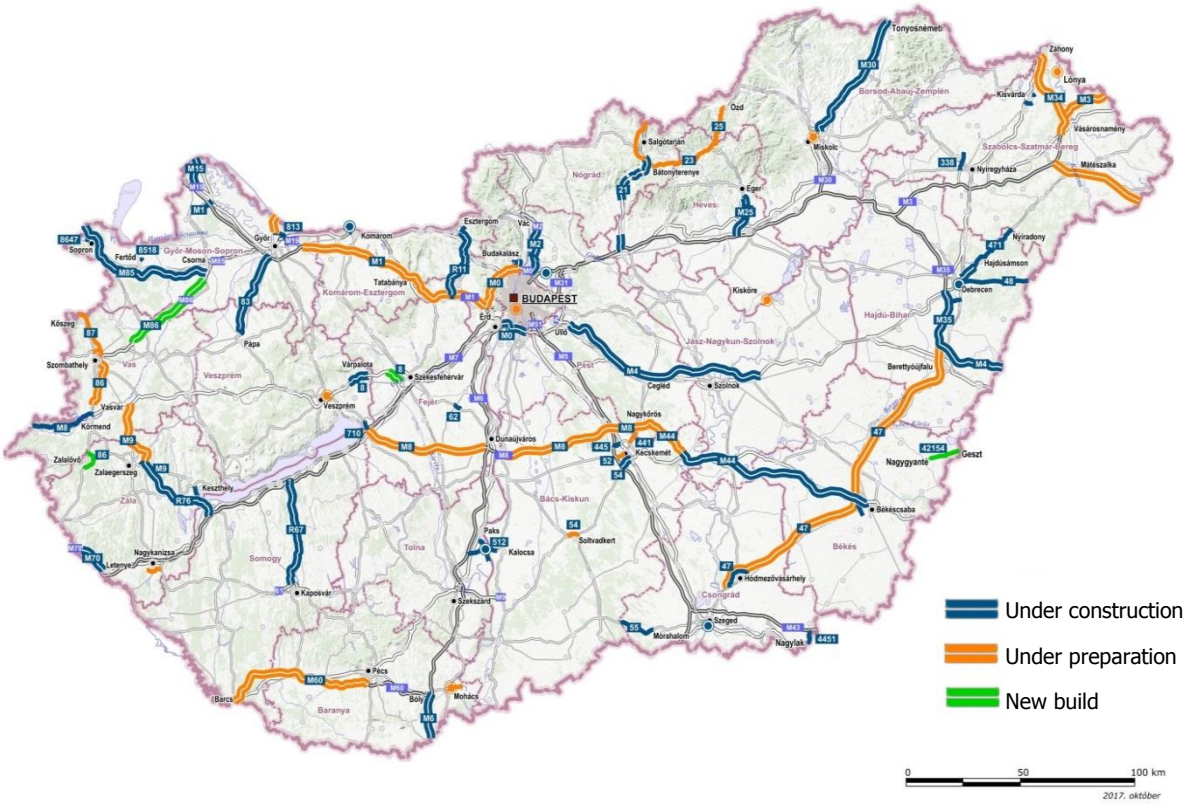


Figure 2.24. Road network in Hungary: existing and planned roads
Source: National Infrastructure Development Corporation (NIF)

Road transport and the transport network are in a contradictory and continuously changing situation in Hungary. This can be characterised by the following factors:

- the network of good quality and rapidly expanding expressways and almost 500 dead-end settlements are present at the same time in the country in the central and western,
- in the south-western and south-eastern parts of the country the problem is caused by the saturation of the public roads and by delayed accessibility, respectively
- while the traffic problems the large towns – congestions, parking difficulties, air pollution – remind us to the developed countries, the access of peripheral areas has hardly improved in 50 years.

There are many, relatively new difficulties: deterioration of the main and secondary road network has grown to dangerous dimensions in the last 10 years. On the national public road network the average period of pavement renewal has been extended from 8 years-interval to more than 40 years.

Railway Network

7712 km-long railway network covers the whole country. 39% of the Hungarian railway network is electrified and 16% of it is double-track. Hungarian railway network is an integral part of the international network (Hungary has 3000 km-long TEN-T railway line), thus providing easy access by international express trains from the neighbouring and numerous other European countries.

Fast connection to sea ports

Several scheduled block train lines connect Hungary with the sea ports of Hamburg (D), Bremen (D) and Rotterdam (NL) on the North Sea, with Koper (Sl) and Trieste (I) on the Adriatic and soon with Constantza (RO) on the Black-Sea. The Koper, Trieste and Constantza seaports also offer alternative shipping routes from Asia. Lead time from these ports to Hungary is within 16-36 hours by road or direct train.

Around 18% of freight is transported by rail in Hungary, well above the EU average. Záhony and its region at the Hungarian-Ukrainian border is the junction and reloading centre for European standard-gauge railways and the wide-gauge system of the CIS states.

Inland Waterways

Hungary is a landlocked country but it has access to the Black Sea and the North Sea via the river Danube. Major inland ports are located in Győr-Gönyű, Komárom, Budapest, Dunaújváros, Paks, Baja and Mohács. The opening of the Danube-Rhine-Main channel in 1992 made possible the performance of export-import traffic with the countries along the Rhine and the maritime ports in the North, too. In Hungary 3-3,5% of freight is transported by inland waterways.

Aviation/Air Transport

The aviation landscape of Hungary has gone through significant changes in the last couple of years. Within less than a year after the demise of the Hungarian national airlines, the market reinvigorated again. Both passenger numbers and cargo volumes soon reached and even exceeded the prior peaks. We can experience a double-digit growth rate every year at Budapest Liszt Ferenc International Airport. Direct connectivity of Budapest improved a lot lately; we can see numerous new entrants in the market, while incumbent carriers have also increased their capacity and frequency offerings flights to and from Budapest. Certain direct long-haul flights have also been re-instated and we expect to see more such overseas services - e.g. to the American continent and to Asia - in the years to come.
The other two international commercial airports of Hungary - Debrecen and Hévíz-Balaton Airport at Sármellék - have also elaborated ambitious strategic plans to thrive and exploit the current positive trends of the industry.
Acknowledging the importance of the regional airports from the local communities' mobility and regional connectivity perspectives, the Hungarian aviation administration assists the worthwhile projects of these airports so as to help them to catch up and grow.

Factors affecting emissions from transportation

The average age of car fleet is increasing constantly since 2007. We arrived to the 2000 level of an average age of 12 years in 2011. The rate of growth is slowing down since 2012, but average age is still increasing every year. The recent value is more than 13 years in 2016, and there is almost 3 years difference between diesel (11,9 years) and gasoline (14,7 years) passenger cars.
The new registrations were at a low point in 2010. Statistics of the Central Statistical Office show that the stock of new registrations started to grow in 2010 after the continuous fall

from 2003. We arrived to the 2005 level (~ 240 000 new registrations) in 2016, which grown 75% in the last 6 years.

The stock of cars is increasing constantly in the last 5 years.

Concerning the composition of the car stock, 69% was equipped with petrol engine in 2016 (2000 – 90%, 2010 – 79%). The change in vehicle stock was therefore fundamentally due to the reduction of gasoline combustion vehicles, the number of petrol cars has been continuously reducing from 2003 to 2014 (2 266 198), but the numbers of gasoline passenger cars are increasing in the last 2 years (2015 – 2 272 447, 2016 – 2 301 168).

The stock of Diesel-engine vehicles is 29% (970 997) (2000 – 10% (230 855), 2010 – 21% 619 807). This is due to the better consumption and increasing performance and happens despite the increasing cost from deNOx-measures already manifesting in (higher) consumer prices.

Numbers of other fuel driven vehicles (hybrid, electric and mixed combustion) are five times higher than in 2010, but their share of total vehicle stock is only 1,2%

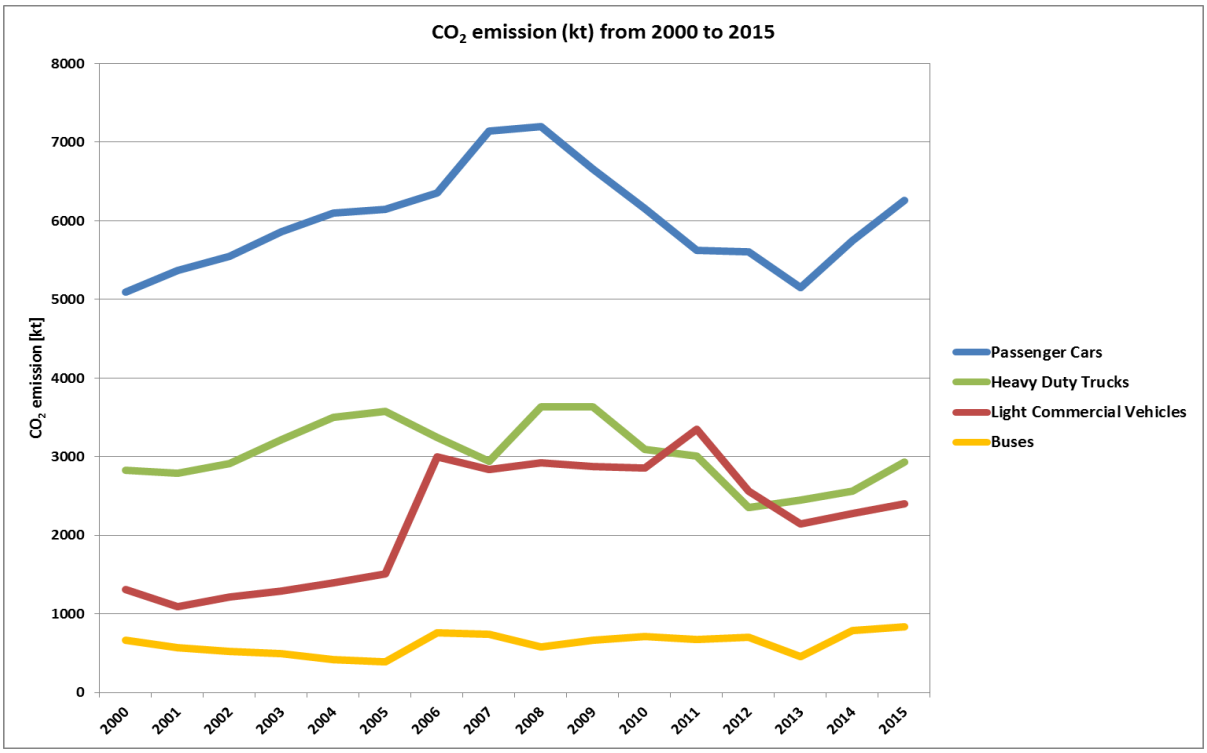


Figure 2.25. CO_2 emission (kt) trends of vehicle sectors from 2000 to 2015

Source: Institute for Transport Sciences (KTI), 2016

Figure 2.25. shows the trends of CO_2 emission between 2000 and 2015. CO_2 emission is increasing again in these vehicle sectors (passenger cars, heavy duty trucks, light commercial vehicles and buses) since 2013.

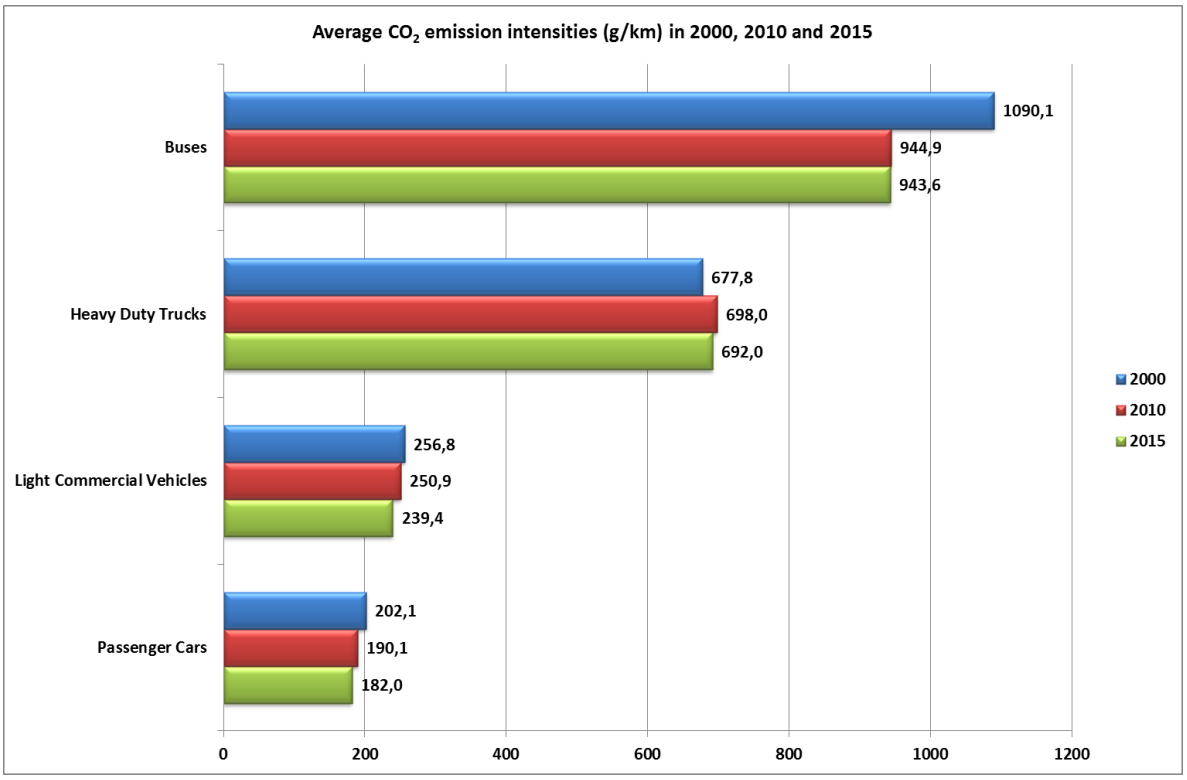


Figure 2.26. Average CO_2 emission intensities (g/km) in 2000, 2010 and 2015
Source: Institute for Transport Sciences (KTI), 2016

For CO_2 emission intensities (g/km) the average values of the year 2005, 2010 and 2015 can be considered. Figure 2.26. shows the difference between vehicle sector groups in 2000 and 2010. In every case (passenger cars, light commercial vehicles, heavy duty trucks and buses) average CO_2 emission intensities (g/km) is decreased between 2010 and 2015.

The increasing number of vehicles and the changing utilisation patterns have significant impact on future fuel consumption and energy use.

2.10. Agriculture

Thanks to its favourable natural endowments, Hungary has had a significant and internationally appreciated agricultural sector for centuries. Moderate climate, fertile soils and outstanding water conditions together with high levels of technology and knowledge enable agriculture to supply domestic citizens and foreign markets with safe, high quality food. Thus, agriculture is of outstanding and strategic importance in the Hungarian national economy, which is shown by its contribution to GDP, its role in the production of safe and healthy food, in sustainable and efficient management of natural resources, in rural employment, as well as its contribution to the maintenance of rural landscapes.

Since Hungary's accession to the EU, its agriculture has developed considerably and its efficiency, competitiveness and profitability have begun to catch up with the EU15. As a result, the significance of Hungarian agriculture has increased in terms of production and income indicators. Nevertheless, there are still many reserves in the agriculture of the

country; its role in the EU's agriculture can be further increased in the future, with a better utilization of its capabilities.

Economic significance

In the period of 2012-2016, the share of agriculture in total gross value added was about 4,4-4,7%, the share of total investment was 4,7-5,7% and the share of total employment was 4,6-5,0%. Agriculture's contribution to growth in GDP was outstanding in three out of the last five years; in 2016 the gross value added of the sector grew by 9,9%, which thus contributed 0.4 percentage points to the 2.2% overall growth.

The output of agriculture increased further in 2016, continuing the trend which started in 2011, and reached a new record. According to the second estimate of Economic Accounts of Agriculture, the output was HUF 2619 billion at current basic prices in 2016, 5.3% more than in 2015. Output volume increased by 8.7%, more than balancing the 3.1% drop in producer prices. The outstanding performance in 2016 was driven by crop production, however the volume of animal output increased further despite the low producer prices.

Between 2012 and 2016, the output of agriculture at current basic prices increased by 20.8 percent, and both crop production (+25.2%) and animal output (+13.5%) contributed to this achievement. Calculated at constant prices, the output of agriculture has increased by 33.1% in the last four years: crop output grew by 47.9%, while the animal sector experienced 13.2% growth.

Exports and the trade balance of agro-food products have expanded significantly in recent years, gaining a major macroeconomic role. Following the trend of the last two years, exports of agro-food products increased further and reached EUR 8037.3 million, EUR 123.9 million more than in the previous year and only EUR 37 million less than the all-time record achieved in 2012. However, the growth of imports was even higher in 2016, thus the trade balance decreased slightly. Imports of agro-food products were EUR 5159.6 million (up 6.3% or EUR 304.4 million compared to 2015), the trade balance was EUR 2877.8 million (-5.9% or EUR -180.5 million). In the last five years, the share of agro food products in total exports was about 8-10%, from imports was about 6%, and from the trade surplus was 29-54%.

Land use

In Hungary, the share of utilised agricultural area and arable land in the total land area is considered to be high in international comparison. Out of the total 9.3 million hectares land, 58% is under agricultural cultivation. The most significant forms of land use are arable land (four fifths of the total agricultural area) and grassland (15% of the agricultural area). By comparison, in the EU, 42% of the total area is agricultural area, and 25% is arable land. In Hungary the share of agricultural area in the total area is the fifth highest, and of the arable land in the total area is the second highest in the EU.

In a multiannual perspective, slow but continuous expansion of the arable land and grassland can be observed, while the areas of the other land use forms have remained almost constant. In the period 2012-2016, the agricultural area increased by 34.0 thousand hectares, of which arable land grew by 11.1 thousand hectares and grassland increased by

25.3 thousand hectares, whereas the size of kitchen gardens, vineyards and orchards decreased by 0.2-1.7 thousand hectares.

Crop production

The natural and climatic conditions of Hungary are very favourable for agricultural production. Owing to the various advantages of the growing areas, crop production is very diverse, but cereals, oilseeds and industrial crops dominate.

While 2012 and 2013 were characterised by extreme droughts, crop yields in 2014 were good due to the mild weather and the very favourable climate of 2016 lead to outstanding good results in crop production in Hungary. The optimum weather of the winter months, the heavy rains in May, and the surprisingly cooler and rainier summer made the conditions ideal for the growth of arable crops, as opposed to the disadvantageous weather in 2015 that had, either because of inland waters or the extremely hot weather and the summer drought, reduced the yield prospects.

In 2016, cereals were harvested on 2.552 million hectares and yielded 17 million tonnes, therefore, while the growing area declined by 5.4% compared to the previous year, the yield increased by 17.8%. The yield result surpassed the average of the period of 2012-2015 by 32.3%. The abundance of cereal stocks and the record production had an impact on stock quotes, which weakened considerably in 2016.

Wheat was produced on 1.040 million hectares in 2016, with. 5.38 tonnes/hectare average yield. The production area of maize was 1.023 million hectares. The average yield in 2016 reached the highest so far, at 8.61 tonnes/hectare, a 51.3 percent increase over the slight results of the previous year. The main oilseeds (sunflower seed, rapeseed) were grown on 899 thousand hectares, that was slightly more in 2016 than in the previous year (+7.4%). The oilseeds producers harvested 30.5% (2.8 million tonnes) more yield than in 2015, and compared to the average of the four years (2012-2015) the harvested quantity was 35.8% higher. Sugar beet was grown on 16 thousand hectares in 2016, 6.7% more than in the previous year. However, the yield of 615 thousand tonnes was 30.6% down on 2015 (2012-2015: -35.7%). In the 2015/2016 economic year, the price of raw and white sugar increased significantly on the world market and also in the European Union. The global consumption exceeded the output, which pushed the price of the product higher.

Horticulture (production of vegetable, fruits and grapes)

Vegetable and fruit production has a long tradition in Hungary, thanks to the favourable natural conditions. Horticulture is a very labour-intensive sector and plays significant role in agricultural employment. Rainy weather in 2016 was advantageous for the open field vegetables, while fruit production was affected negatively by spring frosts, heavy rains and hails in the recent years.

The area of vegetables was 79.3 thousand hectares in 2016, a 6.1% decrease over the previous year, but the quantity produced increased by 6% due to wet weather. The large amount of rain has been expressly beneficial for production of sweet corn and other industrial vegetables (green peas and beans, industrial tomatoes).

The area of fruit plantations is ca. 91 thousand hectares. In 2016, in some areas, the size of apple was smaller because of the frost. The quantity of apple was similar than in the previous years, but the quality was worse than usual, the ratio of industrial apple was 70%. In the main pear production areas, the spring frost and summer hail caused reductions in yield of up to 50%.

Over the past five years, cut-outs and weather have determined the volume of the grape and wine production, and the weather has significantly influenced the quality. The hail caused huge damage in vineyards, so the volume of production in 2016 was lower than in the previous years. Hungary currently produces wine grapes in 22 wine regions on nearly 65,000 hectares.

Animal husbandry

Hungary's agricultural production decreased dramatically between 1990 and 2000 and the drop of livestock reached 50% which has been continued after the EU accession as well. In recent years, due to Government's aims to reverse these trends, several measures were introduced which has resulted slight positive changes in the animal husbandry sector. In the next years further increase of the livestock is expected.
The stock of cattle has increased since 2011 and this trend continued in 2016, which is primarily attributable to the expansion of the beef stock and the favourable market conditions. The number of cattle increased in 2016, a 4% rise over the figure for 2015. The stock of cattle increased by 12.1% between 2012 and 2016, the largest percentage increase among the EU Member States. The stock of cows has increased by 15 thousand to 382 thousand since 2015, that is 12% higher than in December 2012. The number of dairy cows did not change significantly in 2016, however it grew by 5% between 2012 and 2016, despite the two-year milk market crisis. The number of beef cattle has increased since 2015, which has been 65% growth since 2012. Cattle was mainly exported (exports of live cattle to Turkey have doubled in the last year). Hungary was a net exporter of live cattle and beef in 2016.

The pig stock in December 2016 amounted to 2.887 million, which was about 7.6% lower than in the previous year. The number of sows fell by 10.2%. The number of pigs decreased both in agricultural enterprises and in private holdings.

In Hungary, 210.3 million poultry were slaughtered in 2016, 5.8% more than in 2015. During the last four years, the duck and chicken sectors have been developing dynamically, but they have been negatively affected by the appearance of avian influenza, especially in the case of waterfowl.

The sheep stock decreased by 2.5% to 1158 million in 2016 compared to the previous year. The number of ewes also decreased, by 5.1%. The number of private farms with sheep fell by 4.8%, while the number of enterprises rose by 4.2%.

Manure and fertiliser use

Areas fertilised with farmyard manures amounted to 272.6 thousand hectares on average in 2011-2015, the tendency shows decline (2015: 254.9 thousand hectares). Areas fertilised with chemical fertilizer amounted to 3183.2 thousand hectares on average in 2012-2016

(2016: 2840 thousand hectares). Amount of fertiliser used on average in 2012-2016 is 372.6 kg/ha.

Subsidies

Subsidies on agriculture, rural development and fisheries totalled approximately HUF 654.1 billion in 2016, of which 80% came from EU funds, most notably from the European Agricultural Guarantee Fund (EAGF). This amount was supplemented by an additional HUF 27.4 billion of excise duty refund on fuel oil used in agriculture. With the co-financing of the European Agricultural Fund for Rural Development (EAFRD), rural development subsidies for different purposes are disbursed. The aid intensity typically does not reach 100%, which means that own resources are sufficient. Rural development subsidies amounted to HUF 34.9 billion in 2016, and fisheries subsidies to HUF 1.9 billion.

In the case of grants funded purely from national sources, payments of HUF 103.9 billion were realized in the calendar year 2016. A substantial share (HUF 39.7 billion – it includes payments for both claim year 2015 and the advance payments for claim year 2016) was fulfilled through the transitional national support (TNA) related to the single area payment associated with the small amount subsidies. Within the framework of the TNA, milk, beef, cattle extensification, suckler cows, ewe and tobacco sectors have been financed.

The pig and poultry sector does not benefit from EAGF; it is mostly subsidized from domestic budgets, mainly through animal welfare measures. For pig farmers in 2016, HUF 9.4 billion could be paid for pigs, HUF 7.8 billion for breeding sows, while poultry holders could use HUF 12 billion. The pig industry was also supported by the HUF 1.6 billion programme of the pig strategy. Veterinary measures amounted to HUF 12.5 billion. In addition, the sector has benefited from additional EU funds (EARDF) through the 2014-2020 Rural Development Program.

The Agrarian Damage Compensation System (ADCS) is based on the common risk and burden of producers and the state. The funding of the compensation comes from the annual payments made by producers and the equivalent amount of state resources. Producers are compensated for damage caused by drought, inland water, downpour, hail, agricultural flood, spring frost, autumn frost, winter frost or storm, under statutory conditions. In 2016, payments totalling HUF 6 billion were made for damage caused in 2015 by drought, hail, inland water, storm, spring frost and downpour. Within the framework of animal and plant compensation, HUF 3.5 billion was disbursed.

The 'Farmstead Development Programme', operating in tender form, in 2016 supported the renewal and revitalization of farm management, the improvement of the quality of life of the people living on farms and the remaining of young people in rural areas to a total of HUF 1.8 billion.

Future prospects

Hungary is fundamentally interested in a strong and competitive agriculture thanks to its favourable natural endowments, soil quality and climate. Agricultural production has an especially important role in rural areas contributing to the regional and social cohesion. Hungary's agriculture has developed significantly after the EU accession, but there are still

reserves and further progress is foreseen. An accentuated objective is the improvement of the position of animal production and in the coming years a livestock growth is expected. Therefore, innovation, research, emission reduction policies and education has to be given a central role as these can lay down the fundaments of an agriculture that can supply the quantity and quality demands and simultaneously be environmentally sustainable and climate friendly. Hungary's prime interest is that its EU membership through the common market and the common policies contribute to the modernisation of agriculture and the preservation of natural environment.

2.11. Waste management

To describe situation of waste management, three basic indicators are used: the change in annual waste generated, the amount of municipal waste generated, and the amount of municipal waste landfilled are presented in respect of kg/person/year.

Over the past period the amount of the waste generated does not show significant change in time series analysis, it is relatively stable. The amount of municipal waste shows a slight decrease. The most significant displacement was the reduction of the amount of the landfilled waste in domestic waste management, and the increase of the amount of the waste material recovery.

	2012	2013	2014	2015
Total waste* (kt/year)	15167	14766	15731	15526
Change in waste from previous year	96,8	97,4	100,07	98,7
Generated of municipal waste kg/person/year	402	378	385	377
Disposed of by landfill of municipal waste kg/person/year	263	244	221	202

Table 2.9. Tendency of waste generation and relevant indicators, 2012-2015*
Source: FM HIR, KSH

*The amount of total waste, after the entry into force of the Act CLXXXV 2012 on Waste, has reduced with the quantity of municipal liquid waste in order to ensure the relevance of the waste statistics and therefore the 2012 data have also been corrected.

Total waste and its main sectoral distribution shows relative stability for the 2012-2015 period. Typically some 15.5 tonnes of waste are produced annually, which is below EU average provided it is measured in kg/capita/year.

Possible cause of differences are analysed below via production volume of waste streams:

	2012	2013	2014	2015
Agricultural and food industry waste	796,9	932,6	890,3	680,6
Industrial and other business waste	5 797,4	5 759	6 189	5 899,5
Construction and demolition waste	3 808,7	3 772,2	4 204,5	4 738,2
Hazardous waste	776,4	564,8	652,5	498,2
Municipal waste	3 987,5	3 737,8	3 794,8	3 709,6

Table 2.10. Waste generated by source (ktons), 2012-2015
Source: FM HIR, KSH

Based on time series analysis the amount of agricultural waste is changing in a significant way. The range of agricultural and food waste is wide, it includes the agricultural waste, the waste generated in the forestry sector, the waste of the hunting and fishing sectors, and also the waste of the food processing industries. Most of these wastes are biodegradable waste, but it also includes the waste generated in the processing technologies, which is not biodegradable waste (for instance sludge, preservative waste). The amount of the agricultural and food waste on the one hand depends on the size of the agricultural land in Hungary. On the other hand it depends on the size of the food processing capacities, and on the fact that over the past period only a small part of the food by-products appears as waste.

Industrial and business waste is the largest source in waste generation. The reduction of waste can be directly from the shrinking of economy, or the appearance of modern low material intensity industries and measures aiming at waste generation prevention.

The generated volume of construction and demolition waste reflects the industry's performance. Construction industry has expanded, partly due to infrastructural investments, partly due to home building programmes. There is 24% change in volume from 2012 to 2015.

The amount of hazardous waste generated in the given year is in connection inter alia, with the ongoing remediation programs, thus this amount can show smaller or greater differences in each year, so the deduction of long term conclusions is cannot be grounded solely by analyzing the quantity generated annually.

Municipal solid waste has decreased by 6% from 2012 to 2013 and has stagnated since then. According to our forecasts this will not change in the future, and also a radical change in the amount of municipal waste generated is not expected.

Generation of municipal liquid waste (household wastewater not treated by public waste management plants) is in connection with the advancement of national waste drainage projects and by more conservative household use of freshwater. After the adoption of the Act on Waste, liquid municipal waste does not belong to the broad category of waste.

	2012		2013		2014		2015	
	ktons	%	ktons	%	ktons	%	ktons	%
Amount of waste (kt)	15 166		14 766		15 731		15 526	
Material recovery	6 721	44	6 561	44	8 042	51	7 776	50
Energy recovery (Incineration with energy recovery)	980	6	1 191	8	1 215	8	1 211	8
Incineration	92	1	87	1	95	1	89	1
Disposal (Landfill)	6 978	46	6 426	44	5 932	38	6 257	40
Other	395	3	501	3	365	2	192	1

Table 2.11. Generation and treatment of wastes (without sludge) 2012-2015
Source: FM-HIR, KSH

Table 2.11. shows that a significant shift can be observed in the treatment of total waste in the recent years. The amount of the landfilled waste has been decreased, whereas the amount of waste material recovery has been increased.

Legislative background

The EU's 98/2008/EC directive regulates waste management in Member States. It prescribes the recycling rate of paper, metal, plastic and glass waste from households to be over 50% in mass by 2020, for construction waste the reutilisation and recycling rate should be over 70%. Detouring waste from disposal should be aided by the implementation of a separated waste collection system for glass, metal, plastic and paper generated in households. The Directive further specifies the biodegradable organic matter deposited as part of the municipal waste- the biodegradable organic material which was generated in 1995 at a national level, and is the part of the municipal waste- the amount shall be reduced by 1 July 2016 to 35%, it means below 820 000 tonnes.

The domestic legislation for waste management is the Act on Waste (2012/CLXXXV). The Act specifies a waste hierarchy to prioritise waste management practices. According to this hierarchy the best practice is prevention of waste generation. If it is not feasible, reutilisation has to be targeted followed by recycling. Only at the end may come disposal or incineration.

The National Waste Management Plan defines the policy ideas for 2014-2020, it also introduces the legal background of our waste management in Hungary. It explores the current state of treatment per waste stream, the experienced deficiencies, and defines the objectives to be achieved, and also the instruments and measures necessary for the implementation.

An operative programme for prevention is - is part of the National Waste Management Plan - the National Waste Prevention Programme. This strives to achieve the goals of waste reduction by promoting materials and quality products in manufacturing chains, which

ensure longer lifetime or reutilisation potential. This is aided by the extension of manufacturers' responsibilities.

The formulation of segregated waste disposal is undertaken in practically all settlements aiding waste recycling and reducing deposition rate.

In the treatment of waste, significant changes have occurred in the past years, the amount of waste material recovery has increased. Compared to the total amount in 2012, the amount recovered in its material was 37%, in 2015 this rate reached 50%. The amount of disposal decreased from 46% in 2012 to 40% by 2015. The decrease for disposal has been significantly affected by the introduction of the landfill charge by 1 January 2013. The amount of landfill charge is HUF 6 000/ton.

2.12. Forestry and land-use change

There is a detailed system in Hungary to continuously collect data on forests and forestry, run by the Forestry Directorate of the National Food Chain Safety Office (NFCSO FD, or NÉBIH EI in Hungarian). A detailed description of forestry-related databases of NFCSO FD in English can be found at http://portal.nebih.gov.hu/-/supplementary-information A general description of the National Forest Inventory that collects data for the database in a cadastre-type system, as well as the Hungarian forests and forestry can be found in English at

http://portal.nebih.gov.hu/en/web/erdoleltar/?r=0

and

http://portal.nebih.gov.hu/documents/10182/862096/Forestry_related_databases.pdf/3ff92716-2301-4894-a724-72fafca9d4fc.

All statistical data on forests that are reported in this document were taken from the official statistics of the Forestry Directorate of the NFCSO as well as the most recent National Inventory Report, if not reported otherwise.

In general, forests in Hungary have been managed sustainably for about a century (Ministerial reports 2006-2017; Forest Europe 2015), and, overall, have continued to be carbon sinks. Concerning forest area, the fact that the management was sustainable is well demonstrated by the constant increase of the area covered by. Of the total area of the country (9 303 000 ha), 2061 thousand ha were under forest management, and 1 941 thousand ha were covered by forests in 2015. All figures have been increasing for decades (Figure 2.27.). The area of both forest land remaining forest land (FL-FL) and land converted to forest land (L-FL) show an increase with the exception of L-FL that started to decline a bit due to the reduction of the afforestation rate recently. However, altogether almost 800 thousand ha new forests were established in the last eight decades, and more than 160 thousand ha since 1990.

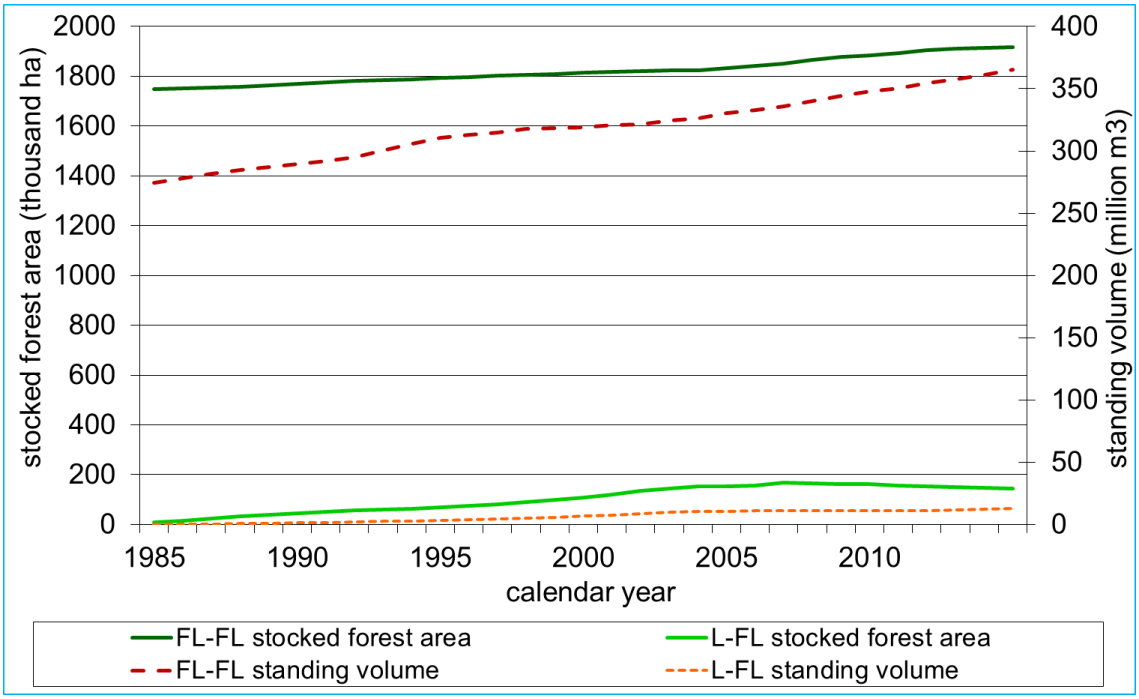


Figure 2.27. The development of the area of stocked forests since 1985
Source: National Inventory Report Hungary, 2017

The new forests have added much to the services of the forests, including the sink capacity. The sink of the biomass of the forests established since 1990 have been 1.1-1.2 million tCO_2 a year in this decade (NIR Hungary 2017). Considering that the sink of the forests that existed already before 1990 and that have ten times as large area have only twice as much sink, these figures show how effective afforestation can be in terms of sequestering carbon from the air.

Also, there is not much pressure on our forests in terms of deforestations. We have deforestations each year (Table 2.12.), but both their area and the emissions from them are small and conversion can only occur if authorities identify good reason for it (such as road building, other infrastructure etc.).

Inventory year	Conversions from FL to other land use			
	Area (ha)		CO_2 emissions (Gg CO_2)	
	forest subcompartments	forest and other subcompartments	from biomass	from soils
1985	326,1	326,1	41,0	0,5
1986	326,1	326,1	41,0	1,0
1987	326,1	326,1	41,0	1,5
1988	326,1	326,1	41,0	2,0
1989	326,1	326,1	41,0	2,4
1990	612,9	612,9	77,1	3,4
1991	239,8	1817,0	30,1	6,2
1992	125,6	1447,1	15,8	8,3
1993	328,6	328,6	41,2	8,5
1994	218,2	218,2	27,4	8,8
1995	357,8	357,8	44,8	9,2
1996	345,9	616,7	43,3	9,6
1997	522,0	522,0	65,6	10,2
1998	402,0	402,0	50,2	10,8
1999	395,4	1446,9	49,4	11,7
2000	719,1	1186,6	89,7	13,4
2001	520,9	1297,0	64,9	14,6
2002	637,5	1856,4	79,4	16,7
2003	593,3	1252,1	73,9	18,4
2004	943,8	1386,7	117,4	20,1
2005	411,1	858,8	51,1	20,9
2006	508,6	1326,7	63,2	22,5
2007	245,5	1353,5	30,5	23,4
2008	293,8	1151,9	27,1	24,4
2009	455,0	1490,0	58,0	24,9
2010	208,3	2351,3	27,8	25,8
2011	276,6	1603,5	45,7	25,2
2012	782,4	1713,2	131,6	22,0
2013	532,1	1246,1	61,5	22,8
2014	601,9	1501,3	84,5	24,1
2015	1382,8	1699,1	116,7	24,8

Table 2.12. The area of deforestations and resulting emissions from biomass cleared in Hungary

Source: National Inventory Report Hungary, 2017

No major changes have taken place in the ownership structure of the forests for the last decade. Most of the changes in the ownership structure are due to afforestation, as by far the most new forests are established in the private sector. The share of private forests amounts to 42.5%, whereas forests owned by local governments only amount to 1%. Most forests (56.5%) are thus still state owned. (The ownership of some 0.2% of forests is unaccounted for).

Most forests (approx. 63%) are classified as production forests. The share of protection forests is 36%, whereas forests serving predominantly social, touristic, educational and scientific purposes amount to 1%.

Sustainability is also demonstrated by the fact that the stock volume of the Hungarian forests has continuously increased in the last several decades (from 257 million m^3 in 1981 to 378 million m^3 in 2015; see also Figure 2.26 above). This increase is partly due to the fact that forests have been predominantly young, but partly due to the continuing afforestation programmes, which have substantially increased forest resources since 1930 when they started. A third reason is that for the last several decades, the wood increment of the forests has always topped the sum of all harvests and mortality due to sustainable forest management (Figure 2.28.): the amount of harvests has only been some 70% of the total increment. Although the health monitoring of the forests indicates the increase of forest damages for the last three decades, the amount of salvage loggings (1995: 552 thousand m^3; 2000: 427 thousand m^3; 2005: 530 thousand m^3; 2011: 393 thousand m^3; 2015: 513 thousand m^3[3)] has not shown any increasing (or decreasing) trend.

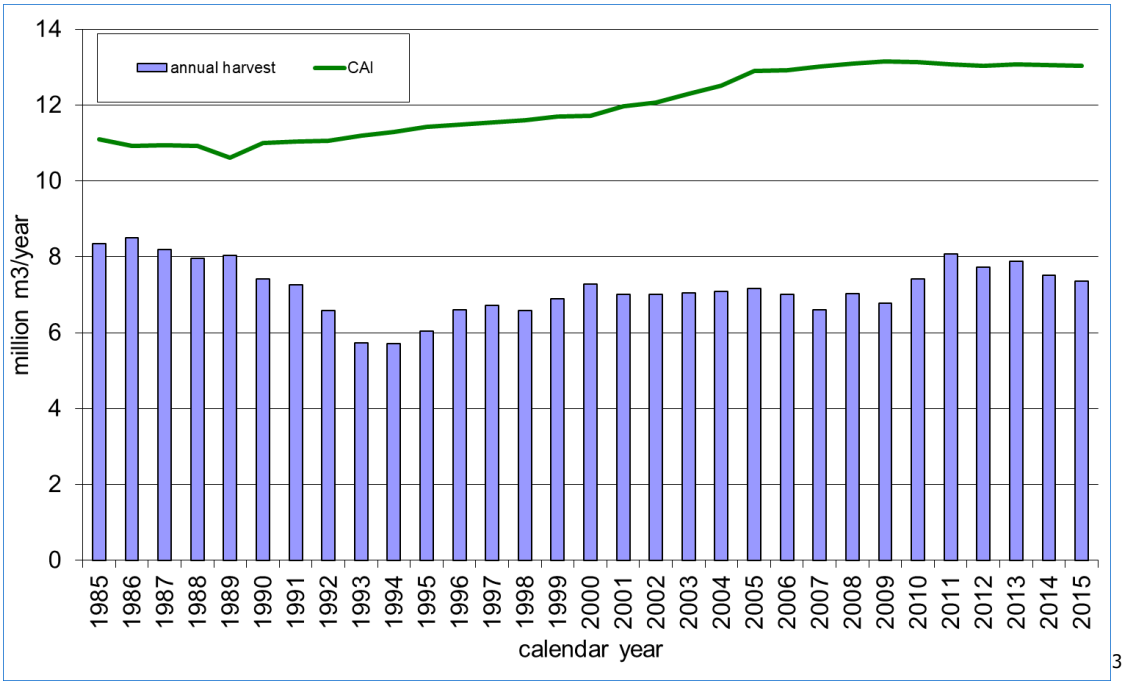


Figure 2.28. The total amount of annual harvest and the estimated current annual increment (CAI) over time in Hungary.

Source: National Inventory Report Hungary, 2017

[3] References: Forest Europe, 2015: State of Europe's Forests 2015.
NIR Hungary 2017. National Greenhouse Gas Inventory Report.
URL: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

3. GREENHOUSE GAS INVENTORY INFORMATION

3.1 Summary Tables

GREENHOUSE GAS SOURCE AND	CO_2 (1)	CH_4	N_2O	HFCs
SINK CATEGORIES	**CO_2 equivalent (kt)**			
Total (net emissions)(1)	40194,66	7643,96	4361,40	2345,79
1. Energy	41623,23	1321,66	329,88	
A. Fuel combustion (sectoral approach)	41491,56	679,25	329,61	
1. Energy industries	13815,53	25,88	65,54	
2. Manufacturing industries and construction	4298,93	7,95	18,67	
3. Transport	12042,39	25,51	134,74	
4. Other sectors	11316,81	619,91	110,51	
5. Other	17,89	0,00	0,15	
B. Fugitive emissions from fuels	131,67	642,41	0,27	
1. Solid fuels	NO,IE,NA	56,67	NO,IE,NA	
2. Oil and natural gas	131,67	585,75	0,27	
C. CO_2 transport and storage	NO			
2. Industrial processes and product use	4775,15	50,49	96,75	2345,79
A. Mineral industry	1140,28			
B. Chemical industry	2325,70	45,36	50,29	NO
C. Metal industry	1166,19	5,14	NO	NO
D. Non-energy products from fuels and solvent use	142,97	NO,NA	NO,NA	
E. Electronic Industry				NO
F. Product uses as ODS substitutes				2345,79
G. Other product manufacture and use	NO	NO	46,46	NO
H. Other	NO	NO	NO	NO
3. Agriculture	184,80	2722,69	3768,86	
A. Enteric fermentation		2036,69		
B. Manure management		667,08	466,01	
C. Rice cultivation		18,92		
D. Agricultural soils		NA	3302,84	
E. Prescribed burning of savannas		NO	NO	
F. Field burning of agricultural residues		NO	NO	
G. Liming	17,91			
H. Urea application	86,83			
I. Other carbon-containing fertilizers	80,06			
J. Other	NO	NO	NO	
4. Land use, land-use change and forestry(1)	-6582,84	18,08	52,65	
A. Forest land	-5881,11	17,33	18,28	
B. Cropland	-282,63	0,15	22,27	
C. Grassland	-200,55	0,61	0,66	
D. Wetlands	221,56	NO	1,27	
E. Settlements	208,04	NO,NA	10,17	
F. Other land	0,05	NO,NA	NO	
G. Harvested wood products	-648,20			
H. Other	NA	NA	NA	
5. Waste	194,33	3531,04	113,26	

A. Solid waste disposal	NO,NA	3058,80		
B. Biological treatment of solid waste		98,85	34,25	
C. Incineration and open burning of waste	194,33	0,31	2,14	
D. Waste water treatment and discharge		373,08	76,86	
E. Other	NO	NO	NO	
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO

Memo items:(2)				
International bunkers	543,17	0,09	4,53	
Aviation	543,17	0,09	4,53	
Navigation	NO,NE	NO,NE	NO,NE	
Multilateral operations	NO	NO	NO	
CO_2 emissions from biomass	12492,14			
CO_2 captured	NO			
Long-term storage of C in waste disposal sites	11957,13			
Indirect N_2O			NO,NE	
Indirect CO_2 (3)	NO,NE			

GREENHOUSE GAS SOURCE AND	**PFCs**	**SF_6**	**Unspecified mix of HFCs and PFCs**	**NF_3**	**Total**
SINK CATEGORIES	**CO_2 equivalent (kt)**				
Total (net emissions)(1)	1,15	111,88	NO	NO	54658,84
1. Energy					43274,77
A. Fuel combustion (sectoral approach)					42500,42
1. Energy industries					13906,95
2. Manufacturing industries and construction					4325,55
3. Transport					12202,64
4. Other sectors					12047,23
5. Other					18,04
B. Fugitive emissions from fuels					774,35
1. Solid fuels					56,67
2. Oil and natural gas					717,69
C. CO_2 transport and storage					NO
2. Industrial processes and product use	1,15	111,88	NO	NO	7381,21
A. Mineral industry					1140,28
B. Chemical industry	NO	NO	NO	NO	2421,36
C. Metal industry	NO	NO	NO	NO	1171,32
D. Non-energy products from fuels and solvent use					142,97
E. Electronic Industry	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes	1,15	NO	NO	NO	2346,94
G. Other product manufacture and use	NO	111,88	NO	NO	158,34
H. Other	NO	NO	NO	NO	NO
3. Agriculture					6676,35
A. Enteric fermentation					2036,69
B. Manure management					1133,09
C. Rice cultivation					18,92
D. Agricultural soils					3302,84

E. Prescribed burning of savannas					NO
F. Field burning of agricultural residues					NO
G. Liming					17,91
H. Urea application					86,83
I. Other carbon-containing fertilizers					80,06
J. Other					NO
4. Land use, land-use change and forestry(1)					-6512,11
A. Forest land					-5845,50
B. Cropland					-260,22
C. Grassland					-199,29
D. Wetlands					222,83
E. Settlements					218,21
F. Other land					0,05
G. Harvested wood products					-648,20
H. Other					NA
5. Waste					3838,62
A. Solid waste disposal					3058,80
B. Biological treatment of solid waste					133,10
C. Incineration and open burning of waste					196,77
D. Waste water treatment and discharge					449,94
E. Other					NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO

Memo items:(2)					
International bunkers					547,79
Aviation					547,79
Navigation					NO,NE
Multilateral operations					NO
CO_2 emissions from biomass					12492,14
CO_2 captured					NO
Long-term storage of C in waste disposal sites					11957,13
Indirect N_2O					
Indirect CO_2 (3)					

Table 3.1 Summary Report for CO_2 Equivalent Emission

Source: National Inventory Report, Hungary 2017

Total CO_2 equivalent emissions without land use, land-use change and forestry 61170,95

Total CO_2 equivalent emissions with land use, land-use change and forestry 54658,84

3.2 Descriptive summary

The trends of the total greenhouse gas emissions may be assessed on the basis of the GWP. The table below shows the time series of net and gross emissions:

	BY[4]	1990	1995	2000	2005	2010	2013	2014	2015
Total (incl.LULUCF)	107,698	91,224	69,775	72,694	69,917	60,854	53,526	52,518	54,580
Total (excl.LULUCF)	109,505	93,896	75,474	73 461	75 774	65,405	57 401	57,879	61,092

Table 3.1 Total GHG emissions (including and excluding LULUCF)
Source: National Inventory Report, Hungary 2017

The figure below shows the net emissions from the base year until the last year assessed in the last two submissions, taking also removals into account. The small effect of the recalculations can also be seen on this figure.

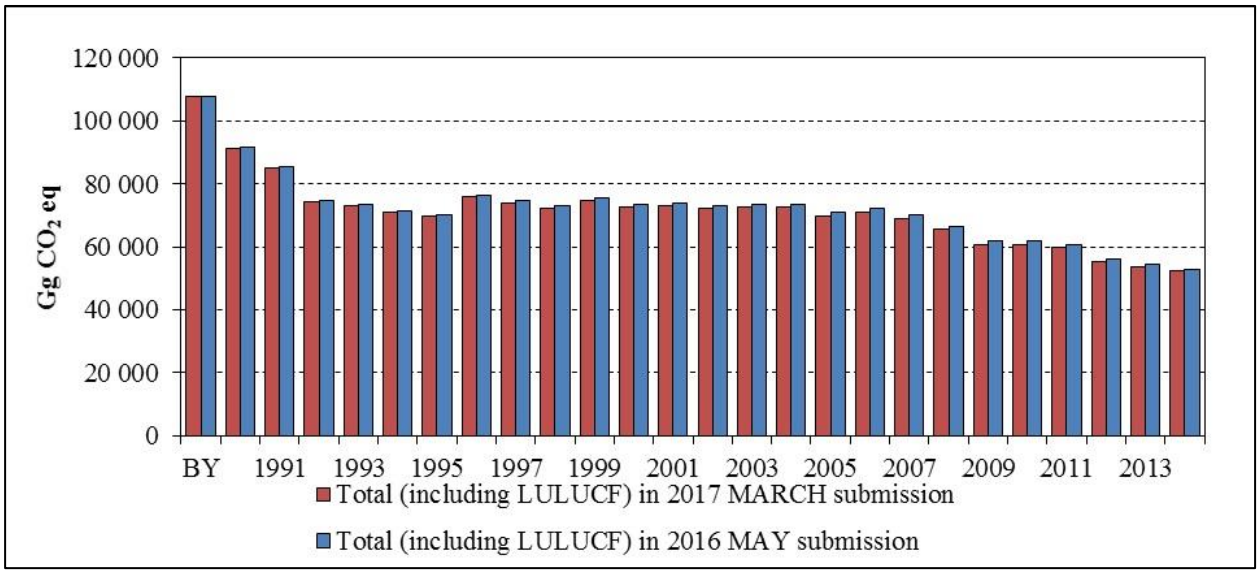


Figure 3.1 Total emission (including net CO_2 from LULUCF) between 1985 and 2014
Source: National Inventory Report, Hungary 2017

Compared to the base year, emissions were significantly reduced in the energy (-45%), industrial processes and product use (-52%), and agriculture (-44%) sectors. In contrast, emissions in the waste sector have increased since 1985 (+14%). The land use, land-use change and forestry (LULUCF) sector shows fluctuating behaviour. Looking at the most recent trends since 2005, emissions have significantly decreased in the energy and industrial processes sectors by 23% and 22%, respectively. The agriculture sector seems to have recovered and could show an increase of 10% since 2005. The previous growing trend turned back in the waste sector (-13%).

[4] BY=average of 1985-87

For a better understanding of the Hungarian emission trends, the time interval of the inventory should be split into three periods with different emission relevant economic processes in the background. The first period (1985-95) would be the years of the regime change in Hungary, whereas in the second period (1995-2005) the rules of the market economy became decisive. The second period can also be characterized by the decoupling of GDP growth from the GHG emission trend which is undoubtedly an important development. By 1999, the GDP reached the pre-1990 level; however, emission levels remained significantly below the levels of the preceding years. Thus, the emissions per GDP were decreasing.

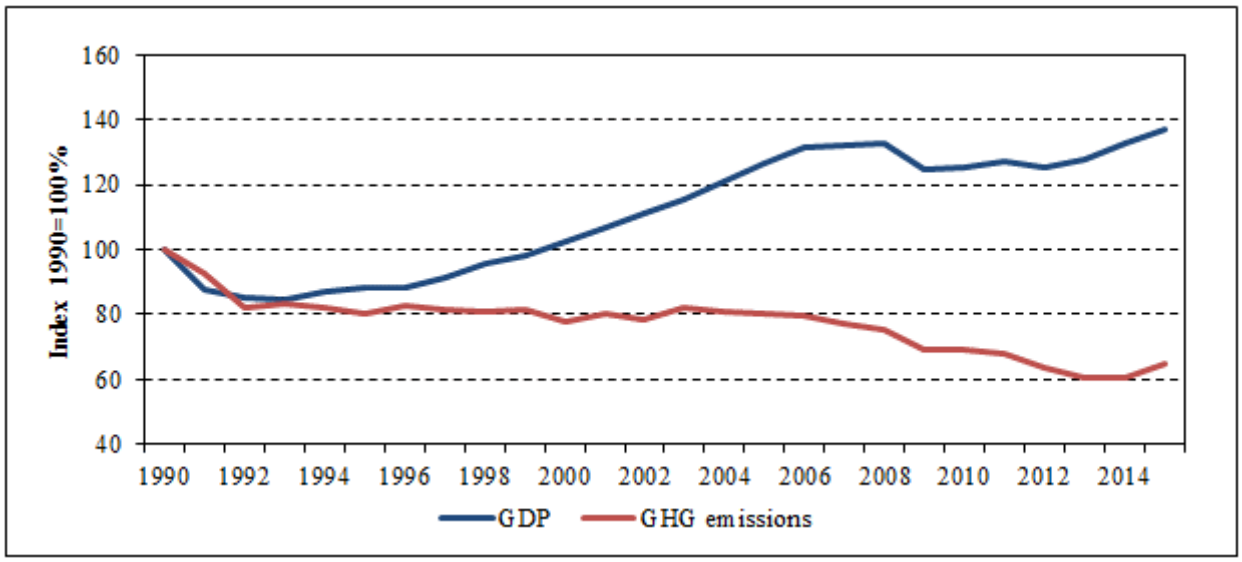


Figure 3.2. Comparison of trends in GDP and GHG emissions
Source: National Inventory Report, Hungary 2017

In the third period, after 2005, Hungary experienced an emission reduction of 24% up to 2013, out of which 6% occurred in the first three years up to 2008: basically, due to mild winters, higher energy prices, and modernization in the chemical industry. Then in 2009, the global financial-economic crisis made its radical influence felt which can also be seen at the dropping GDP values in *Fig. 2.2*. From 2010 on a slight recovery of the economy could be observed, the emissions, however, not just remained at a relatively low level but decreased again quite significantly. The decreasing trend stopped in 2014 and an increase of 7% could be observed in 2015.

Starting with the first period, the process of transition into market economy brought in its train radical and painful decline in the output of the national economy. The production decreased in almost every economic sector including also the GHG relevant sectors (energy, industry and agriculture). Consequently, GHG emissions decreased substantially in these years by around 34 million tonnes CO_2 equivalent. Between the mid 80's and the mid 90's emissions fell back in the *energy* sector by around 28%, and even more, by around 45-50% in the *industrial processes* and *agriculture* sectors.

The most significant drop in energy use occurred in the industry especially in the energy-intensive industrial sectors (manufacture of basic metals and machinery, mining etc.). The industrial output of 1992 was two third of that of 1989. Several factories were closed down,

capacity utilization was reduced, consequently the production decreased more or less drastically in each industrial sector.

Some examples:

- Iron and steel production: two out of three plants were provisionally closed down;
- Aluminium: two out of three plants were closed down in 1991 (aluminium production stopped in 2006 eventually);
- Ferroalloys: ceased to exist (1991);
- Ammonia: four out of five plants were closed down (1987, 1991, 1992 and 2002);

The agricultural sector suffered a similar decline. As a result of the political and economic processes, the number of agricultural farms was reduced by more than 30%, the number of employees by more than 50%, the volume index of the gross agricultural production by more than 30%, the livestock by about 50%, and the use of fertilizers by more than 60%. As a consequence, the share of the agricultural sector in total GHG emissions decreased from 11% to 8%.

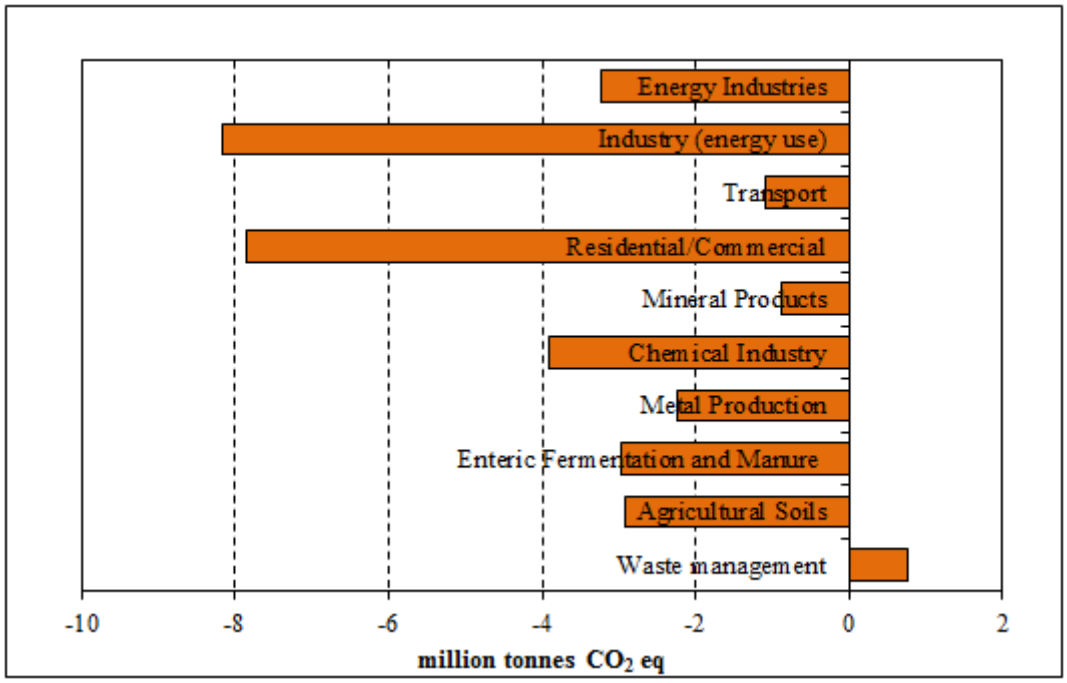


Figure 3.3. Changes in emissions due to regime change, Y1995-BY, million tonnes CO_2-eq
Source: National Inventory Report, Hungary 2017

The small increase of emissions in the *Waste* sector is exceptional among all the sectors, and it is attributable to the slightly increasing quantities of waste generated and collected but more importantly to the applied calculation method which assumes that the degradable organic component in waste decays slowly throughout a few decades.

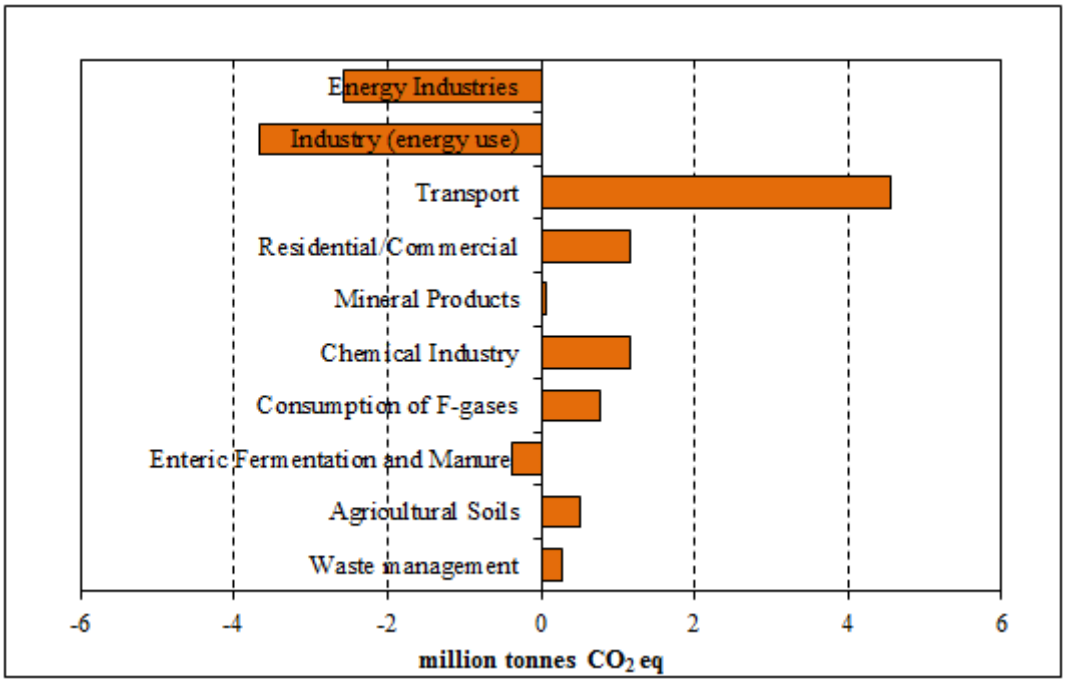


Figure 3.4 Changes in emissions between 1995 and 2005, million tonnes CO_2-eq
Source: National Inventory Report, Hungary 2017

After the mid 90's, emissions seemed to have stabilized around 75-76 million tonnes CO_2 equivalent. However, behind the quite stable emission level opposite processes could be observed which can be illustrated by the relatively bigger changes in the energy sector. The fuel use of industry decreased further which led to about 6% share only in GHG emissions around 2005. In contrast, emissions from transport increased significantly by almost 5 million tonnes CO_2 equivalent which represented a growth of 61%.

In the third period, between 2005 and 2015, emissions fell by 14.7 million tonnes or 19%. (The decrease was even higher, 24%, if we look at the period between 2005 and 2013.) About a quarter of this decrease occurred between 2005 and 2008. The decreasing energy use by other sectors and manufacturing industries, and the diminishing process related emissions in the chemical industry were the main drivers of these changes. Most importantly, total fuel consumption in the residential sector decreased by about 17% (including a 33% drop in solid fuel and a 18% decrease in natural gas use) - mainly due to extreme mild winter in 2007 but probably the growing energy prices and the support for modernization of buildings might have played a role as well. Decreased production volumes and modernization in the chemical industry led to an emission reduction of about 45%. In contrast, emissions from energy industries and transport grew further.

Then in 2009, the Hungarian economy was hit hard by the global economic crisis that exerted a significant effect on the emission level. Emissions (excluding LULUCF) decreased by 9% (-6.1 million tonnes) between 2008 and 2009. In comparison with 2008, emissions in 2009 were lower in all major sectors. The highest relative reduction (-14%) occurred in the industrial processes and product use sector mainly due to lower production volumes especially in mineral product manufacturing (-27%). Parallel to that, also energy use decreased in manufacturing industries and construction, consequently GHG emission fell by

28% here. Regarding absolute changes in emissions, out of the 6.1 million tonnes reduction, fuel combustion was responsible for about 4.6 million tonnes. Although the energy demand increased in the heating season due to less favourable weather conditions, the fall in the production of energy intensive sectors led to an overall decline in energy use.

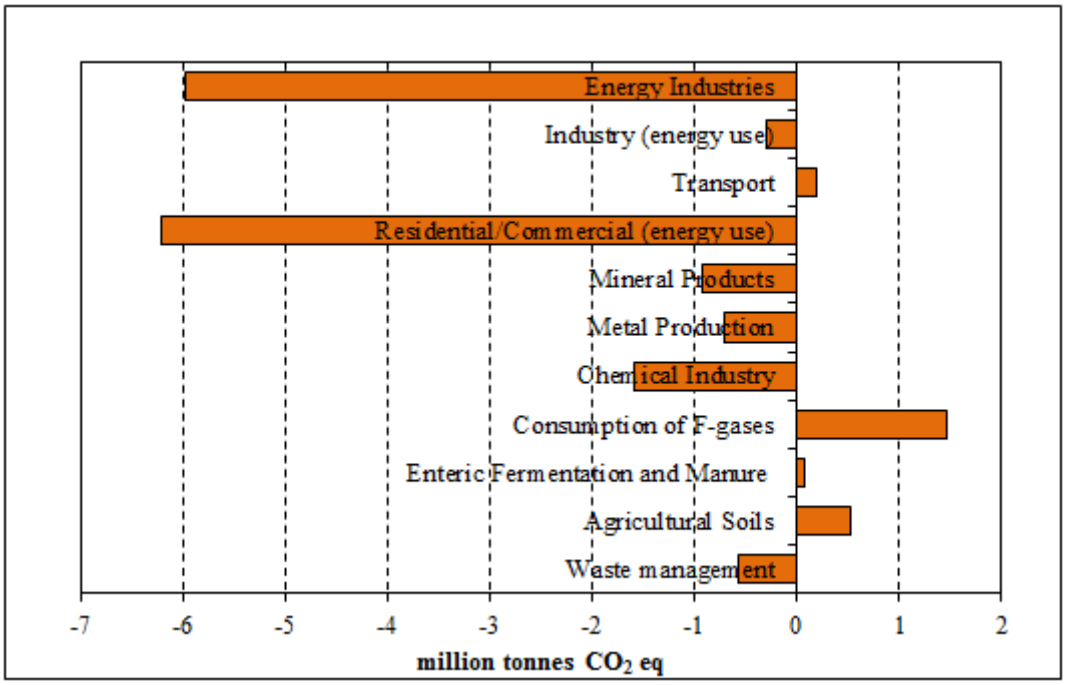


Figure 3.5. Changes in emissions between 2005 and 2015, million tonnes CO_2-eq
Source: National Inventory Report, Hungary 2017

The decline in economic output stopped in the first quarter of 2010. Mainly driven by the growth in export-oriented industrial production, the GDP grew by 0.5% in 2010. The change in GHG emissions was about the same. In the next three years, however, emissions decreased again altogether by 12%.

In 2011, we could see decreases in many areas but especially in the energy sector. Electricity production had decreased by 4% which resulted in a similar fall in GHG emissions. Natural gas consumption of the residential sector dropped by 9%. Transport emissions fell by 5%, mineral production by a further 15%. In this overall decreasing trend, agricultural soils were the main exceptions. In agriculture, we had higher fertilizer use, and greater crop production (hence higher emissions from crop residues). In this respect, it is worth noting that the economic growth in 2011 was mainly driven by agricultural production.

In 2012, the decreasing trend in emissions continued. The decrease of 3.7 million tonnes (or -6%) can almost be explained by processes in the energy sector alone (e.g. further decrease in electricity production, a 13% drop in natural gas consumption in "other sectors").

2013 was not an exception in the decreasing trend, either. Total emissions have decreased by 5% corresponding to 2.7 megatons in CO_2-eq. The decrease was dominated again by the energy sector. Emissions from power and heat production alone dropped no less than 2.6 Mt CO_2-eq due to significantly lower electricity production from fossil fuels.

Total emissions have not change much in 2014; they increased slightly by 0.8 percent. In the energy sector, we could observe some counterbalancing processes. After several years of decreasing emissions, the transport sector started to show some growth. Nevertheless, the diminishing fossil fuel based electricity production, and the lower and lower energy consumption in the residential sector led to an overall decrease of emissions.

The decreasing trend of emissions seems to have stopped in 2014. Moreover, an increase of 6% could be detected in 2015. About 74% of this growth was realized in the energy sector, whereas industrial processes contributed by a further 24%. Despite the 3.2 million tonnes increase in 2015, current emissions remained by 19% far below the emission level of 2005.

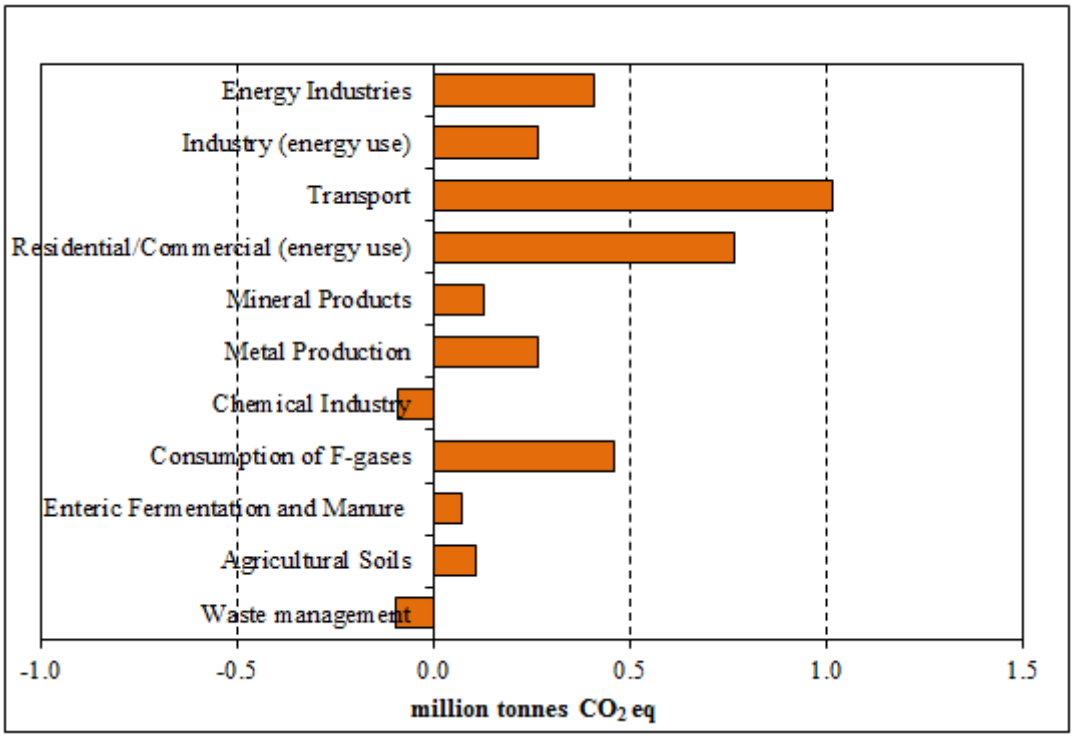


Figure 3.6. Changes in emissions between 2014 and 2015
Source: National Inventory Report, Hungary 2017

3.3 National systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol

Institutional arrangements

The minister responsible for the environment has overall responsibility for the Hungarian Greenhouse Gas Inventory and the Hungarian National System for Climate Reporting. He is responsible for the institutional, legal and procedural arrangements for the national system and the strategic development of the national inventory. The Ministry of Environment and Water had been abolished after the elections in spring 2010, and its tasks have been taken over by the Ministry of Rural Development. The structure and duties of the ministries changed again somewhat after the elections in 2014, and the Ministry of Rural Development turned to Ministry of Agriculture which nevertheless has the same responsibilities regards

environmental matters. Therefore, the designated *single national entity* is now the Ministry of Agriculture.

Contact details of the single national entity are as follows:

Ministry of Agriculture

Head office:	1055 Budapest, Kossuth Lajos tér 11.
Postal address:	1860 Budapest
Phone:	+36-1-795-2000
Fax:	+36-1-795-0200
E-mail:	info@fm.gov.hu, press@fm.gov.hu

Sándor Fazekas, Dr., Minister of Agriculture

Postal address:	1055 Budapest, Kossuth L. tér 11.
Phone:	+36-1-795-3723
Fax:	+36-1-795-0072
E-mail:	miniszter@fm.gov.hu

See also at: http://www.kormany.hu/en/ministry-of-agriculture/contacts

The national system has to be operated by the minister responsible for the environment but, as prescribed by legislation, in consent and cooperation with the ministers responsible for energy policy, forest management, agricultural policy, and national budget. Within the Ministry of National Development, i.e. the ministry responsible for energy policy, a Climate Policy Department has been established that plays a coordinating and supervisory role in the national system. The head of this department is Hungary's current UNFCCC Focal Point.

At the end of 2006, a Greenhouse Gas Inventory Division (GHG division) was established in the Hungarian Meteorological Service (HMS) for the preparation and development of the inventory. This division is responsible for most inventory related tasks, compiles the greenhouse gas inventories and other reports with the involvement of external institutions and experts on a contractual basis and supervises the maintenance of the system. In 2015, the name of the division was changed to Unit of National Emissions Inventories.

At the very end of 2009, a new government decree 345/2009 (XII.30.) on data provision relating to GHG emissions was put into force. This decree confirmed the designation of the Hungarian Meteorological Service as the compiler institute. As a new element, the participation of the Forestry Directorate of the National Food Chain Safety Office (NFCSO, Forestry Directorate) together with the National Agricultural Research and Innovation Centre (hereafter referred to as NARIC) Forest Research Institute was formalized by this decree. These two institutes were responsible for the forestry part of the LULUCF sector and for the supplementary reporting on LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol by making recommendations to HMS of the content of the inventory. The govt. decree had to be revised according to the changing EU regulations and reporting needs, therefore Govt. Decree 345/2009 (XII.30) was replaced by Govt. Decree 528/2013 (XII.30.).

1 January 2015, a new government decree 278/2014. (XI. 14) entered into force in Hungary designating the National Food Chain Safety Office (NFCSO) Plant Protection and Soil Conservation Directorate, together with the Hungarian Chamber of Agriculture, responsible for the development of the GHG inventory of the non-forest sectors. (This is a change from the previous system, in which the Hungarian Meteorological Service was responsible for the non-forest sectors. In order to facilitate this change, and in order to ensure a smooth transition to the application of the IPCC 2006 Guidelines, a new estimation system has been recently developed for, and together with, the NFCSO by an external expert.)

The Hungarian Meteorological Service is a central office under the control of the Ministry of Agriculture. The duties of the Service are specified in a Government Decree from 2005. The financial background of operation is determined in the Finances Act. HMS has introduced the quality management system ISO 9001:2000 for the whole range of its activities in 2002 to fulfill its tasks more reliably and for the better satisfaction of its partners. The Unit of National Emissions Inventories functions as part of the Department of Climate and Ambient Air. The Unit of National Emissions Inventories of the Hungarian Meteorological Service coordinates the work with other involved ministries, government agencies, consultants, universities and companies in order to be able to draw up the yearly inventory report and other reports to the UNFCCC and the European Commission. The Unit of National Emissions Inventories can be regarded as a core expert team of four people. The division of labour and the sectoral responsibilities within the team are laid down in the QA/QC plan and other official documents of HMS. The Head of Unit coordinates the teamwork and organizes the cooperation with other institutions involved in inventory preparations. He is responsible for the compilation of CRF tables and NIR. Within the team the experts are responsible for different sectors. Besides, a QA/QC coordinator and an archive manager have been nominated.

Most parts of the inventory (energy, industrial processes and product use, agriculture, and waste) are prepared by the experts of the Unit of National Emissions Inventories themselves. The whole LULUCF sector is compiled by the institutes listed in the above-mentioned government decree. As before, and also complying with the decree mentioned above, the Forestry Directorate of the NFCSO is responsible for the GHG inventory of the forestry sector. Quality control for the forestry sector is provided by the NARIC Forest Research Institute. The role of the Hungarian Chamber of Agriculture in the inventory preparation is not clarified yet. Data for the estimation of non-forest related emissions is also provided by the Central Statistical Office, the Hungarian Mining Authority and National Directorate General for Disaster Management.

Szent István University, Gödöllő had been heavily involved in the calculations for the agriculture sector of the inventory for several years. For the calculation of emissions from agricultural soils the Karcag Research Institute of University of Debrecen (Department of Soil Utilization and Rural Development) provided inputs. The following table summarizes the institutional arrangements:

Function	Institution	Responsibilities
Single national entity	Ministry of Agriculture (in consent and cooperation with Ministry of National Development and Ministry for National Economy)	• Supervision of national system • Official consideration and approval of inventory
Inventory coordination and compilation	HMS Unit of National Emissions Inventories	• Provision of work plan • Contracting consultants • Inventory preparation of Energy, Industry, Agriculture and Waste sectors • Compilation of the CRF and NIR • Archiving • Coordinating QA/QC activities • Reporting to UNFCCC secretariat
Inventory preparation of the LULUCF sector and LULUCF activities under the KP. (by law)	National Food Chain Safety Office (NFCSO) NARIC Forest Research Institute Hungarian Chamber of Agriculture	• Data collection, choice of methods and EFs, inventory preparation • Compilation of the relevant parts of the CRF and NIR
Contribution to the inventory preparation of the Agriculture sector	Szent István University, Gödöllő Karcag Research Institute of University of Debrecen	• Data collection, choice of method, development of country specific emission factors • Background studies

Table 3.2. Institutional arrangements
Source: National Inventory Report, Hungary 2017

Inventory preparation

The annual inventory cycle is carried out in accordance with the principles and procedures set out in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As a general method of preparing the inventory, the procedures described in the IPCC Guidelines are applied and the latest CRF Reporter software is used. Usually, the sectoral experts are responsible for the choice of methods and emission factors in consultation with the head of Unit of National Emissions Inventories. According to the recommendations of the IPCC Guidelines, the calculation methods are chosen by taking into account the technologies available in Hungary whenever possible. The calculation of emissions occurs basically by using the formula: AD x EF, where the activity data (AD) can be raw material or product or energy use etc. Part of the available data (e.g. production data) can directly be entered into the IPCC tables; others require previous processing and conversion. For example, energy data are not always available in the required depth and resolution. The default emission factors (EF) are being gradually replaced by country-specific emission factors characteristic of domestic technologies. Efforts are made to use the highest possible Tier method, especially in case of key categories. After preliminary quality control of the basic data, the necessary calculations are carried out with the coordination of the core team. The sectoral data are compiled and - after repeated checks - unified by using the CRF Reporter software. QA/QC activities are described in more detail in chapter 1.7 and the full, updated QA/QC Plan (synthesizing the former QA/QC Plan, the old ISO Procedure and the old archiving manual) is included in Annex 5. of the National Inventory Report.

Recalculation of some data-series of the inventory can be justified by several reasons. Just to name a few, QA/QC procedures, ERT recommendations, changing for higher Tier methodologies can lead to a recalculation. As a basic rule, whenever new information emerges that improves the quality or accuracy of the emission data, the emissions are recalculated. The Hungarian Meteorological Service funds research and development projects for the improvement of the inventory whenever possible. Recalculations are always documented in the relevant chapter of the national inventory report.

The inventory cycle can be summarized with the following table based on our QA/QC plan:

Date/deadline	Item	To
From May to November	Overview of sectors to identify areas for possible improvements; Data collection, choice of methodologies, Start of calculations Repeated checks	
From September to December (and April)	Calculations from external expert	
From September to December (and April)	Calculations, checks, archiving	
08 January	Main features for National Inventory Report (CRF tables and part of NIR) for approval	National Authority
15 January	Official submission	EU
Between January and March	QC procedures including EU internal review	
08 March	National Inventory Report final version for approval	National Authority
15 March	National Inventory Report, Official submission	EU
Between March and April	QC procedures in the process of finalizing the NIR and CRF tables	
08 April	National Inventory Report for approval	National Authority
15 April	Official submission	UNFCCC
31 July	Preliminary inventory of year x-1	EU
From 15th of April to October	Archiving, QA/QC and Development Plan	internal

Table 3.3. The inventory cycle

Source: National Inventory Report, Hungary 2017

Data collection, processing and storage

Data is collected in several ways and throughout the whole yearly cycle of the inventory preparation. Sector specialists of the core team (or external experts on contractual basis) are making the data inquiry and collection in addition to the data arriving based on the reporting obligation set up by Govt. Decree 278/2014. (XI. 14) as described below in more detail). Plant specific data are collected if possible (especially in case of power stations, heating stations and industrial technologies) but statistical databases are also heavily used as source of information. The most important statistical publications are the Statistical Yearbook of Hungary, the Environmental Statistical Yearbook of Hungary and the Environmental Report of Hungary published by the Hungarian Central Statistical Office (HCSO) and the Energy Statistical Yearbook published earlier by the Energy Efficiency, Environment and Energy Information Agency. As regards energy statistics, the practice has changed in recent years. The compiler institute relies less to classic statistical publication and more to databases sent

by the Hungarian Energy and Public Utility Regulatory Authority to the IEA and Eurostat. The compiler institute receives the same completed joint questionnaires that are sent to the international organizations which ensure the consistency with data reported under Regulation (EC) No 1099/2008.

Since the use of ETS data has several advantages, the inventory team was granted access (by the same Govt. decree) to the verified emissions database held by the National Climate Protection Authority (NCPA) (formerly: National Inspectorate for Environment and Nature).

In addition to statistical data, contacts were established with the representatives of a number of major emitting sectors. Moreover, information from the web sites of international associations (e.g., International Iron and Steel Institute, IISI) is used as well.

For the calculation of F-gas emissions, import data from the Customs Office and Police were used together with data obtained directly from companies importing and using fluorinated gases and information from cooling industry associations, the Hungarian Monitoring and Certification Body (OMKT-HMBC), the Hungarian Electrotechnical Association (MEE) and the National Directorate General for Disaster Management, Ministry of the Interior (NDGDM).

Data reported pursuant to Article 6(1) of Regulation (EC) No 842/2006 on F-gases (for the consistency check required by the MMR) is received from Hungarian contact point responsible for the reporting under 842/2006/EC. This data provision is also included in Govt. Decree 278/2014. (XI. 14).

The Act LX of 2007 on the implementation framework of the UN Framework Convention on Climate Change and the Kyoto Protocol thereof aims to give direct data collection authorization to the Ministry of Agriculture in order to collect data for the national system for climate reporting and gives a permanent status to the system. Relevant paragraphs for data collection are the following: "The state authorities having disposal of the data necessary to operate the National Registration System and the organizations emitting at least 100 tons of carbon dioxide equivalent per year shall provide these data for the National Registration System in accordance with the provisions of a separate legal instrument." "The data (…) necessary to fulfil international data supply shall be provided for the National Registration System irrespective of the fact that they are qualified as individual data pursuant to the relevant provision of Act XLVI of 1993 on statistics." This separate legal instrument, the above-mentioned government decree 278/2014. (XI. 14) on data provision relating to GHG emissions prescribes compulsory data provision for GHG inventory purposes for numerous governmental bodies and emitters. QA/QC Activities connected to data collection are regulated by the updated QA/QC Plan included in Annex 5.

All the collected data, where relevant, are also used for the elaboration of the air pollutant emission inventories (NFR). Therefore, the consistency with the reporting of air pollutant emission inventories under Directive 81/2001 and the Convention on Long-range, Transboundary Air Pollution (CLRTAP) is ensured.

A copy of all data, information necessary for the compilation of the given annual inventory is stored in printed or electronic form either by the Unit of National Emissions Inventories of the HMS or by the institutions involved in inventory preparations. Significant steps were

taken to create a central archive in the premises of the Hungarian Meteorological Service where all background data would be stored.

The most important paper information archived already in the Service is the following:

- Statistical Yearbooks of Hungary from the year 1961
- Environmental Statistical Yearbook of Hungary from 1996
- Energy Statistical Yearbook published by the Energy Efficiency, Environment and Energy Information Agency from 1985.
- Hungarian Statistics on Road Vehicles (in electronic format since 2000)
- National, regional and local emission survey of the Hungarian road, rail, water-borne and air transport (1995-2004) made yearly by the Institute of Transport Sciences

Lots of background data are stored by contracted expert institutions as well, which increases the security of data availability. Nevertheless, at least a copy of all important information has been transferred to the HMS. The following information is stored elsewhere:

- Data from individual industrial plants – Ministry of Agriculture
- ETS data, registry - National Climate Protection Authority (NCPA)
- Forestry statistics – National Food Chain Safety Office Forestry Directorate
- Wastewater data – Ministry of Interior.

Electronic information is stored on disks on a fileserver with a regular backup. The whole data files are backed up once a week, while the implements (those files that have been modified since the last saving) are saved two times a week. The data are stored on tape storage system. The cassettes of the data storage system are stored far from the recording system, in another room, which is air conditioned and equipped with an up-to-date fire service system. All events connected with the data saving are logged in accordance with the documents of the Quality Management System of HMS.

As HMS is a central office, strict record management, documentation and archiving rules apply in general. HMS's general record management, documentation and archiving regulation have been amended in 2011. The new regulation had been supplemented with a new chapter relating to the Unit of National Emissions Inventories. The main elements of the former proposal of the 'manual for the maintenance and management of the archiving system' as the procedures of documents and data handling had been formalized in this regulation.

A particular issue of this regulation is to ensure the integrity of the data handling in relation to the GHG inventory. The regulation has specific rules on handling confidential data as well. These rules are as follows

Confidential data are

- accessible only for members of the Unit of National Emissions Inventories. They are not allowed to be forwarded to other institute or persons, except for the ERT

- it is not allowed to make hard copies of these documents, only one electronic copy can be made, which is stored on the server of the Unit of National Emissions Inventories;
- data stored on the server of GHG are protected by password;
- it is not allowed to take out any confidential information from the HMS, not even their copies;
- the original hard copies are not allowed to be forwarded to the Hungarian Environmental

Archives; they are stored in the records of the HMS's Unit of National Emissions Inventories.

The new regulation has been endorsed by the Minister of Public Administration and Justice and has been in force since January of 2012.

The directories of the server, where the data of the Unit of National Emissions Inventories are stored have access protection, so they are available only for the staff of the Unit in charge of the different sectors of the GHG inventory. It is important to note that there are different directories for all the calculations and drafts (working folder) and for the submitted reports and incoming data which cannot be modified. Within the Unit of National Emissions Inventories of HMS, the nominated archive manager is responsible for the maintenance of the archiving system in close cooperation with the IT Department of the Service.

The most important elements of the previously planned procedural manual for management and maintenance of the archiving system (archiving manual) have been included formally into the general record management, documentation and archiving regulation of the HMS and the new QA/QC Plan of the Unit of National Emissions Inventories of the HMS. (Instead of the introduction of a new regulation the already existing regulations have been amended and supplemented with the issues of the draft manual.). So, these two regulations define the QA/QC activities connected to data collection, processing, storage and the documentation and archiving activities of the Unit of National Emissions Inventories. Further development of the system may include the incorporation of other emission data, which are relevant to air pollution.

Brief general description of methodologies and data sources used

The IPCC Guidelines provide methodologies for estimating emissions and removals of greenhouse gases. However, the basic idea is not greenhouse gas specific, the same approach is used for other pollutants, and other emission inventories, as well (e.g. see the EMEP/EEA air pollutant emission inventory guidebook). The basic equation is as simple as this:

Emission = AD x EF, where AD stands for activity data which represents some human activity (e.g. fuel use, industrial production, animal population, dwellings supplied with public sewerage, area of vineyard abandonment), whereas EF is the emission factor that quantifies the emission (or removal) per unit of activity. For example, in energy industry, which is the most important source category, emission factors for combusting natural gas or lignite are

56.1 t CO_2/TJ and 107.9 t CO_2/TJ, respectively; the importance of the mix of fuels used to produce energy becomes apparent at a glance.

Emission factors are usually dependent on several other factors, used technologies etc. which leads us to the concept of tiers. A tier represents a level of methodological complexity. In the Guidelines, usually three tiers are provided. Tier 1 is the basic method, where activity data are usually aggregated national statistics and the emission factors are default values representing typical process conditions. Higher tier methodologies are more demanding in terms of complexity and data requirements as they require country-specific information on the used technologies, facility level data whenever possible, or use of complex models. For key categories, i.e. categories that have a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level of emissions and removals, the trend in emissions and removals, or uncertainty in emissions and removals, it is required to apply higher tier methods. Accordingly, the compilers of the Hungarian inventory aim at taking into account the technologies available in Hungary to the extent possible. For example, the emission trading system of the European Union makes possible to have access to facility level activity and verified emission data.

Although this basic equation can widely be used, in some source categories other approaches are used. For example, mass balance method is used for estimating the change in carbon content of living biomass in forests, or in case of solid waste disposal sites, a calculation method is applied which assumes that the degradable organic component in waste decays slowly throughout a few decades.

To ensure that the national inventory fulfils its main purpose, namely monitoring the country's compliance with its commitments, it has to meet certain quality standards, in other words it has to be accurate, complete, consistent, comparable and transparent (ACCCT). The first two requirements need no special explanation: an inventory is accurate, if it has no systematic bias towards under- or overestimations, whereas a complete inventory covers all relevant sources and sinks, and gases within the borders of the country. The next two criterions are closely linked to the requirements of the UNFCCC. Consistency ensures that the trends in the times-series of the inventory reflect real differences in emissions, and not caused by any methodological changes. National greenhouse gas inventories of all countries shall be comparable; therefore, the submitted information shall be compiled in accordance with the UNFCCC reporting guidelines and the 2006 IPCC guidelines.

Key source categories

Key categories have been identified based on the IPCC Tier 1 methodology. As the category *3D Agricultural Soils N_2O was split into 3.D.1 Direct N_2O Emissions From Managed Soils and 3.D.2 Indirect N_2O Emissions From Managed Soils, it isn't* possible to identify changes compared to last year.

	TIER 1 (excluding LULUCF) Number of key category / number of categories	TIER 1 (including LULUCF) Number of key category / number of categories
LEVEL	**25/144**	**31/171**
TREND	**26/144**	**31/171**

Table 3.4. Number of identified Key categories
Source: National Inventory Report, Hungary 2017

KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Criteria used for key source identification			
1A1 Energy Industries - Gaseous fuels	CO_2	L incL	L excL	T incL	T excL
1A1 Energy Industries - Liquid fuels	CO_2	L incL	L excL	T incL	T excL
1A1 Energy Industries - Other fossil fuels	CO_2			T incL	T excL
1A1 Energy Industries - Solid fuels	CO_2	L incL	L excL	T incL	T excL
1A2 Manufacturing industries - Gaseous fuels	CO_2	L incL	L excL	T incL	T excL
1A2 Manufacturing industries - Liquid fuels	CO_2	L incL	L excL	T incL	T excL
1A2 Manufacturing industries - Other fossil fuels	CO_2	L incL	L excL	T incL	T excL
1A2 Manufacturing industries - Solid fuels	CO_2	L incL	L excL	T incL	T excL
1A3b Road trasport - All Fuels	CO_2	L incL	L excL	T incL	T excL
1A3c Railways - All Fuels	CO_2			T incL	T excL
1A4 Other sectors - Biomass	CH_4	L incL	L excL	T incL	T excL
1A4 Other sectors - Gaseous fuels	CO_2	L incL	L excL	T incL	T excL
1A4 Other sectors - Liquid fuels	CO_2	L incL	L excL	T incL	T excL
1A4 Other sectors - Solid fuels	CH_4			T incL	T excL
1A4 Other sectors - Solid fuels	CO_2	L incL	L excL	T incL	T excL
1B1 Solid fuels	CH_4			T incL	T excL
1B2b Natural Gas	CH_4	L incL	L excL		
1B2c Venting and flaring	CO_2				T excL
2A1 Cement Production	CO_2	L incL	L excL	T incL	T excL
2A4 Other Process Uses of Carbonates	CO_2	L incL	L excL		
2B1 Ammonia Production	CO_2	L incL	L excL		
2B2 Nitric Acid Production	N_2O			T incL	T excL
2B8 Petrochemical and carbon black production	CO_2	L incL	L excL	T incL	T excL
2C1 Iron and Steel Production	CO_2	L incL	L excL	T incL	T excL
2C3 Aluminium Production	PFC			T incL	T excL
2F1Refrigeration and Air Conditioning Equipment - HFC+PFC	Aggregate F-gases	L incL	L excL	T incL	T excL
3.D.1 Direct N2O Emissions From Managed Soils	N2O	L incL	L excL	T incL	T excL
3A Enteric Fermentation	CH_4	L incL	L excL	T incL	T excL
3B Manure Management	CH_4	L incL	L excL		
3B Manure Management	N_2O	L incL	L excL		
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils - CO_2	CO_2	L incL		T incL	
4A1 Forest Land Remaining Forest Land	CO_2	L incL		T incL	

4A2 Land Converted to Forest Land	CO_2	L incL		T incL	
4B1 Cropland Remaining Cropland	CO_2	L incL		T incL	
4B2 Land Converted to Cropland	CO_2	L incL		T incL	
4C2 Land Converted to Grassland	CO_2			T incL	
4G Harvested Wood Products	CO_2	L incL			
5A Solid waste disposal	CH_4	L incL	L excL	T incL	T excL
5D Wastewater Treatment and Discharge	CH_4	L incL	L excL		

Table 3.5. Key category analysis summary
Source: National Inventory Report, Hungary 2017

Note: L = Level assessment; T = Trend assessment.

QA/QC information

The national system has to ensure high quality of the inventory, i.e. to ensure that the inventory is transparent, consistent, comparable, complete and accurate. These principles guide the internal expert team that *maintains* the system. QA/QC activities are performed in two levels: based on the ISO 9001 standards and following the IPCC recommendations. The updated QA/QC Plan that entered into force in 2013 aims to integrate these two set of requirements. The QA/QC Plan was updated again and entered into force in the beginning of 2016 in order to follow the changes of legislation and the Guidebook, and the change of the name and acronym (from "UHG" to "NELO") of the Unit of National Emissions Inventories.

ISO activities

The Hungarian Meteorological Service introduced the quality management system ISO 9001:2000 in 2002 for the whole range of its activities which was quite unique among meteorological services. However, GHG inventory preparation was not among its activities in that time. Therefore, the scope of our ISO accreditation had to be modified and lots of efforts have been made to bring also the national system under the umbrella of the ISO QM system. Several regulatory ISO documents were created, among others: ISO procedure on the activities of the GHG Division; QA/QC plan; registers and records for quality checks and documentation. Naturally, from that time on, HMS level QA/QC activities apply for the Unit of National Emissions Inventories as well, such as general quality objectives, application of QA/QC Manual of the HMS, QA/QC regarding contractors, etc. Further information on quality management system of the HMS is available in English at: http://www.met.hu/en/omsz/minosegiranyitas/

In 2012 the ISO procedure of the GHG division was reviewed, and the former QA/QC Plan with the archiving manual was integrated into it. ISO document No.: ELFO_UHG_401.01 entered into force on 4th January 2013 can be regarded as the QA/QC Plan required for inventory preparation. In addition, the records used for documentation of QA/QC and other standardized activities have also been renewed. On 21 May 2014, an update of the QA/QC Plan (No.: ELFO_UHG_401.02) entered into force in order to insert the recommendation of the review of the year before regarding the documentation of QA activities. The update of the QA/QC Plan (No.: ELFO_NELO_401.01) that entered into force in the beginning of 2016 did not contain significant changes, mainly changes of names and references to legislation and the Guidebook are reflected.

The records and their functions are the following at the moment:

- NELO01: QA/QC checklist: to be filled in by sectoral experts which includes a compulsory check list, summary of results of checks, suggestions for corrective actions and planned improvements;
- NELO02: Data quality check: to be filled in case of data providers and external experts on data quality;
- NELO03: Development Plan: to be filled in every year by the end of the inventory cycle based on the outcome of all reviews and own experience;
- NELO04: Responsibility: for the specification of the sectoral responsibilities of the core team and the QA/QC coordinator
- NELO05: Data source logbook: for the standardized documentation of data sources;
- NELO06: Uncertainty and NELO07: Key category analysis; for the standardized documentation of uncertainty and key category analysis

The records and the English translation of the QA/QC Plan are presented in the Annex 5 of the NIR.

The QA/QC Plan contains detailed description of the data collection, inventory preparation and reporting processes, regulates the documentation and archiving activities in order to ensure transparency and reproducibility of the inventory the same as before, especially:

- ELFO_NELO_401.01 formalizes the data collection and inventory preparation procedure as it is described also in chapters 1.4 and 1.5 above. It is important to note that the authorization of HMS for collecting non-public data has been raised in a legally binding level by since 2009 when 528/2013. (XII.30.) Govt. Decree entered into force. In addition, Act LX of 2007 on the implementation framework of the UN Framework Convention on Climate Change and the Kyoto Protocol authorizes HMS to collect confidential data if needed as well. ELFO_NELO_401.01 prescribes that any data used by the preparation of the inventory have to be documented and archived.
- Documentation and archiving: As it is mentioned in chapter 1.4 above, the Hungarian Meteorological Service is a central office under the control of the Ministry of Agriculture. Strict documentation and archiving is a basic requirement by the institution. The HMS has a documentation and archiving manual valid for the whole institution, which defines that all the incoming letters and emails containing data have to be registered in the central registry system of HMS. This ensures that every document is traceable. In additional data, data sources and calculation files and background documents for every inventory submission need to be documented and archived by the sectoral experts. The exact process of documentation and archiving (naming and location) is detailed in document ELFO_NELO_401.01.
- Data quality check. Besides self-checking, the entries of data providers and external experts are checked regularly which is an interactive process during the whole inventory cycle. Significant changes compared to previous data shall be explained. NELO02 QC record was created for standardized documentation of evaluation of data quality by the data providers which can be regarded as a continuous development.

The QA/QC plan prescribes the obligation of filling in the records mentioned before, including Development Plan, where first of all the recommendations of the last years' reviews conducted by the expert review team of the UNFCCC have to be taken into consideration as much as possible every year.

Having an ISO system in place has an advantage of being subject to regular internal and external audits. During our last external audit, the activities of the Unit of National Emissions Inventories were audited as well. Our system was audited favorably in the end of March 2007; and our ISO certification has been renewed in January 2012 and a comprehensive external audit was again performed in January 2014 2015, 2016, 2017 as well. On the 5th April 2013 and on the 12th December 2014 and 11th October 2016 an internal audit has been performed too. In both cases the result was a few non-significant recommendations. Therefore, we can claim that the GHG inventory is subject to and our procedures are in line with ISO 9001:2008.

As part of the QA and verification activities there is an ongoing QA procedure between the two institutes involved in the forestry part of the inventory. Peer-reviews will be conducted depending on available resources

In 2012 the EU carried out a comprehensive individual technical review concentrating on the years 2005, 2008, 2009 and 2010, which can be regarded as an additional QA activity. Starting with the data reported for the year 2013, the European Commission will conduct an annual review of the national inventory data submitted by Member States. We believe that this process contributes significantly to the quality assurance procedures.

In November 2015, Hungary took part in an informal review organized by the EU, where all the sectors had been thoroughly reviewed by international experts. Several recommendations have been formulated and some of them are already implemented in the present submission.

In May 2016, a comprehensive review was carried out by the EU for the compliance years 2013 and 2014, and for the years 2005, 2008, 2009 and 2010 pursuant to Monitoring Mechanism Regulation (EU) 525/2013 Article 27.

The in-country review of Hungary's 2016 submission had also an important impact on the development of quality and transparency of the emission estimates. The majority of the recommendations in the 2016 review processes have been implemented in the 2017 submission, while further recommendations in the 2016 reviews will be addressed where feasible in the next submission.

Other QA/QC activities

Besides ISO requirements, other QA/QC activities are carried out, as well. For every sector of the inventory, there is a responsible person within the core team in the Meteorological Service. These sectoral responsibilities are laid down in the QC record No. NELO04. Especially in case of external experts, this responsible member of our team conducts several quality checks on the provided calculations. Moreover, this exercise can be regarded as an interactive process throughout the whole inventory cycle, since the used methodologies, early results are discussed during the process of the emission/removal calculations. This QC

procedure also led to a few recalculations. The used parameters and factors, the consistency of data is checked regularly. Completeness checks are undertaken, new and previous estimates are compared every time. Data entry into the database is checked many times by a second person. If possible, activity data from different data sources are compared and thus verified. In response to our request, several data suppliers made declarations as regards quality assurance systems in place during the collection of the data and QC record NELO02 has been introduced for the documentation of evaluation of data quality by data providers. Experts involved in emission forecast consulted in many areas with inventory experts of the Hungarian Meteorological Service to reach better consistency, which in turn represented some sort of QA procedure for the inventory itself.

Nevertheless, the work continues to refine the used QA/QC procedures and implement further elements. The QA/QC Plan is under review in order to implement all changes required by the EU Monitoring Mechanism Regulation and implementation of the 2006 IPCC Guidelines.

3.4. National registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and Decision 24/CP.8.

The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union registry and was developed together with the new EU registry based on the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
- The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public is fulfilled by each Party through a publically available web page hosted by the Union registry;
- All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
    (a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a secure communication link through a consolidated communication channel (VPN tunnel);
    (b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
    (c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
    (d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
    (e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the Union registry, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the go-live process, all relevant transaction and holdings data were migrated to the Union registry platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry have occurred since the last National Communication report.

Reporting Item	**Description**
15/CMP.1 Annex II.E paragraph 32.(a) Change of name or contact	The primary contact is: Name: dr. Anna Fetter Mrs. Ilyésné Position: head of department Organization: National Climate Protection Authority (NCPA) Address: 1011 Budapest, Iskola utca 13., Hungary Tel: +36-1-795-9423 E-mail: anna.fetter.ilyesne@nfm.gov.hu Further contacts are: Name: Ágnes Gulyás-Béky Position: head of unit Organization: National Climate Protection Authority (NCPA) Address: 1011 Budapest, Iskola utca 13., Hungary Tel: +36-1-795-8203 E-mail: agnes.gulyas-beky@nfm.gov.hu
15/CMP.1 Annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2016 new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last NC submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to each release of a new version in Production. Annex H testing is carried out every year. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 Annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(f) Change regarding security	The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.
15/CMP.1 Annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is provided via the Union registry homepage for each registry e.g. https://ets-registry.webgate.ec.europa.eu/euregistry/HU/public/reports/publicReports.xhtml
15/CMP.1 Annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	Both regression testing and tests on the new functionality are carried out prior to release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on behalf of and assisted by the European Commission. Annex H testing is carried out on an annual basis.

Table 3.6.Changes to the EU national registry
Source: National Inventory Report, Hungary 2017

4. NATIONAL POLICIES AND MEASURES

4.1. Policy making process

4.1.1. European Union framework

Hungary's mitigation actions, as member state of the European Union, are determined to a great extent by the policies and regulations of the EU.

In 2009 the EU established internal rules under its "2020 climate and energy package"[5] which underpin the EU implementation of the target under the Convention. The package introduced a clear approach to achieving the 20% reduction of total GHG emissions from 1990 levels, which is equivalent to a 14% reduction compared to 2005 levels. This 14% reduction objective is divided between the ETS and ESD sectors. These two sub-targets are:

- a 21% reduction target compared to 2005 for emissions covered by the ETS (including domestic and international aviation);
- a 10% reduction target compared to 2005 for ESD sectors, shared between the 28 Member States (MS) through individual national GHG targets.

Below is a list of the cross-sectoral and sectoral policies and measures of the EU. For further details on EU climate legislation please see the 7th National Communication and 3nd Biennial Report of the European Union.

Cross Cutting Polices and Measures

- The EU Emissions Trading System (EU ETS) (2003/87/EC)
- The Effort Sharing Decision (ESD) (Decision No 406/2009/EC)
- Carbon Capture and Storage Directive (2009/31/EC)
- Monitoring Mechanism Regulation (Regulation No 525/2013)
- Energy Taxation Directive (2003/96/EC)
- Horizon 2020
- European Structural and Investment Funds (ESIF)
- National Emissions Ceilings Directive (2016/2284/EU)
- Covenant of Mayors for climate and energy
- Proposal for a revision to Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments (COM (2015) 337 final)
- Proposed Regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union (COM(2016) 482 final)

[5] https://ec.europa.eu/clima/policies/strategies/2020_en

Sectoral policies and measures: Energy

- Directive 2009/28/EC on the promotion of the use of energy from renewable sources
- Directive 2010/31/EU on the energy performance of buildings
- Directive 2012/27/EU on energy efficiency
- Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy- related products
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy- related products
- Proposal for a Regulation setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU
- Green Public Procurement
- Energy Star Programme
- EU Project Development Assistance (PDA) Facilities
- European Energy Efficiency Fund (EEEF)
- European Regional Development Fund (ERDF)
- Motor Challenge Programme
- Strategic Energy Technology Plan (COM(2007) 723)
- Energy Union Strategy (COM(2015) 80 final)
- Biomass Action Plan
- Communication on Accelerating Clean Energy Innovation (COM(2016) 763 final)
- Communication on Ecodesign Working Plan (COM(2016) 773 final)
- Proposals for revised Energy Efficiency Directive (COM/2016/0761 final)
- Proposal for revised Energy Performance of Buildings Directive (COM/2016/0765 final)
- Proposal for revised Renewable Energy Directive (COM(2016) 767 final/2)
- Commission Implementing Decision on energy labelling, in support of and as regards: Commission Delegated Regulation (EU) 2015/1186, Commission Regulation (EU) 2015/1188, Commission Regulation (EU) 2015/1185
- EU heating and cooling strategy (COM(2016) 51 final)

Sectoral policies and measures: Transport

- CO_2 and Cars Regulation (EC 443/2009)
- CO_2 and Vans Regulation (EC 510/2011)
- Strategy for reducing Heavy-Duty Vehicles' fuel consumption and CO_2 emissions
- Car and tyre labelling Directives (1999/94/EC and EC 1222/2009 respectively)

- Regulation of Safe motor vehicles and trailers (EC 661/2009)
- Renewable Energy Directive (2009/28/EC)
- Fuel Quality Directive (2009/30/EC)
- Infrastructure charging for heavy goods vehicles (1999/62//EC, amended by 2006/38/EC and 2011/76/EU)
- Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure
- Clean Vehicles Directive (2009/33/EC)
- Integrating maritime transport emissions in the EU's greenhouse gas reduction policies (COM(2013) 479 final and Regulation (EU) 2015/757)
- White Paper: Roadmap to a Single European Transport Area COM(2011) 144 final
- A European Strategy for Low-Emission Mobility (COM(2016) 501 final)
- Electromobility initiative, Green eMotion
- Fuel Cells and Hydrogen Joint Undertaking (JU)

Sectoral policies and measures: Industry / industrial processes

- Mobile Air Conditioning Systems (MAC) Directive (Directive 2006/40/EC)
- Fluorinated greenhouse gases regulation (Regulation (EU) No 517/2014)
- Industrial Emissions Directive 2010/75/EU (IED)

Sectoral policies and measures: Agriculture

- Agricultural Market and Income support (1st pillar of Common Agricultural Policy / CAP)
- Rural Development Policy (2nd pillar of CAP)
- Soil Thematic Strategy (COM(2006) 231)
- Nitrates Directive (91/676/EEC)

Sectoral policies and measures: Forestry / LULUCF

- LULUCF accounting (Decision 529/2013/EU)
- Proposal to integrated greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework (COM/2016/0479)

Sectoral policies and measures: Waste

- Directive on Waste (2008/98/EC)
- Landfill Directive (1999/31/EC)
- Management of biodegradable waste (COM/2008/0811 final)
- Urban Waste Water Directive (91/271/EEC)

- Directives on end-of-life vehicles (2000/53/EC)
- EU action plan for the Circular Economy (COM(2015) 614 final)
- Motor Vehicles Directive (2005/64/EC)
- Directive on batteries and accumulators and waste batteries and accumulators (2006/66/EC)
- Directive on waste electrical and electronic equipment (2012/19/EU)
- Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Directive 2011/65/EU)
- Packaging and Packaging Waste Directive ((EU) 2015/720 regarding 94/62/EC)
- A legislative proposal on online sales of goods (December 2015)
- A legislative proposal on fertilisers (March 2016)
- Launch of the Innovation Deals for a circular economy (May 2016)
- Ecodesign Working Plan 2016-2019 (COM(2016) 773 final)
- Establishment of the EU Platform on Food Losses and Food Waste (August 2016)
- A Communication on waste-to-energy processes and their role in the circular economy (January 2017).

4.1.2. National framework

Rules for the implementation of the Kyoto Protocol and the mitigation of F-gases are ruled by 2007 Climate Change Act (no. LX). The EU ETS and ESD policies were transposed by the law on emission trading (CCXVII. of 2012).

The Programme of National Cooperation

Although the Programme of National Cooperation is not focused on the GHG mitigation, the implementation of the Programme includes several such elements, and the Programme itself has some priorities that serve this purpose. These are briefly summarized here:

- In reviving the economy, the construction industry has an important role. It is stated in the programme that one means to boost the construction industry is to promote the European initiative to employ "green" technologies and to develop the energy efficiency of buildings and the construction materials.
- A large scale energy efficiency program is to be launched with components such as deep reconstruction of pre-fab buildings (reduce consumption by 80%), thermal insulation projects of other buildings, reconstruction of public buildings etc.
- Investments in renewable energy have to be encouraged.
- Environmental considerations shall be integrated in the national development policy.
- Environmental protection shall be taken into consideration in the public procurement procedures.

- In order to boost the economy, new take-off points need to be found. Green economy and the utilisation of renewable energies are among the possible take-off points.

National Climate Change Strategy

The 2007 Climate Change Act (no. LX) provides a mandate for the Government to develop a strategy on climate change in Hungary. In 2008, the former Ministry for the Environment and Water developed Hungary's First National Climate Change Strategy for 2008-2025 (NCCS I), which entered into force via the Parliamentary Resolution 29/2008. This strategy covered three major areas of action: mitigation, adaptation and awareness raising.

According to the statutory requirements the NCCS I was reviewed in 2013 and the second National Climate Change Strategy (NCCS II) for 2014-2025 has been made, but after the Paris Agreement the NCCS II has been updated again. The updated NCCS II for 2017-2030 (NCCS II) was published and opened to public consultation in the spring of 2017. It was accepted by the Government and submitted to the Parliament in May 2017.

The NCCS II includes:

- analysis of the expected effects of climate change in Hungary, its natural and socioeconomic consequences and the climate vulnerability of ecosystems and sectors;
- a Hungarian Decarbonisation Roadmap on the transition into a competitive, low carbon economy until 2050 and comprising the goals, priorities and action lines of the reduction of greenhouse gas emission, considering the strategic documents of similar timescale of the European Commission;
- a strategic framework for national adaptation, with special regard to the prevention and risks and mitigation of damage related to climate change and climate security; the strategic framework is supported by the National Adaptation Geo-information System and the results of the territorial and sectoral climate vulnerability studies based on that;
- a target system of awareness-raising activities to prevent the climate change and to prepare and adapt to the climate change.

National Sustainable Development Framework Strategy 2012-2024

The National Sustainable Development Framework Strategy has been adopted by the Hungarian Parliament in 2013. No changes were made to the strategy since the last national Communication. Every two year the government prepares a report to the Parliament on the implementation measures of the strategy related to four groups of resources: human, social, natural and economic. The latest report was adopted in 2015.

National Environmental Protection Programme 2015-2020

The National Environmental Programme (NEP) is the comprehensive strategic plan of environmental issues in Hungary. The Programme is closely linked to the National Framework Strategy on Sustainable Development approved by the Hungarian Parliament but the Programme has a horizontal approach covering society and economy in their entirety.

The recent National Environmental Programme 2015-2020 (NEP-IV) was adopted by the Parliament in 2015 (Resolution of the Parliament 27/2015 (VI 17) OGY). Similarly to the previous programmes, the NEP-IV identifies general objectives, which are the following:

- Improving the quality of life and the environmental conditions of human health.
- Protection of natural values and resources and their sustainable use.
- Improving resource efficiency and making steps toward a green economy.

The elaboration of the strategic objectives of the NEP-IV is facilitated by the strategic areas specified according to environmental elements, systems and sectors. Some strategic areas contribute to the achievement of several strategic objectives. The strategic areas of the Programme build on the progress made by the implementation of the NEP-III.

The strategic objectives of the programme include the following:

- By way of transitioning to a low carbon economy, the decrease of greenhouse gases and the strengthening of natural absorption-capacities
- Successful implementation of adaptation to climate change in order to preserve the reserves and the quality of national resources (natural, human, social and economic).
- Increasing knowledge about climate change, promoting awareness about prevention and adaptation measures.

4.1.3. Responsibilities

The *Ministry of National Development* is primarily responsible for transport, energy, key public services and climate policy. Some of the priority goals of the Ministry are supporting domestic climate and environmental projects and keeping the private sector representatives informed of the latest EU and domestic funding opportunities. This Ministry includes the Climate Policy Department, which is responsible for international and EU level climate negotiations and national climate lawmaking. It also includes the National Climate Change Authority, which carries out authority tasks relating the administration on F-gases and the EU ETS; and the task related to the National Administrator of the Registry.

The *Ministry for National Economy* is involved in the climate policy as it is responsible for quota trading and EU ETS free allocation tasks. It is also responsible of the Jedlik Ányos Plan on electromobility. This Ministry is responsible for determining the level of taxes in Hungary, through which it has an effect on the level of energy prices.

In the framework of its responsibilities for water protection, the *Ministry of Interior* prepares legislation on the protection of surface waters and groundwater, such as the protection of groundwater from nitrates from agricultural sources and economic control instruments for the identification of surface waters and their catchment areas sensitive to urban wastewater treatment. The Ministry contributes to the preparation and implementation of environmental legislation affecting water as an environmental element and it manages the implementation of tasks deriving from bi- and multilateral international agreements on water protection.

The *Ministry of Agriculture* is responsible for agricultural policy development including emission reduction from agricultural sources. In addiction prepares the general rules of

environmental protection, waste management, integrated pollution prevention, transboundary environmental impacts, environmental remediation, air protection and the protection from the harmful effects of noise and vibration. The Ministry regularly analyzes and evaluates the economic instruments of environmental protection, proposes to further develop them. It monitors and encourages the development of environmental protection equipment, tools, methods and procedures, such as the introduction of environmentally-friendly materials, energy and water-saving waste-efficient technologies. It is also responsible to develop environmental awareness-raising and educational programmes.

Beside the many competencies of the *Prime Minister's Office (PMO),* it is also responsible for agriculture and rural development. The PMO manages agriculture and rural development, as the second pillar of the Common Agricultural Policy (CAP) of the European Union, as well as the related research and development, while specifying short, medium and long-term goals.

4.2. Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

Hungary has deposited its ratification documents concerning the Kyoto Protocol (including its Doha Amendment) and the Paris Agreement under the Convention. Hungary has also finished its internal ratification process concerning the Kigali Amendment of the Montreal Protocol aiming for the reduction of emissions of F-gases.

Rules for the implementation of the Kyoto Protocol and the mitigation of F-gases are ruled by the act on climate change (LX of 2007). This also describes the rules of joint implementation projects on the territory of Hungary.

Hungary, as an EU Member State, fulfills its commitments for 2020 and 2030 jointly with the whole EU. The Emission Trading System (EU ETS) and Effort Sharing Decision (ESD) policies of the EU, serving this purpose, were transposed to the national law by the act on emission trading (CCXVII. of 2012). Concerning EU ETS, it should be noted that since the start of 2013, the system works in an EU-wide harmonized manner. Therefore Hungarian Authorities are bound by the EU law in the operation of the system, including auctioning and free allocation of emission allowances (the latter used to be carried out via adopting national allocation plans before 2013).

These two laws and the Governmental Decrees on their implementation (Governmental Decrees 323/2007 and 14/2015; 410/2012 and 341/2013) provide the detailed rules of the enforcement and administrative procedures of the climate-related obligations in Hungary, in a publicly accessible form.

LULUCF is not included in the EU-wide emission reduction target till 2020, therefore the EU and Hungarian law only focuses on monitoring of emissions in this sector.

4.3 Policies and measures and their effects

In this section, planned, adopted and implemented policies and measures are presented which contribute to the reduction of GHG emissions on a sectoral basis. Table 2 provides information on sectors affected by cross-sectoral policies. Information on whether a policy or measure is included in the "with existing measures" or "with additional measures" is presented in Annex section 5 of the 3rd Biennial Report.

4.3.1 Cross-sectoral policies

Name	Objective	GHG affected	Type of instru-ment	Status	Implement-ing entity	Estimate of mitigation impact		
						2015	2020	2030
National Energy Strategy 2030	Multi-sectoral policy; Increase in renewable energy; energy efficiency improvement	CO_2	Planning	Implemented 2011-2030	Ministry of National Development	-	-	-
National Renewable Energy Action Plan	Increase in renewable energy	CO_2	Planning	Implemented 2010-2020	Ministry of National Development	-	-	-
Energy and Climate Awareness Raising Action Plan	Demand management/reduction	CO_2	Planning	Implemented 2015-2020	Ministry of National Development	-	-	-
National Energy Efficiency Action Plan (NEEAP)	Efficiency improvements of buildings; Demand management/reduction	CO_2	Planning	Implemented 2015-2030	Ministry of National Development	-	-	-
Environment and Energy Efficiency Operational Program (EEEOP)	Increase in renewable energy; Efficiency improvements of buildings; Efficiency improvement of appliances; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Efficiency improvement in the energy and transformation sector; Improved wastewater management systems; Enhanced recycling; Reduced landfilling	CO2	Economic	Implemented 2014-2023	Ministry of National Development	-	-	-
Territorial and Settlement Development Operative Programme (TSDOP)	Increase in renewable energy; Efficiency improvements of buildings; Modal shift to public transport or non-motorized transport; Improved transport infrastructure	CO_2	Economic	Implemented 2014-2023	Ministry of National Economy	-	-	-
Competitive Central-Hungary Operational Programme (CCHOP)	Increase in renewable energy; Efficiency improvements of buildings; Efficiency improvement in the energy and transformation sector;	CO_2	Economic	Implemented 2014-2023	Prime Minister's Office	-	-	-

	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors							
Rural Development Programme	Afforestation and reforestation; improving energy efficiency	CO_2	Economic	Implemented 2014-2020	Ministry of Agriculture Prime Minister's Office	-	-	-

Table 4.1 Cross-sectoral policies and measures

	Energy	**Transport**	**Industry**	**Agricutlture**	**Forestry**	**Waste**
National Energy Strategy 2030	x	x				
National Renewable Energy Action Plan	x	x				
Energy and Climate Awareness Raising Action Plan	x	x	x			x
National Energy Efficiency Action Plan (NEEAP)	x	x				
Environment and Energy Efficiency Operational Program (EEEOP)	x	x				x
Territorial and Settlement Development Operative Programme (TSDOP)	x	x				
Competitive Central-Hungary Operational Programme (CCHOP)	x	x				
Rural Development Programme	x				x	

Table 4.2. Sectors affected by cross-sectoral policies

National Energy Strategy 2030

The National Energy Strategy published in 2012 is the overarching policy document of the energy sector. The goal of the strategy is to increase security of energy supply, competitiveness, the sustainability of the sector. Hungary intends to achieve these through five tools: first, via increasing energy efficiency; second, via increasing the share of renewable energy sources; third, via the long-term use of nuclear energy; fourth, via regional cooperation particularly with the neighbouring countries; finally, through the renewal of the government's energy institution system.

National Renewable Energy Action Plan

The Renewable Energy Action Plan (NREAP) (the official title is: Hungary's Action Plan for the Utilisation of Renewable Energies 2010-2020) reconfirms Hungary's overall target for the share of renewable energies and identifies the key areas of intervention, stating individual quantitative targets. It sets more ambitious targets than originally set by the European Union in order to support the overall economic objectives (job creation, improving competitiveness, reducing energy import dependency) through boosting "green" economy. While the RED Directive (2009/28/EC) of the EU sets the renewable target for Hungary a minimum of 13% of the total gross final energy consumption, the objective defined by the NREAP is 14.65%.

Energy and Climate Awareness Raising Action Plan

The Energy and Climate Awareness Raising Action Plan – adopted by 1602/2015 Government Decision in 2015 – aims fostering awareness of energy and climate. Therefore, the Plan identifies governmental "soft" measures within a short time – the majority by 2020 – which are capable for contributing to change attitudes about both climate change and energy efficiency on the following five main areas: (1) energy efficiency and energy conservation; (2) renewable energy use; (3) transport energy saving and emission reduction; (4) a resource-efficient and low-carbon-intensity of economic and social structures; (5) accommodation.

National Energy Efficiency Action Plan (NEEAP)

The 3rd National Energy Efficiency Action Plan (NEEAP) - published in 2015 - describes the planned energy efficiency measures for each economic sector, the state of implementation of practical applications and measures related to Directive 2012/27/EU on Energy Efficiency and other programmes supporting better energy efficiency. Measures related to better energy efficiency of buildings - including new buildings with low energy consumption levels, and reconstruction of existing buildings - have the most significant effects on fulfilling the energy efficiency targets. The main objective of the 3rd NEEAP is to achieve a significant reduction in primary energy consumption in all sectors of the economy, which means a remarkable reduction in building, residential and transport sector, as well. The Action Plan also includes the National Building Energy Performance Strategy, the Energy and Climate Awareness-Raising Action Plan, and the planned Transportation Energy Efficiency and District Heating Development Action Plans.

Environment and Energy Efficiency Operational Program (EEEOP)

EEEOP is one of the operational programmes during the 2014-2020 period accepted by the European Commission. The programme aims to support sustainable growth and contributes to achieving the Europe 2020 targets for smart, sustainable and inclusive growth. It should improve flood protection, provide better waste and wastewater management services and good quality drinking water to more residents, help protect natural habitats and species of community importance, and it should improve energy efficiency and the use of renewable energy sources. Priority axis 2 includes supporting waste water treatment capacity building projects. Priority axis 3 includes supporting investment in separate waste collection and in

municipal waste treatment facilities. Priority axis 5 supports investments in renewable energy supply, energy efficiency, enhancing district heating and heat energy supply systems.

Territorial and Settlement Development Operative Programme (TSDOP)

TSDOP is one of the operational programmes during the 2014-2020 period accepted by the European Commission. The programme aims to support regional, decentralised economic development and an increase in employment based on local resources. Priority axis 3 and 6 of TSDOP supports the following investments: 1. Investments related to sustainable public mobility 2. Energy efficiency improvements of buildings and use of renewable energy. The beneficiaries are local governments.

Competitive Central-Hungary Operational Programme (CCHOP)

CCHOP is one of the operational programmes during the 2014-2020 period accepted by the European Commission. The comprehensive objective of the programme is to ensure the development of the Central-Hungary Region and to further improve its competitiveness, whilst simultaneously decreasing the socio-economic disparities within the region. Priority axis 5 of CCHOP supports the following investments in the Central Hungarian Region: 1. Energy efficiency improvements and renewable energy use of companies 2. Modernisation of energy systems, district heating and other heat supply systems, increasing the share of renewables in the residential sector 3. Sustainable mobility.

Rural Development Programme

Rural Development Programme is one of the operational programmes during the 2014-2020 period accepted by the European Commission. The priority axis 5 of the Rural Development Program supports projects related to increasing the energy efficiency in the agricultural sector and promoting carbon sequestration by afforestation. Projects supported by the Programme: improvement of energy efficiency in the horticulture sector, construction of small sized energy-efficient silos and grain dryers, improvement of effectiveness of energy consumption in the livestock sector, promotion of resource efficiency in processing sector, promotion of afforestation, investments in wood production, forestry technologies, forestry processing and market sale.

4.3.2 Energy

Name	Objective	GHG affected	Type of instrument	Status	Implementing entity	Estimate of mitigation impact		
						2015	2020	2030
Operational grant for the production of renewable energies	Increase in renewable energy	CO_2	Economic	Implemented 2017-2026	Ministry of National Development; Hungarian Energy and Public Utility Regulatory Authority	-	-	-
Capacity maintenance of the Paks Nuclear Power Plant	Enhanced non-renewable low carbon generation (nuclear)	CO_2	Other	Implemented 2014-2026/27	Minister without portfolio responsible for the planning, construction and commissioning of the two new blocks at the Paks Nuclear Power Plant	-	-	-
National Building Energy Performance Strategy	Efficiency improvements of buildings	CO_2	Planning	Implemented 2015-2030	Prime Minister's Office	-	-	-
New requirements on energy performance of buildings	Efficiency improvements of buildings	CO_2	Regulatory	Adopted 2018-	Prime Minister's Office	-	-	-
Energy saving programme for public buildings	Efficiency improvements of buildings; Efficiency improvement of appliances	CO_2	Regulatory	Adopted 2017-	Offices of National Energy Efficiency Advisory Network	-	-	-
Establishment of the National Energy Efficiency Advisory Network	Efficiency improvements of buildings	CO_2	Information	Adopted 2017	County Government Offices	-	-	-
Funding for the energy modernization of residential buildings - Warmth of Home Programme	Efficiency improvements of buildings; Increase in renewable energy	CO_2	Economic	Implemented 2008- (referred to as Warmth of Home Programme since 2014)	Ministry of National Development	-	-	-
Funding for the energy modernization of residential buildings – interest-free loan programme	Efficiency improvements of buildings; Increase in renewable energy	CO_2	Economic	Implemented 2017-	Ministry for National Economy	-	-	-
Tax advantage for companies after energy efficiency investments	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Demand management/reduction; Efficiency improvements of vehicles	CO_2	Regulatory	Implemented 2017-	National tax Office	-	-	-

Mandatory energy audit	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Demand management/reduction; Efficiency improvements of vehicles	CO_2	Regulatory	Implemented: 2017--	Hungarian Energy and Public Utility Regulatory Authority			
Mandatory employment of an energy rapporteur	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Demand management/reduction; Efficiency improvements of vehicles	CO_2	Regulatory	Implemented 2015-	National Tax Office	-	-	-
Economic Development and Innovation Operational Programme	Increase in renewable energy; Efficiency improvements of buildings; Modal shift to public transport or non-motorized transport; Improved transport infrastructure	CO_2	Economic	Implemented 2014-2020 (2023)	Ministry for National economy	-	-	-

Table 4.3 Energy policies and measures

Operational grant for the production of renewable energies

The METAR (Hungarian support scheme for renewable electricity) system was introduced with a lower rate of return on the 1st of January 2017 without the support categories of the so called brown premium and demonstration project, because of the system had to be notified to the European Commission in advance in order to fully operate. The European Commission has found the METÁR to be in line with EU state aid rules on the 11th July 2017 and this way all support schemes would come into force after the publication of the relevant acts. The premium will be determined – in line with the guideline of the EU – and beneficiaries selected in a competitive bidding process. Just the minor energy producers (with a capacity of less than 1 MW, except of wind power plants) gain exemption under this rule. The tenders will be presented – according to the request of the Ministry of National Development – by the Hungarian Energy and Public Utility Regulatory Authority and the minor producers can request the grant form it too.

Capacity maintenance of the Paks Nuclear Power Plant

In accordance with the National Energy Strategy, it is assumed that two new units - of approximately 1,200 MWe each - will be put into operation by 2026 (1st) and by 2027 (2nd). The main objective of building the two new nuclear units is the replacement of the Paks Nuclear Power Plant currently in operation. The replacement of its capacity will be the basis for a long-term low-carbon electricity generation in Hungary.

National Building Energy Performance Strategy

The National Building Energy Performance Strategy, which was published in 2015, is a part of the National Energy Efficiency Action Plan. The strategy sets out the main targets and directions for modernising the domestic building stock and achieving a significant decrease in the energy demand of buildings until 2020, with projections until 2030. It also defines a conceptual framework for the building energy action plans and the specific programmes and actions to be implemented at a later stage. Detailed analysis of the domestic building stock can also be found within the Strategy. The list of government buildings that are covered by the renewal obligation in Article 5 of Directive 2012/27/EU and in the relevant national legislation (Act LVII of 1995 on Energy Efficiency, Section 8), and buildings with almost zero energy requirements (2010/31/EU Directive, Article 9) are both parts of the Strategy. As part of the 4th National Energy Efficiency Action Plan, the National Building Energy Strategy was also revised in 2017.

New requirements on energy performance of buildings

For new buildings of authorities: from 1 January 2018; for every other new buildings: from 1 January 2021 – from the mentioned deadlines new buildings have to meet nearly zero-energy building requirements: maximum 100 kWh/m2 specific annual energy demand for residential, maximum 90 kWh/m2 for commercial and office buildings and maximum 80 kWh/m2 for educational buildings. Furthermore, 25% of annual energy needs should be provided from renewable energy sources.

From 1 January 2018, buildings after renovation have to meet the following requirements: maximum 110-140 kWh/m2 for residential buildings, maximum 132-160 kWh/m2 for commercial and office buildings and maximum 90-150 kWh/m2 for educational buildings. New requirements are defined in terms of the heat transfer of the outer delimiters (U-value), the building engineering systems and the energy certificates of buildings.

Energy saving programme for public buildings

From 2017 all public institutions must register their energy consumption and report it to the offices of the National Energy Efficiency Advisory Network and, at the same time, they must prepare energy saving plans and report annually on their implementation. An awareness-raising campaign is also needed to be launched targeting the employees of public institutions.

Establishment of the National Energy Efficiency Advisory Network

The National Energy Efficiency Advisory Network was established in 2017 and consists of 76 offices within the institutional framework of County Government Offices and District Offices. Their tasks, among others, are: to collect and monitor energy consumption data of municipal

and state owned public buildings; to provide assistance in awareness-raising activities targeting the users of municipal public buildings; to support the preparation and development of energy saving action plans of municipalities and public institutions; to contribute to the conclusion of energy supply contracts and to provide free energy consultation and advice for SMEs.

1 Funding for energy modernization of residential buildings - Warmth of Home Programme

The aim of the programme – since 2008 - is to achieve further reduction of households' energy costs from domestic budgetary resources by replacing outdated household machines, boilers, doors and windows. The majority of domestic resources available for improving the energy efficiency of residential buildings come from the revenues of CO_2 emission allowances. Between 2008 and 2013 revenues from Kyoto units were utilised within the Green Investment Scheme (GIS) budget heading. From 2013 a part of the revenues from the European Union's Emission Trading Scheme (EU ETS) will be used within the Green Economy Financing Scheme (GEFS) budget heading. The sources of these budget headings are available for the promotion of non-refundable subsidies for residential energy efficiency.

The main target areas of the programme are: the increase of energy efficiency, the increase of energy savings, the reduction of GHG emissions and the reduction of energy dependency. In addition, emission reduction has direct environmental benefits: the mentioned improvements result in heat, energy and cost savings for buildings, heating systems and businesses; and the increase of renewable heat and power generation, which reduces dust and PM10 pollution.

The Warmth of Home Programme focuses on creating a complex, short and long term package of measures that increases household energy efficiency and energy savings, thus contributing to lower energy costs. The programme was relaunched during the autumn of 2017 with an allocation of 31 billion forints, and until nowadays it has enabled the energy modernization of more than 164,000 households with a funding of approximately 23 billion forints.[6] The subprograms will be announced continuously, and new subprograms are also expected to be announced.

The programme is part of the Government's overheads reduction policy, as with the replacement of outdated household appliances Hungarian families can save up to 20 thousand forints, and with the modernization of residential buildings up to 150-180 thousand forints on their annual energy expenditures. The majority of the governmental household replacement programmes – which achieve the consumers' level – targets social policy, family support and regional development considerations as well: certain grants were dedicated to large families and pensioners, and certain financial quota was defined for the inhabitants of each regions in order to provide geographical balance and equal opportunities.

As a result of the above mentioned energy efficiency investments, Hungary's carbon dioxide emissions are reduced by more than 79,000 tons/year and the country's energy savings are increased by 0,7 PJ/year.

Funding for energy modernization of residential buildings – interest-free loan programme

[6] According to the status on 8 September, 2017.

There are many free loans available in the operational programs for energy modernization of family houses and condominiums and for the use of renewable energy sources. The financial sources of the credit line are the Economic Development and Innovation Operative Programme (GINOP) and the Competitive Central Hungary Operative Programme (VEKOP) of the EU. The credits are, inter alia, available for insulating residential properties, modernizing heating or hot water systems, and installing solar-panelled, solar-powered and heat pump systems. The amount of the loan, in case of natural persons, may vary from 500 thousand to 10 million forints, while in case of condominiums and housing associations from 500 thousand to 7 million forints for each apartment, with a maturity of 20 years. The expected contribution of the applicants is min. 10% of the eligible costs. The loan can also be used as an own contribution for other non-refundable constructions. According to the expectations, the loan programme will enable to renovate tens of thousands of apartments and family houses.

Tax advantage for companies after energy efficiency investments

In 2017 a new tax advantage was introduced, which can be requested by companies after their investments that increase energy efficiency.

Mandatory energy audit

According to Directive 2012/27/EU on Energy Efficiency, since 2015 it has been obligatory for non-SME enterprises to have an energy audit every 4 years (or to operate an energy management system).

Mandatory employment of an energy rapporteur

Since 1 January, 2017 for enterprises and other institutions with high energy consumption, (where the annual energy consumption is higher than 400 000 kWh electricity or 100 000 m3 natural gas or 3 400 GJ heat energy), it is compulsory to employ an independent energy expert. The main task of the energy expert is to promote the introduction of energy efficient approaches and behaviours within the operation and decision-making of the organization.

Economic Development and Innovation Operational Programme (EDIOP)

EDIOP is one of the operational programmes during the 2014-2020 period accepted by the European Commission. Priority axis 4 of EDIOP supports energy efficiency improvement of buildings and economic activities and also investments related to renewable energy. The beneficiaries are SMEs. The EDIOP priority axis 8 supports investments in energy efficiency and renewable energy projects by companies and households.

4.3.3. Transport

Name	Objective	GHG affected	Type of instru - ment	Status	Implement-ing entity	Estimate of mitigation impact		
						2015	2020	2030
National Transport Infrastructure Development Strategy	Efficiency improvements of vehicles; Low carbon fuels/electric cars; Modal shift to public transport or non-motorized transport; Improved transport infrastructure	CO_2	Planning	Implemented : 2014-2020	Ministry of National Development	**-**	**-**	**-**
National Framework Plan for the Development of Alternative Fuels Infrastructure	Efficiency improvements of vehicles; Low carbon fuels/electric cars; Improved transport infrastructure	CO_2	Planning	Implemented : 2016-2030	Ministry of National Development , Ministry of National Economy	**-**	**-**	**-**
Ányos Jedlik Plan for the promotion of e-mobility	Efficiency improvements of vehicles, Low carbon fuels/electric cars, Improved transport infrastructure	CO_2	Planning	Implemented : 2015-	Ministry of National Economy	**-**	**-**	**-**
Financial support for enterprises and private persons to buy electric cars	Low carbon fuels/electric cars	CO_2	Economic	Implemented : 2016-	Ministry of National Economy	-	-	-
Financial support for the establishment of electric charging stations	Low carbon fuels/electric cars; Improved transport infrastructure	CO_2	Economic	Implemented : 2016-	Ministry of National Development , Local governments	-	-	-
Tax allowances after environmentally friendly vehicles	Low carbon fuels/electric cars; Efficiency improvements of vehicles	CO_2	Fiscal	Implemented 2016	Ministry of National Economy	-	-	-
Application of usage-based road toll on heavy duty vehicles.	Efficiency improvements of vehicles; Demand management/reduction	CO_2	Fiscal	Implemented : 2013	Ministry of National Economy	79.4	136.6	-
CNG Clean Fuel Box Project	Low carbon fuels/electric cars; Improved transport infrastructure	CO_2	Economic	Implemented : 2016-2018	Companies	-	-	-
PAN-LNG project	Low carbon fuels/electric cars; Improved transport infrastructure	CO_2	Economic	Implemented : 2015-2019	Ministry of National Development . Companies	-	-	-

Improvement of the bicycle transportation network	Modal shift to public transport or non-motorized transport; Improved behaviour; Improved transport infrastructure	CO_2	Economic	Implemented: 2010-2020	Ministry of National Development	213	1550	-
Improvement of the railway vehicle fleet	Modal shift to public transport or non-motorized transport; Efficiency improvements of vehicles	CO_2	Economic	Implemented: 2015-2020	Ministry of National Development	-	2,4	-
Replacement of vehicle of public transport service companies	Efficiency improvements of vehicles; Modal shift to public transport or non-motorized transport	CO_2	Economic	Planned: 2017-2020	Ministry of National Development	-	13	35
Education and broad application of eco-driving	Improved behaviour	CO_2	Voluntary/ negotiated agreements, Education, Regulatory	Planned: 2018-	Ministry of National Development	-	68.2	-
Integrated Transport Development Operational Program (ITOP)	Improved transport infrastructure; Modal shift to public transport or non-motorized transport; Efficiency improvements of vehicles	CO_2	Economic	Implemented: 2014-2023	Ministry of National Development	-	-	-

Table 4.4.Transport policies and measures

National Transport Infrastructure Development Strategy

The National Transport Infrastructure Development Strategy is the main policy document in the transport sector. It depicts the current status of the transport sector in Hungary and determines targets while proposing measures to achieve these targets. Among other targets the strategy aims to mitigate the environmental impacts of transport in Hungary through modal shift to public transportation, energy efficiency improvement, demand management and use of renewables. The implementation period of the plan is between 2014 and 2030/2050.

National Framework Plan for the Development of Alternative Fuels Infrastructure

The National Framework Plan for the Development of Alternative Fuels Infrastructure (adopted by 1782/2016. Government Decision in 2016) identifies national targets on the deployment of alternative fuel infrastructure (CNG/LNG, biofuels, electricity, hydrogen and in the transport sector) by 2020, 2025 and 2030 and summarizes the legal and financial incentives allocated for the deployment and R&D concerning these type of fuels.

Ányos Jedlik Plan for the promotion of e-mobility

Ányos Jedlik Plan is the main policy document for the promotion of e-mobility in Hungary. The Plan, which was published in 2015, defines targets for the number of electric cars and charging points. It also supports local municipalities to install public electric charging points; and enterprises and private persons to buy electric cars. In order to promote electric cars, it also introduces tax advantages (exemption from certain taxes such as registration tax or annual turnover tax). It also represents indirect support (such as the exemption from paying parking fees), and regulations to promote the installation of electric charging points and to sell electricity at charging points.

Financial support for enterprises and private persons to buy electric cars

This is a sub-programme of the Ányos Jedlik Plan that provides support to private persons and companies to buy electric cars and trucks under 3.5 tonnes. The maximum contribution rate is 21% of the price and maximum 1.5 million forints/vehicle. The sub-programme was launched in 2016.

Financial support for the establishment of electric charging stations

This sub-programme of the Ányos Jedlik Plan supports the establishment of electric charging stations by local governments.

Tax allowances after environmentally friendly vehicles

Fully electric, partially electric plug-in cars and zero-emission cars are exempt from motor vehicle tax, company car tax and registration tax. Moreover for buses, lorries and trucks the rate of the motor vehicle tax is dependent on the environmental classification of the vehicle. Trucks also receive tax allowance for using combined transportation. The rate of company car tax and registration tax also depends on the environmental classification of the vehicle.

Application of usage-based road toll on heavy duty vehicles.

A road toll was introduced for heavy duty vehicles in 2013. The road toll depends on vehicle weight (characterised by number of axes) and on environmental performance of the vehicle (Euro norm). It gives an incentive for better organisation of freight delivery and for better use of payload capacity.

CNG Clean Fuel Box Project

The project is a wide-scale pilot market deployment of an innovative CNG refuelling network that will be implemented in Hungary along two transport Core Network Corridors (Mediterranean and Orient/East-Med). The objective of the project is to develop CNG availability and use at national level. This will be achieved through the deployment of the Clean Fuel Box (CFB) refuelling network solution. This is a CNG self-service station network, which is able to refill CNG vehicles, independently of the gas distribution network, based on a 24/7 service. The project includes a market study of the CFB system and the market launch of this innovative technology through real-life trial including a network of 39 CFB stations, the delivery of five LNG truck feeders and the introduction of 50 CNG vehicles to test the functioning of the network and to support the emerging demand. The CFB network

will be monitored by a central operator service with smart information technology. The implementation started in 2016 and will be finished in 2018.

PAN-LNG project

The aim of the project is to prepare the establishment of the liquefied natural gas (LNG) infrastructure, building the first filling stations and establishing the supply system. To deliver on its objectives, the project includes studies, works and pilot deployment for:
- five LNG/LCNG filling stations to deliver LNG as a replacement for diesel for heavy duty vehicles (HDV) and;
- a Small Scale pilot liquefaction plant, to develop the most advanced long term solution for the LNG supply, based on fossil gas wells and on biogas sources.

The PAN-LNG-4-DANUBE's overall objective is to foster LNG use in inland navigation sector across the Danube, through two pilots: one pilot for the innovative LNG bunkering and refuelling station for vessels and trucks in the Freeport of Csepel, and one pilot to retrofit and operate a freight vessel with LNG propulsion. The Action, including a study and the real-life pilot deployment, is implemented in the Core Port of Csepel-Freeport, the biggest inland port in Hungary and a crossroad for flows and transhipment of freight between inland waterway, rail and road transport. The project is to be implemented between 2015 and 2019.

Improvement of the bicycle transportation network

The government aims to increase the length of bicycle roads by an additional 1000 kms until 2020, in order to increase the share of daily bicycle users up to 27% of the total population, and to increase the share of recreational bicycle users by 30.000 persons/year. A group of measures are meant to achieve these targets, such as the development of bicycle infrastructure, the support to the establishment of cycling facilities (e.g. bicycle racks, B+R parking), the establishment of cyclist public transport systems and the awareness-raising campaigns. These measures are planned to be introduced between 2010 and 2020.

Improvement of the railway vehicle fleet

Modern electric suburban train acquisition, which is planned to enter into service between 2015 and 2020. Within the framework of this improvement 40 suburban trains are going to be purchased by 2020. The purchases of trains are financed from the Integrated Transport Development Operative Programme (IKOP) of the EU.

Replacement of vehicle of public transport service companies

The replacement of public transport service companies vehicles has decreased in recent years. The average age of Hungarian public bus fleet was 14,46 years at the end 2015. Between 2016-2020 1813 buses are required to be replaced, and after 2020 additional 6000 bus replacement becomes necessary.

Education and broad application of eco-driving (environmentally conscious driving)

Learning environmentally-conscious Eco-driving techniques is a framework that includes the development of educational materials, the certification of learning equipment and facilities,

the organization and implementation of awareness-raising campaigns, the implementation of pilot projects with voluntary participants and periodic compulsory driving education for transport safety, in order to increase environmental performance of cars. Currently, this is only a planned measure, which is not yet adopted and its implementation may start only after 2018.

Integrated Transport Development Operational Program (ITOP)

ITOP is one of the operational programmes during the 2014-2020 period accepted by the European Commission. It serves the improvement of energy efficiency in the transport sector through the direct strengthening of public transport and other means of transport which are less harmful to the environment. Transport on road, railway and rivers are included, both freight and passenger transport. However, this strategy was not designed to serve climate purposes only but it plays an essential part in the development of the Hungarian TEN-T infrastructure (both road and railway), shortening travel times and decreasing the emission of air pollutants (PM10, NOx).

4.3.4. Agriculture

Name	Objective	GHG affected	Type of instrument	Status	Implementing entity	Estimate of mitigation impact		
						2015	2020	2030
Protection against soil erosion	Protection and sustainable us of natural resources	CO_2, N_2O	Regulatory	Implemented 2013-	Governmental offices and farmers	-	-	-
Good Agricultural Practice to protect waters against pollution caused by nitrates from agricultural sources	Protection and sustainable us of natural resources	CH_4, N_2O	Regulatory	Implemented 2008-	Governmental offices, farmers	-	-	-
Greening payment	Adopting and maintaining environmental and climate friendly farming practices	CO_2, N_2O	Economic	Implemented 2015-	Paying agency and farmers	-	-	-
Rural development measures to develop animal husbandry farms	Improving energy efficiency and competitivene ss	N_2O, CH_4	Economic	Implemented 2014-	Prime Minister's Office NFCSO	-	-	-

Table 4.5 Agriculture policies and measures

Protection against soil erosion

Soil plays an important role in carbon capture, so loss of soil is a major threat, as soil formation is a very slow process. That is why great emphasis should be put on the fight against erosion, which also has a bearing on climate change. Erodibility is determined by the grain size, humus content, structure, moisture state and water absorption of the soil. (The greater the water absorption capacity of a soil, the less eroded.) The erosion work of the rain is greatly increased by the slope of the hill, which increases the destroying energy of the water.

The Decree 50/2008 of the Ministry of Agriculture and Rural Development has been modified in 2013 to implement regulations in Common Agricultural Policy (CAP). The Decree contains regulations on "Good agricultural and environmental condition". It bans cultivating certain cultures with high erosion risk on steep slopes (more than 12%). It prescribes practices for maintaining cover on agricultural land after harvest.

The Act No. CXXIX of 2007 on the protection of arable land contains general rules on soil erosion control and preserving soil organic matter content. Providing a set of measures from which farmers can choose to apply according to the characteristics of their land to control soil erosion if appropriate for example contour ploughing, cover crops, preserving soil structure, avoiding overgrazing, covering intersections in orchards. Another set of measures helps preventing loss of soil organic matter, for example appropriate nutrient management, reduced tillage, protecting of layer with high organic matter content, utilising in plant residues on the plot.

Good Agricultural Practice to protect waters against pollution caused by nitrates from agricultural sources

Hungary, as member state of the EU had to implement Directive 91/676/EC. Therefore, the rules of Good Agricultural Practice were set out in the Ministerial Decree 59/2008. The rules concern – among others – environmental friendly manure and slurry management including storage and land application. According to Good Agricultural Practice the maximum application rate of nitrogen from slurry and manure is 170 kg/ha. It is also forbidden to take manure and slurry to the field between 31st of October and the 15th of February. There are certain regulations concerning storing, treating of manure or slurry on the animal farm and on the field as well.

Greening payment

Since 2015, farmers entitled to payment under the single area payment scheme shall observe, on all their eligible hectares, the agricultural practices beneficial for the climate and the environment. In return, they receive the so-called greening payment. The agricultural practices beneficial for the climate and the environment are the following:

- crop diversification – for improved soil quality,
- maintaining existing permanent grassland – for carbon sequestration and protection of environmentally sensitive grasslands

- having a certain amount of ecological focus area (EFA) on or adjacent to the arable land of the farm – for safeguarding and improving biodiversity on farms.

Rural development measures to develop animal husbandry farms

Due to these measures, farms have a chance to build new and modern manure-silos or slurry tanks or purchasing new manure or slurry sprayer facilities using modern technology of measuring and spraying and controlling. The technology applied by the farms shall meet the requirements of the Best Available Technology (BAT). The capacity of the manure silos or slurry tanks shall be planned for storing at least for 6 months. The isolation of the ground and wall has to be absolute 100%. These measures enable farmers to apply the rules of Good Agricultural Practice and to decrease the NH_3, NO_2, CH_4 emissions.

4.3.5 Forestry

Name	Objective	GHG affected	Type of instrument	Status	Implement-ing entity	Estimated mitigation impact		
						2015	2020	2030
National Forest Programme	Afforestation and reforestation	CO_2	Regulatory	Implemented 2016-2030	Ministry of Agriculture	-	-	-

Table 4.6.Forestry policies and measures

National Forest Strategy 2016-2030

The National Forest Strategy's main goal is to continue the track on reaching goals for 2050 of the earlier National Forest Program 2006-2015, which was presented in the previous national communication. One of its main goals is to reach 27% forest coverage in Hungary by 2050, which creates a need of around yearly 15 thousand ha afforestation. The Strategy is referring to climate change mitigation by promoting wood as renewable raw material and forest biomass for energy. Also put emphasis on the protection of forests and on adaptation to climate change as well as on monitoring forest condition including adverse effects of climate change, prepare measures to mitigate climate change related damages, promote close to nature forest management. These measures aims to maintain or even increase carbon sequestration in forests and in wood products, through them it directly affects CO_2 emission reduction targets.

4.3.6 Waste

Name	Objective	GHG affected	Type of instrument	Status	Implement-ing entity	Estimated mitigation impact		
						2015	2020	2030
Waste Law	Prevention of the production of waste, Preparing waste for re-use, Enhanced recycling; Other recovery of waste, such as, in particular, energy recovery, Improved treatment technologies; Improved landfill management; Reduced landfilling	CH_4	Regulatory	Implemented: 2014-	Ministry of Agriculture	-	-	-
National Waste Management Plan	Enhanced recycling; Improved treatment technologies; Improved landfill management; Reduced landfilling	CH_4	Planning	Implemented: 2014-2020	Ministry of Agriculture	-	-	-
The National Waste Management Public Services Plan	Enhanced recycling; Reduced landfilling; Improved treatment technologies	CH_4	Planning	Implemented: 2016-	Ministry of National Development	-	-	-
Environmental Product Fee	Demand management / reduction; Enhanced recycling; Reduced landfilling	CH_4	Fiscal	Implemented: 2011-	Ministry of Agriculture	-	-	-
Lowering the share of landfilling in municipal solid waste treatment	Reduced landfilling	CH_4	Planning	Implemented: 2016-2030	Ministry of National Development and Ministry of Agriculture	-	-	-
Jenő Kvassay Plan	Improved wastewater management systems; Improved treatment technologies	CH_4, N_2O	Planning	Implemented: 2017-2030	Ministry of Interior	-	-	-
National Implementation Programme on Waste Water Collection and Treatment	Improved wastewater management systems	CH_4	Regulatory	Implemented: 2002-2015	Ministry of Interior	-	-	-
Sewage Sludge Treatment Strategy	Improved wastewater management systems	CH_4, N_2O	Planning	Implemented: 2014-2017	Ministry of Interior	-	-	-

Table 4.7.Waste policies and measures

Waste Law

The Act on Waste (Act No. CLXXXV in 2012) and its implementing regulations implement the Waste Framework Directive (2008/98/EC) of the European Union. It entered into force on 1st of January, 2013. It sets out several basic principles on waste management; it introduces a landfill tax, compulsory separate household waste collection for household paper, plastic and metal, and contains a prescription on the creation of a National Waste Prevention Programme. The landfilling tax is levied on almost all kinds of waste landfilled. The tax was increased to 6000 HUF per tonne in 2016 from 3000 HUF. Revenues from this tax are allocated for waste management purposes.

National Waste Management Plan

The National Waste Management Plan (hereinafter referred to as NWMP) contains the main waste management objectives for the 2014-2020 period. The NWMP has been approved by Government Resolution No. 2055/2013 (XII. 31.). The NWMP defines the general and specific actions for each waste flow and, in addition to the objectives, also identifies the areas of intervention in waste management, the future tasks, measures and the funds required for their implementation. The targets of NWMP are set in accordance with the EU waste targets. Sustainable development is one of the basic elements of the NWMP and the main principle is to follow the waste hierarchy. Waste legislation and policy of the EU Member States shall apply the waste hierarchy as a priority: prevention, re-use, preparing for re-use, recycling, other kinds of recovery, and finally as a last resort, disposal. The NWMP includes the National Prevention Programme (NPP). The NPP covers the sectors of agriculture, construction and infrastructure, manufacturing, sale, retail, transport, households and public services. The waste types cover food or organic waste, construction and demolition waste, hazardous waste, household and municipal waste, packaging waste, WEEE/batteries and many others. The NPP defines the intervention areas in five sets of measures (prevention of construction and demolition waste generation; reuse; green public procurement; environmentally friendly production and business operation; awareness raising) that need to be addressed as priorities in the 2014-2020 period.

The National Waste Management Public Services Plan

The National Waste Management Public Services Plan (hereinafter referred to as: NWMPSP) came into force with the declaration of Government Resolution No.1250/2016. (V. 27.). The NWMPSP describes the current status of public waste management service in Hungary, the related regulations, and also lists the tasks of the public service providers. It also includes the various EU requirements related to public waste management, the fulfilment of the objectives related to this task and further directions of development. These are the following: reducing the amount of landfill, increasing the amount of recovered waste materials, building glass and plastic waste recycling plants as necessary, prioritizing the use of non-recyclable waste for energy production and developing infrastructure for biodegradable waste (composting). The ongoing review of the NWMPSP also reviews the requirements for public service providers and the targets set for 2020.

Environmental Product Fee

Hungary's environmental product fee was introduced in 2011, and it is perceived as an effective environmental management tool, which has favourable effects on domestic waste management processes. The regulatory advantage of this tool is its ability to stimulate the manufacture and marketing of environmentally favourable products and to restrict environmentally undesirable products. It is levied on batteries, packaging, other petroleum products, electronic equipment, tires, promotional flyers, other plastic products, other chemical products and office paper. The generated revenue provides funding for the state in order to achieve EU targets related to recovery, and it supports the development of domestic waste recovery. Government Decree no. 343/2011 (XII. 29.) and Act LXXXV. of 2011 regulates the environmental product fee.

Jenő Kvassay Plan

The Jenő Kvassay Plan, which was published in 2017, describes action until 2030 that aims to improve water management, including public utility sewage systems, the sewerage of settlements and regions and to increase the recovery rate of water in the settlement water management

National Implementation Programme on Waste Water Collection and Treatment

The program was accepted by the Hungarian Government in 2002. The aim was to implement Directive 91/271/EEC on urban wastewater treatment in Hungary: the treatment of wastewater collected in the public utility sewage systems and the sewage treatment of settlements and regions. The quantified targets set by the program should be updated every two years.

Sewage Sludge Treatment and Recovery Strategy

The timeline of the Strategy covers the medium term (5 years, 2018-2023) improvement of the Hungarian municipal sewage sludge management, with an outlook till 2027. The Strategy includes the detailed situation analysis and assessment of the Hungarian sewage sludge management (creating the basis of the Strategy), the setting of quantitative objectives regarding the improvement of sewage sludge management (target system of the Strategy), the exact definition of the instruments and areas where intervention is needed (instruments of the Strategy), the HR, professional, financial and organizational conditions of the necessary interventions, the implementation of the Strategy as well as its monitoring system (the follow-up of output, outcome and impact indicators) and the basic principles of the assessment. The aim is to continue agricultural fertilization with sewage sludge recovery. The creation of compost and marketable products is recommended instead of the direct distribution of sewage sludge on agricultural areas. In case of the stagnation and decline of agricultural recovery, recovery from combustion needs to be put forward.

4.4. Policies and measures no longer in place

This section presents a list of policies and measures that were included in the 6th National Communication of Hungary, but are no longer in place. In the list there are strategies and action plans that have expired and have been revised.

- Second National Energy Efficiency Action Plan (Expired and revised)
- Compulsory take-over of renewable based power at subsidized prices(KÁT)
- "Liveable panel buildings" sub-programme
- "Our home reconstruction" sub-programme
- "Renewable Public Institutions" Sub-Programme
- "Power saving households" programme
- National Forest Programme 2006–2015 (Replaced by the National Forest Strategy 2016-2030)
- National Environmental Protection Programme 2009-2014 (Expired and revised)
- New Hungary Rural Development Strategic Plan (2007–2013) (Expired and revised)
- New Széchenyi Plan with its operative programmes (have expired and were replaced by Széchenyi 2020)

5. PROJECTIONS OF GREENHOUSE GAS EMISSION

5.1. Projections

This chapter gives information on projected future greenhouse gas emissions and removals.

The projections are based on the latest 2017 National Inventory Report which contains information about the years 1985-2015. Recalculations made in October due to the review of the inventory report were not considered. Projections are presented both by sectors and by GHG. GHG emissions are presented for five-year intervals in this chapter from 2015 to 2035. Projections were made for all direct greenhouse gases occurring, namely: CO_2, CH_4, N_2O, PFCs, HFCs and SF.

Two scenarios were constructed. The "with existing measures scenario" (WEM) encompasses implemented and adopted policies and measures, while the "with additional measures scenario" (WAM) takes into account planned measures.

All emissions are presented in kilotonnes of CO_2 equivalent. The global warming potentials in the calculations are presented in table 5.1 below.

GHG	**CO_2-equivalent**
CO_2	1
CH_4	25
N_2O	298
SF_6	**22800**

Table 5.1. Global warming potentials used

Throughout the development of the projections the impacts of EU and national regulations, specific domestic policies and EU and national level targets were considered (e.g. Renewable Energy Directive, EU ETS). Whether a policy or measure is included in the "with existing measures" or in the "with additional measures" is presented in CTF table 3. The projections were not performed with a comprehensive model; different methods were used in every sector. The used methods and assumptions are described in detail for each sector. Emissions in each section are presented in kt CO_2 equivalent.

Information included in this report are mostly consistent with the information reported under the EU's Monitoring Mechanism Regulation in 2017, but some recalculations were made in the following sectors: industrial processes and product use, public electricity and heat production.

	2015	2020	2025	2030	2035
By sector					
Energy	31072.13	28855.81	28045.05	27242.73	26688.90
Transport	12202.64	11729.48	13808.59	14877.03	15399.69
Industrial processes and product use	7302.01	6783.24	6762.05	7068.16	7574.57
Agriculture	6676.35	7362.04	7664.27	7891.61	8119.30
Land use, land-use change and forestry	-6512.11	-3384.96	-3329.6	-3156.19	-3076.39
Waste	3838.62	4027.05	3627.58	3269.07	3015.69
Total without LULUCF	61091.75	58757.63	59907.54	60348.6	60798.14
Total including LULUCF	54482.89	55272.39	56457.64	57053.52	57564.03
International aviation	547.79	653.66	757.76	864.05	974.74
By gas					
CO_2 excluding net CO_2 from LULUCF	46777.5	44932.89	46790.3	47632.63	48193.42
CH_4 emissions excluding CH_4 from LULUCF	305.0352	321.01	306.57	291.85	283.07
N_2O emissions excluding N_2O from LULUCF	14.46	15.20	15.70	16.15	16.49
HFCs	2266.59	1291.96	702.64	498.65	475.98
PFCs	1.15	1.15	1.15	1.15	1.15
SF_6	111.88	116.13	125.799	133.94	141.05
Memo items					
International aviation	**547.79**	**653.66**	**757.76**	**864.05**	**974.74**

Table 5.2. GHG projections with existing measures (2015-2035) (kt CO_2-eq)

	2015	2020	2025	2030	2035
By sector					
Energy	31072.13	28857.58	28056.03	27274.02	26720.16
Transport	12202.64	11712.09	13729.1	14653.89	15102.52
Industrial processes and product use	6676.35	7362.04	7664.27	7891.61	8119.3
Agriculture	6676.35	7362.04	7664.27	7891.61	8119.30
Land use, land-use change and forestry	-6512.11	-3384.96	-3329.60	-3156.19	-3076.39
Waste	3838.62	3952.97	3385.60	2927.69	2623.39
Total without LULUCF	61091.61	58667.93	59597.05	59815.36	60139.94
Total including LULUCF	53823.19	54133.36	54547.68	55908.08	55907.27
By gas					
CO_2 excluding net CO_2 from LULUCF	46663.72	45151.61	46962.08	47711.69	48245.61
CH_4 emissions excluding CH_4 from LULUCF	279.33	296.86	278.82	262.70	253.90
N_2O emissions excluding N_2O from LULUCF	14.46	15.20	15.70	16.15	16.49
HFCs	2266.59	1291.96	702.64	498.65	475.98
PFCs	1.15	1.15	1.15	1.15	1.15
SF_6	111.88	116.13	125.8	133.94	141.05
Memo items					
International aviation	547.79	653.66	757.76	864.05	974.74

Table 5.3. GHG emission projection by sector with additional measures (2015-2035) (kt CO_2-eq)

Total GHG projections

Total GHG emissions without LULUCF has been decreasing from 2007 until 2013 almost continuously, but it increased again in the last two years. According to our WEM scenario this will turn again into a downward trend with total emissions without LULUCF reaching 3.8% lower level in 2020 and then manly because many of the existing measures don't span out until 2030 it will rise slowly reaching a level 1.2% below the 2015 level. In this scenario emissions will be 35.6% and 33.8% lower than they were in 1990.

According to the WAM scenario emissions will decrease by 4% until 2020 and by 2%% until 2030. This compared to the 1990 level equals 35.7% and 34.4% respectively.

GHG projections by sector

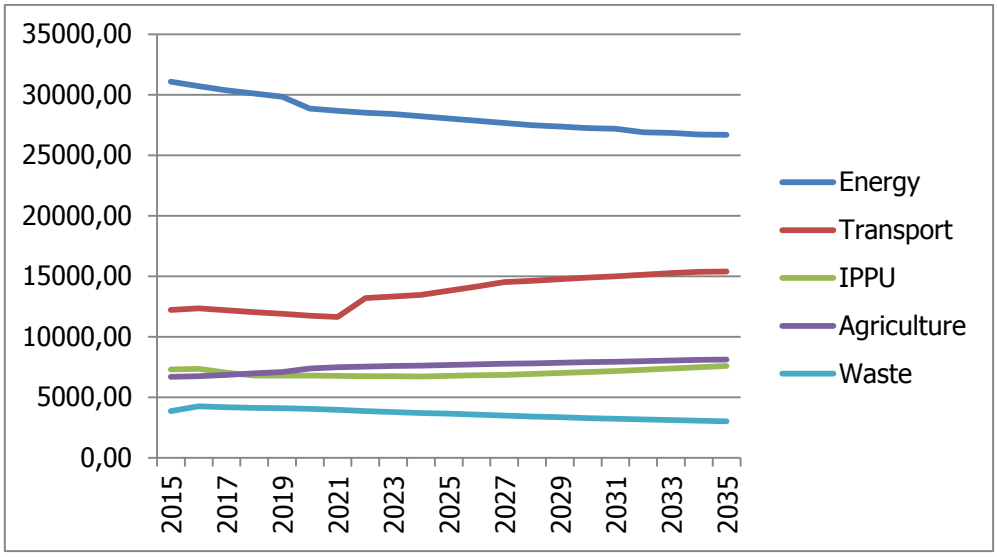


Figure 5.1. GHG emissions projection by sector (2015-2035)

Figure 5.1. shows expected levels of GHG emissions in CO_2-equivalent by sector from 2015 to 2035.

Energy sector (without transport) emissions are projected to decrease by 7.1% until 2020 compared to 2015 and by 5.6% until 2030 in the WEM scenario and by 6.6% and 11.3% respectively in the WAM scenario. The residential sector is responsible for most of this change. The residential sector is expected to emit 18% and 41% less in 2020 and 2030 respectively mainly due to the new regulations on energy performance of buildings.

The demand for transport and most of all for road transportation will most certainly continue to rise in the coming decades. The penetration of alternative fuels in road transportation won't be able to counterbalance this effect. Altogether in the WEM scenario we project emissions from transport to be 22% higher in 2030 than they were in 2015. In the WAM scenario we expect emissions to be 20% higher in 2030 than in 2015.

In case of industrial processes and product use emissions are expected to be 7.1% lower in 2020 and to 4.1% higher in 2030. So we don't expect major changes if we look at total emissions from the sector, but this can be broken down to two completely different trends. Industrial emissions experienced a huge fall from 2008 due to the economic crises and they are still in a relatively low level. According to our projections emissions from mineral, chemical and metal industries will rise by 13% until 2020 and by 33% until 2030. The other major expect trend is the decrease of F-gas emissions from product use which are expected to decrease by 49% until 2020 and 79% until 2030.

Agriculture is one of the few areas where emissions are projected to increase. The sector will emit 10% more 2020 and 2030 more in 2030 relatively to 2015 driven mostly by the increasing trend of cattle stock and the government's policy to increase the swine stock.

Land use, land-use change and forestry will remain a net absorber, but will absorb 48% less CO_2 in 2020 and 52% less CO_2 in 2030 than in 2015 according to our WEM scenario, while in the WAM scenario these values are 35% and 42%.

We expect emissions in the waste sector to increase until 2020 by 5% and then to decrease by 15% relative to 2015 in the WEM scenario. In the WAM scenario we expect emissions from waste to increase by 3% until 2020 and to decrease by 23.7% by 2030.

Emissions from international aviation are expected to continue to rise. According to our projections they will be 19% and 58% higher in 2020 and in 2030 respectively compared to 2015.

GHG projections by gas

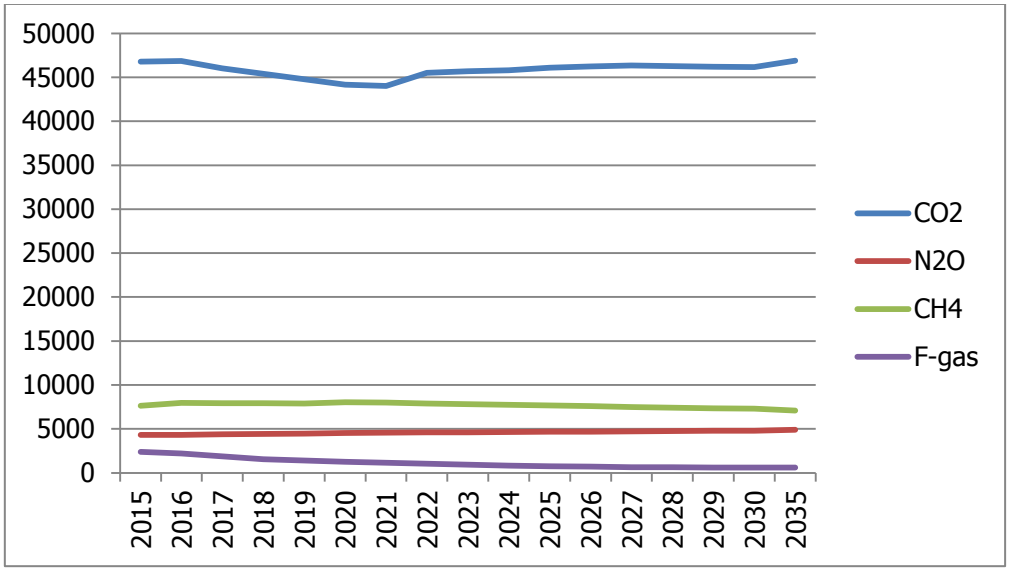


Figure 5.2 GHG emission projection by gas (2015-2035)

Emissions are presented without LULUCF in this section, and F-gases are presented as a group.

Figure 5.2 shows expected levels of GHG emissions by gas from 2015 to 2035.

We expect CO_2 emissions in the WEM scenario to be 4% lower in 2020 and 1.8% higher in 2030 than in 2015 In the WAM scenario a 3.2%decrease is expected until 2020 and 2.1% increase until 2030.

CH_4 emissions have shown a slowly decreasing trend in the latest years. We expect CH_4 emissions to increase until 2020 by 5.2% and to decrease by 4.3% until 2030 compared to 2015. In the WAM scenario we expect a 6.3% increase until 2020 and a 6% decrease until 2030.

N_2O emissions have increased by 13% since 2010. We expect that this trend will continue. We project N_2O emissions to be 5.1% and 11.7% higher in 2020 and 2030 respectively than in 2015 both in the WEM and the WAM scenario.

The largest decrease is expected in F-gases, 46.5% until 2020 and 74.3% until 2030.

5.2. Sensitivity analysis

Sensitivity analyses were performed in the case of the agriculture and the waste sector for some of the key parameters and assumptions in the calculations. The values in the tables below represent the effects in GHG emissions per gases resulted by 1% increase of the independent variables listed in the first column of each table.

Agriculture

In the case of agriculture, sensitivity analyses were performed on the change in cattle and swine population as these are the most important livestock related sources of emissions.

	Total GHG			
	2020	**2025**	**2030**	**2035**
Cattle	0,32%	0,33%	0,34%	0,35%
Swine	0,13%	0,14%	0,14%	0,14%
	CH_4			
Cattle	0,65%	0,66%	0,68%	0,70%
Swine	0,25%	0,26%	0,25%	0,25%
	N_2O			
Cattle	0,06%	0,06%	0,07%	0,07%
Swine	0,04%	0,05%	0,05%	0,05%

Table 5.4 The result of the sensitivity analyses on agriculture

Waste

In the case of the waste sector solid waste disposal is the most important in Hungary in respect of GHG emissions as 40% of total CH_4 emissions is coming from this subcategory. Sensitivity analyses were performed on the share of landfilling in the management of municipal solid waste, construction and development waste, and industrial waste.

	Total GHG			
	2020	**2025**	**2030**	**2035**
Share of landfilling (MSW)	0,13%	0,26%	0,38%	0,52%
Share of landfilling (C&D)	0,04%	0,10%	0,17%	0,20%
Share of landfilling(Industrial waste)	0,08%	0,19%	0,30%	0,37%
	CH_4			
Share of landfilling (MSW)	0,14%	0,29%	0,43%	0,58%
Share of landfilling (C&D)	0,04%	0,11%	0,19%	0,23%
Share of landfilling(Industrial waste)	0,09%	0,21%	0,33%	0,41%

Table 5.5. The result of the sensitivity analyses on waste

5.3. Supplementarity relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

The joint mitigation effort of the EU is mainly based on action on EU level. As the EU has a common emission reduction target, this is considered as domestic action. The emission allowances of the intra-EU policies can be traded:

- between stationary installations and aircraft operators in different Member States under the EU Emission Trading System (EU ETS) (EUA and EUAA allowances)
- between Member States under the Effort Sharing Decision (ESD) (AEA allowances).

However, in the period 2013-2020, it is still possible to use credits generated in projects under Article 6 and 12 of the Kyoto Protocol (CER and ERU) in a limited amount for compliance within the two above-mentioned EU policies. The principles of doing so is described in Articles 11a and 11b of the currently applicable text of the 2003/87/EU Directive concerning EU ETS and Article 5 of the 2009/406/EU Decision concerning ESD.

5.4. Methodology

1. Energy

1.A Fuel combustion

1.A.1 Energy industries

1.A.1.a Public electricity and heat production

To determine the amount of fuel combusted to produce electricity and heat, first the demand for electricity and district heating was determined. Demand was determined using projected amount of fuel in the manufacturing industries, transportation and other sectors.

To determine the weight of each fuel type in the production of electricity, the "nuclear-coal-green" scenario from the National Energy Strategy was used. This scenario includes the construction of new nuclear units at the Paks site, the extension of the renewable energy utilization path set out in the NREAP, and the construction of a new coal power plant. In this scenario 9% of the electricity used will be imported in 2020, while in 2030 this will turn into 14% export.

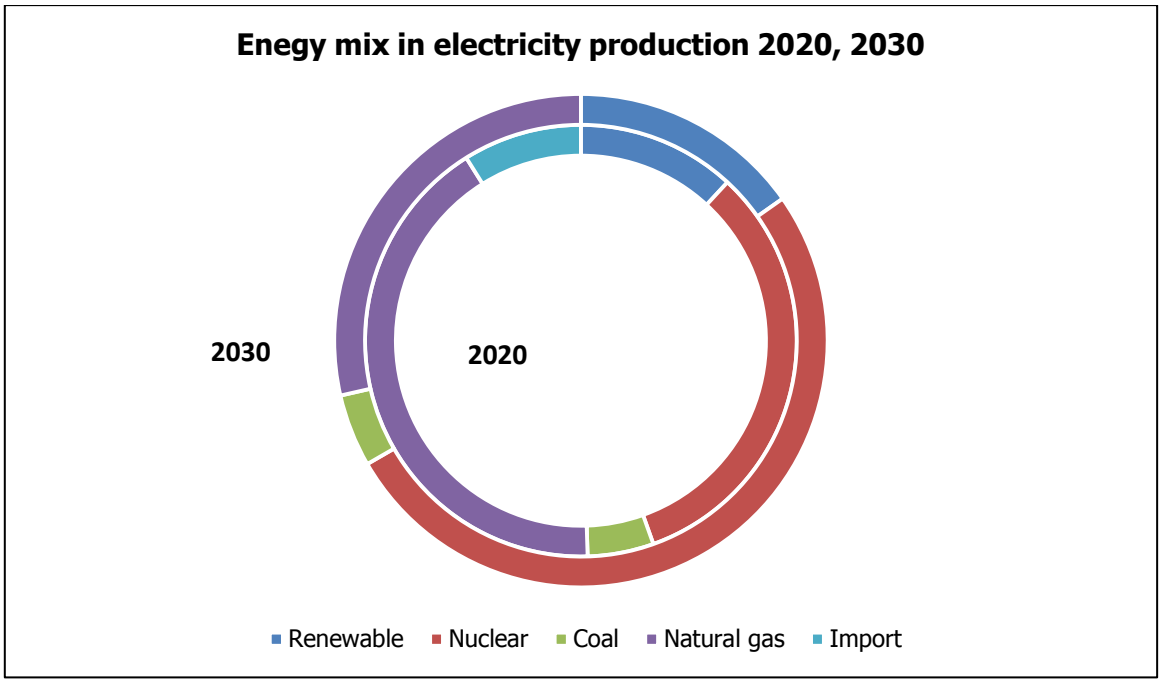


Figure 5.3: Energy mix in electricity production in 2020 and 2030

The 2015 energy mix of heat production was kept for the entire time series. Network losses have been decreasing constantly. We expect that this trend will continue as envisaged by the National Energy Strategy.

The average of emission factors in the years 1985-2015 was applied.

1.A.1.b Petroleum refining

The average growth of energy consumption from 2000 to 2015 was applied. The 2015 emission factors were kept.

1.A.1.c Manufacturing of solid fuels

Energy consumption in the sector kept falling until 2005. This trend changed in 2006, and energy consumption has been rising since with only a small drop in 2015. We expect that this trend will continue in a slowing manner thus we made a logarithmic extrapolation based on the 2005-2015 data. The average emission factors of the 2006-2015 period was applied.

1.A.2 Manufacturing industries and construction

Emissions were projected using multivariate or bivariate regression models or in some cases extrapolation where no regression model could be constructed.

In principle, emissions were projected in three steps: first, the gross value added of the subsector was projected, then the fuel consumption of the sector, and then from this the GHG emissions were calculated. In some cases, where data on gross value added of the sector did not correlate with the fuel consumption data, the first step was left out.

1.A.3 Transport

To project energy consumption of the transport sector (except domestic aviation, navigation and other transportation) the values of projected demand in the National Transport Infrastructure Strategy was used. Domestic aviation has been showing a stagnating trend for the last couple of years with little fluctuation, thus the average energy consumption of 2008-2015 was used for the future years. In case of domestic navigation, the 2015 value was used. Energy consumption in other transportation between 1985 and 2015 has been fluctuating to a great extent, but altogether it is showing a decreasing trend. This trend was extended linearly until 2035.

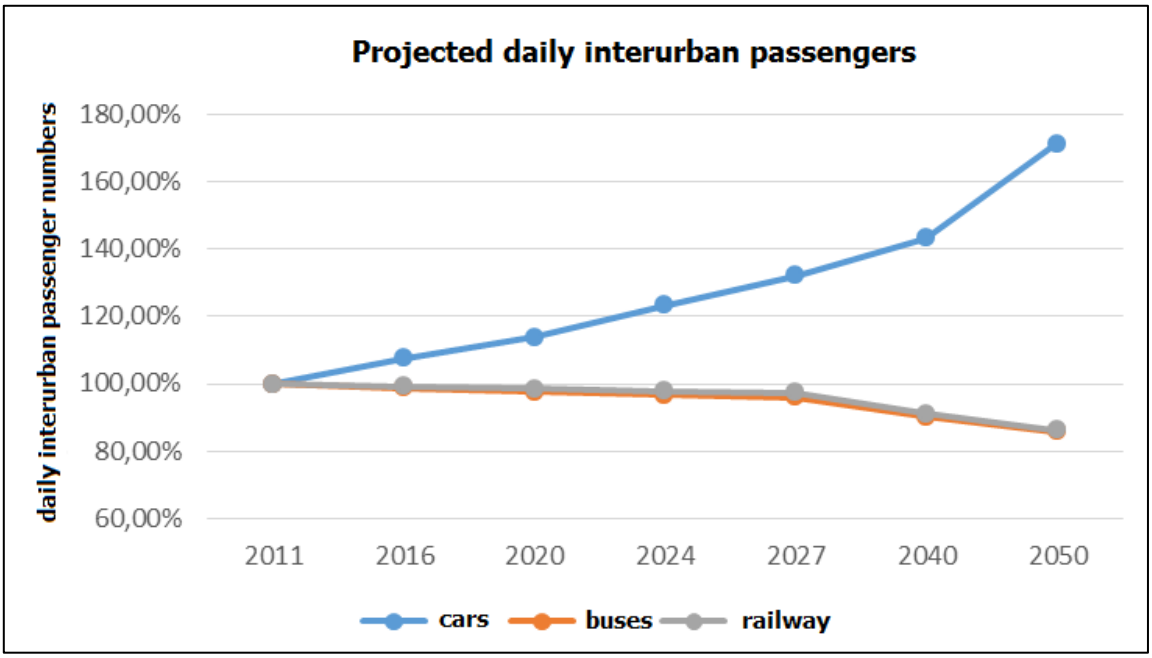


Figure 5.4.: Projected daily interurban passengers

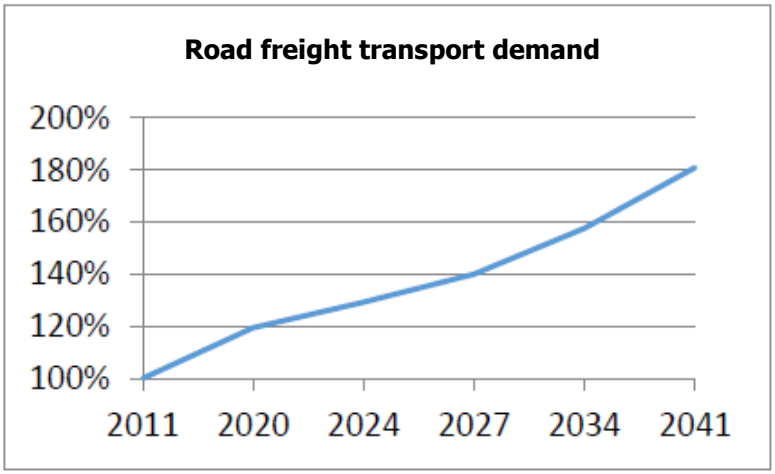


Figure 5.5: Road freight transport demand

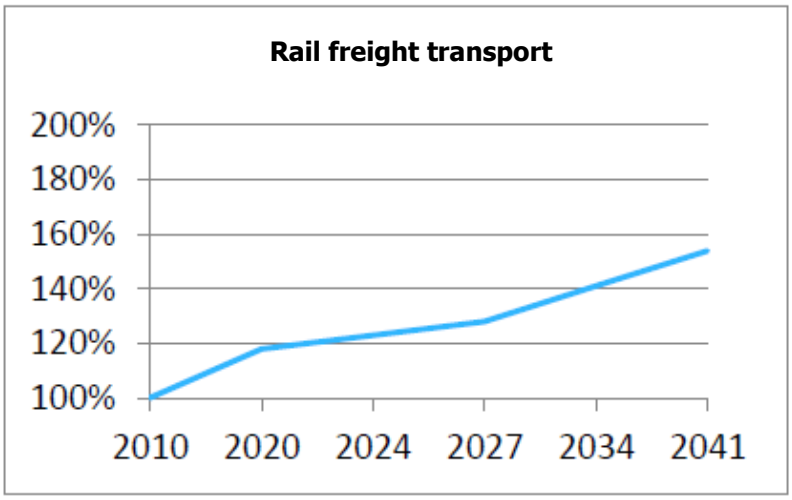


Figure 5.6: Rail freight transport

After drawing up this baseline the expected effects of the policies and measures were deducted in the WEM and WAM scenarios. The assumptions (WEM: pessimistic, WAM: optimistic) of the infrastructure development program on the penetration of electric vehicles were used.

1.A.4. Other sectors

1.A.4.a Commercial, institutional

According to the survey made in the framework of Hungary's National Building Energy Efficiency Strategy, the average primary energy use of public buildings is Hungary is 219 kwh/m2 and through refurbishments in line with the regulations of the Energy Performance of Buildings Directive, 55% of this can be saved for buildings refurbished after 2015.

We made the conservative assumption that 1% of the total floor area of the sector is refurbished, and 0.5% of the stock is built newly and also 0.5% is decommissioned every year.

1.A.4.b Residential

Emissions from the residential sector were projected through the following 5 step approach:

- *Determining annual change in the building stock*: area of the existing stock, plus the area of the newly built minus decommissioning. Newly built floor area was projected using linear regression with the gross value added of the construction sector, while decommissioned floor area is projected using linear regression with newly built floor area. The building stock itself in the base year was taken from the National Building Energy Performance Strategy (NBEPS).[7]
- *Determining energy consumption per type of building:* The NBEPS includes energy performance data of the building stock per building type. This was multiplied by the area data of the building stock. Energy use in the form of district heating, auxiliary electricity use and renewables were deducted.

[7] https://ec.europa.eu/energy/sites/ener/files/documents/2014_article4_hungary_en%20translation.pdf

- *Taking into account refurbishment*: The refurbishment rate used is based on expert judgement. The energy saving values are from the NBEPS.
- *Polices and measures:* The expected energy saving from priority axis 5 of Environment and Energy Efficiency Operational Program was taken into account. We assumed that the share of ETS revenues spent in the residential sector on energy efficiency and renewable energy will be the average of the years 2009-2015, while we calculated with the expected growth of revenues due to the expected rise of allowance prices.
- *GHG emission factors:* Apart from 2014 and 2015, GHG emissions/fuel combusted has been decreasing in the residential sector. We expect that this trend will continue in a slowing manner, thus we used exponential extrapolation.

Assumptions:

- The residential building stock consists of 15+2 types of buildings based on the National Building Strategy;

- Decommissioning of floor area is distributed among the building types built before 2001, based on their relative share in the building stock;

-Newly built floor area is all Nearly Zero after 2021;

- 2% of the building stock is refurbished yearly;

-Before 2021 1.5% is refurbished with meeting the "cost-optimal energy performance requirements and 0.5% meeting the nearly zero energy performance requirements

- From 2021 all refurbishments meet the

- Cost-optimal: Renovation in accordance with the cost-optimal levels of minimum energy performance requirements applicable from 2015, having regard to the requirements under the amendment of the Energy Performance Characteristics Decree entered into force on 1 January 2015.

- Nearly Zero: Buildings completed at a cost-optimal level in accordance with the Energy Performance Characteristics Decree or at a more energy-efficient level, with at least 25% of the annual energy requirement expressed in primary energy being met using renewable energy sources occurring in the building, originating from the property or produced in the vicinity. The requirements for new buildings currently in force apply to major renovations as well.

1.A.4.c Agriculture/Forestry/Fishing

The average growth of emissions in the period 1985-2015 was applied.

1.A.5.

Emissions has been stagnating in the sector, thus we kept the 2015 value**.**

1.B Fugitive emissions from fuels

1.B.1 Solid fuels

Currently emissions occur in Hungary from underground mines. Emissions were decreasing until 2013, but after that it seems to have stabilized. We kept the 2015 value for the entire time series.

1.B.2 Oil and natural gas and other emissions from energy production

Fugitive emissions arise during production, transportation and refining of oil and natural gas, and also emissions from venting and flaring activities connected to these occur under this section. Emissions from all of these activities are declining. We expect that these trends will continue, thus we extrapolated these trends separately and then aggregated them.

2. Industrial processes and product use

2.A,B,C Mineral, metal and chemical industries

Process emission projections from these industries were constructed the following way: multi- or univariate regression models were constructed to determine the production levels for each product included in the inventory then these were multiplied by the emission factors of 2015. An exemption is pig iron production where an increasing ratio of recovered CO_2 is estimated and ammonia production where the average ratio of CO_2 in 1995-2015 was applied.

2.D Non-energy products from fuels and solvent use

Emission from lubricant use has been decreasing for the last 15 years with some fluctuation. We extrapolated this trend logarithmically. Emissions from paraffin wax use and emissions from other non-energy products have been fluctuating from year to year, but showed a stagnating trend, thus we used the average emission of the 2000-2015 period.

2.F Product uses as substitutes of ODS: Emissions of PFCs were decreasing until 2014, but stayed on this level for 2015. The 2014-2015 level was used for the entire time series. The EU F-Gas regulation (No 517/2014 repealing Regulation (EC) No 842/2006) will compel a large-scale conversion to climate-friendly technologies in new equipment and products by 2030. It will progressively reduce the emission of HFCs measured in CO_2 equivalent. From 2015 onward, the total sum of HFC quotas allocated to producers and importers cannot exceed the maximum quantity calculated for the calendar year. The maximum quantity is determined for the whole of the EU. We assumed that emissions of HFCs will decrease following the same trend drawn by the EU level cap.

2. G Other product manufacture and use

This sector contains emissions from manufacturing and use of electrical equipment and SF_6 and N_2O used in other products. For the last 15 years emissions from electric equipment were following a stagnating trend, with some fluctuation. We used the average of the 2000-2015 time series for the future years.

The two main sources of N_2O emissions under this section are bulk N_2O use as an anaesthetic gas and the use of whipped cream cartridges. Emissions from the former and more important one kept rising until 2005, but after that point it stagnated with a small fluctuation. Emissions from the latter have been falling sharply from 2000. We expect that these trends will continue.

3. Agriculture

In case of enteric fermentation and manure management first the changes from 1985 to 2015 in the livestock population were examined. The average growth of the selected years was applied for the future years with the exemption of swine population. We assumed that the Swine Strategy's target will be met and there will be 6 million swine in 2020 and 6.5 million in 2022.

Emissions from agriculture other than enteric fermentation and manure management were projected based on their average growth in emissions in the selected time series.

4. LULUCF

For the forestry sector, projections were developed using two methods:

(1) for afforestations (AR) since 1990, the model CASMOFOR was used,
(2) for all other forests (managed forests, FM), linear extrapolation was used.

The CASMOFOR model [8]is an accounting-type, IPCC methodology compatible model that applies the gain-loss method using standard yield tables, silvicultural models and other basic parameters of the forest carbon cycle. Although a different methodology (i.e., the stock change method) is used in the greenhouse gas (GHG) inventory, the two methodologies are compatible. As we have so far not estimated either carbon stock changes of the non-biomass pools or non-CO_2 emissions for AR in the GHG inventory, the projections also exclude such emissions and removals, which results in an underestimation of the net sink in the projections.

For the historical period since 1990, the areas actually afforested have been used for the same seven species groups that are used in the GHG inventory. The estimates are close to the ones in the GHG inventory (the difference being 9%), but in order to reduce the differences, the CASMOFOR estimates were adjusted for each year by the ratio of the total (1990-2015) net removals from the GHG inventory estimates and those of the CASMOFOR estimates.

For the WEM projections, we have assumed that (1) existing AR areas will continue to remove carbon according to the estimates by CASMOFOR, (2) only small new AR areas will be added until 2020 and even less after that, and (3) some additional plantations and agroforestry areas will be added until 2020 but not later. This latter two assumptions are consistent with the fact that afforestations have practically stopped recently. For the WAM scenarios, we assumed that until the end of the currently implemented national forestry program, i.e., 2020, the same area of afforestations will be made as with the WEM scenario,

[8] www.scientia.hu/casmofor

but a higher rate of afforestations will take place later, and that there will be some afforestations for plantations and agroforesty until 2020 and higher ones after that relative to the WEM scenario.

For the FM area, the historical emissions were calculated by deducting the adjusted AR estimates by CASMOFOR from the total net emissions of all forests. These latter emissions include non-CO_2 emission and "found forests" (see our national GHG inventory). For the WEM projection, the historical FM data thus derived was linearly extrapolated. These extrapolations more or less assume that the amount of found forests will remain the same, that emissions from forest fires will remain at the same level, and that harvest intensity will increase a bit for the projection period as a continuation of the increasing historical trend. As the international timber trade, the prospects of the bioeconomy, the future of nature conservation in forests, and the health condition of the forests are rather uncertain, we have decided to not develop separate WAM scenario for the FM areas.

For the total forest area, and for both the WEM and WAM scenarios, the projected emissions are calculated by adding up the emissions for the AR and FM areas.

Sinks and emissions not related to forestry were projected with extrapolation.

5. Waste

5. A. Solid waste disposal

For projecting emissions from solid waste disposal the IPCC Waste Model was used for the creation of the inventory. The model keeps a running the total amount of decomposable DOC (degradable organic carbon) in the disposal site, taking account of the amount deposited each year and the amount remaining from previous years. This is used to calculate the amount of DOC decomposing to CH_4 and CO_2 each year. The model calculates the amount of CH_4 generated from the amount of decomposable degradable organic carbon, and subtracts the CH_4 recovered and CH_4 oxidized in the cover material to give the amount of CH_4 emitted. For the calculation we used the option to enter the amount of each type of degradable waste separately.

The required input variables of the model for the period after 2015 were generated the following way. The assumptions of Hungary's NWMAP were used to the extent possible.

First data on municipal solid waste per million HUF of GDP was extrapolated linearly. Multiplying this with the GDP projection we got total municipal solid waste generated. In the WEM scenario 45%, in the WAM scenario 29% share of landfilling was assumed for 2030. According to the National Waste Law, by 2016 the amount of biodegradable residual wastes landfilled shall be reduced by 35% compared to 1995. In our calculations we assumed that this would result in 35% reduction in the amount of degradable carbon in the deposited solid waste.

The amount of industrial and construction/demolition waste was projected using industrial and construction industry gross value added respectively. According to the National Waste Law, by 2020 the share of landfilling shall be reduced to 30% in the management of

construction waste. We applied this value for the years starting with 2020. The 42% share of landfilling in the management of industrial waste was kept for the entire time series.

5.B. Biological treatment of solid waste

The importance of composting shows a growing tendency in Hungary. According to the expectations of the Ministry of Agriculture, in 2020 500 tonnes of solid waste will be composted (92 tonnes in 2015). We kept this value for the years after 2020. The amount of composted sludge was linearly, while N_2O emission from anaerobic digestion in biogas facilities was logarithmically extrapolated.

5.C. Incineration and open burning of waste

Emissions from incineration have been stagnating. The 2015 values were kept.

5.D. Wastewater treatment and discharge

Emissions from wastewater discharge have been following a decreasing trend. Emissions from wastewater treatment and discharge have a very close correlation (-0.984) to the ratio of households connected to the sewage system, thus emissions were projected from this ratio. According to the estimates of the Ministry of Interior this ratio will rise to 85% in 2030. We kept the 85% value until 2035.

Memo items: International Aviation

Emissions were projected directly from GDP growth linearly.

Methodological changes since Hungary's 6th National Communication

As Hungary's latest GHG projections reported to the UNFCCC was t included in the 2nd Biennial Report only a brief comparison is made here. A more comprehensive description is included in the 3rd Biennial Report which details the changes since the 2nd Biennial Report.

Some of the more significant changes:

- In the previous NC the basis of the projection was not consistent in all cases with the latest National Inventory Report.
- The time-scale of the projections has been extended to 2035.
- In the NC6, a more complex model, the European Electricity Market Model developed by REKK was used to project emissions from electricity generation.
- For projecting emissions from solid waste disposal, the IPCC waste model was used for the current report, while the previous methodology consisted of a combination of expert judgement and extrapolation.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE INPACTS AND ADAPTATION MEASURES

6.1. Expected impacts of climate change

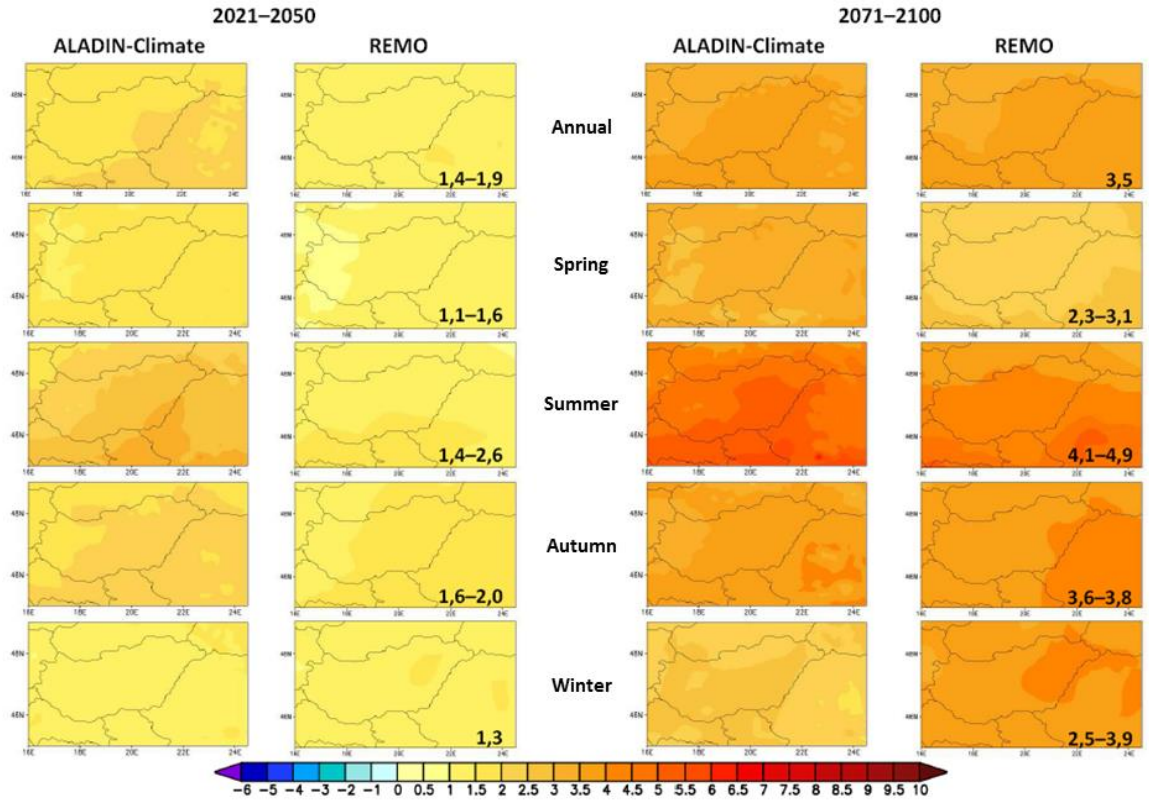
6.1.1. Modelling background for impact assessment

Knowledge of the direction and quantified degree of the changes are indispensable for the preparation in terms of the effects of climate change, during the mapping of which it can rely basically on two sources: on the one hand, one can draw consequences regarding the climatic situation of the recent past and the present using collected and available measurements; on the other hand, one can quantify the expected, future changes of the 21st century applying model simulations. The trend analyses basing on the controlled and homogenised measurement data recorded in the climatology database of the *Hungarian Meteorological Service (OMSZ).* The overview of the expected future changes in Hungary based on the results of the regional climate models used by the OMSZ, for the period of 2071–2100.

6.1.2. Simulated temperature change by 2017-2100

Expected future evolution of the average temperature

Like on a global level, average temperature will undoubtedly increase in Hungary as well in the future (6.1. Figure); moreover, in a statistically significant way in case of all the seasons (in other words, the magnitude of the change will exceed the extent of natural variability). The increase in the average value does not mean that every year will be gradually hotter than the preceding one, there will be cooler years and seasons in the future as well; however, a temperature that is warmer than currently will be typical. The model results foresee the largest changes for summer and autumn, the precise extent of their warming is however different. By the mid-century, a change of 1,4–2,6°C may be expected in summer while 1,6–2,0°C in autumn, compared to the reference period, while, by the end of the century the increase may come near to 4°C in autumn and may also exceed it in summer. In view of the spatial distribution of the temperature increase, the simulations show the uniform picture that the higher degree of warming is to be expected in the eastern and southern parts of the country.



6.1. Figure: Annual and seasonal change in the average temeprature (°C)
Source: Hungarian Meteorological Service

Note: based on the results of ALADIN-Climate[9] and REMO[10] regional climate models, and compared to the model averages of 1961–1990 (SRES A1B scenario). The numbers indicated show the lowest and highest limit of the national average change.

Expected future evolution of temperature extremities

Following the trend of warming, the number of days of frost will clearly and significantly decrease (6.1. Table): from the average of 96 days a year, as observed in the past, only by 18–19 days by 201–2050 on the country average, *but by 32-55 days by 2071–2100*. The number of days of frost is expected to decrease in the whole country, but the smallest decrease is expected to occur in the northeastern parts.

The number of summer days will clearly increase in the future, the two models show that the extent will be the same: from the average annual 66 days that was typical of the period of 1961–1990 by 21-23 days by 2021–2050 and *by 41-54 days by the last decades of this century.* The highest increase is expected to occur in the eastern part of the country, although one of the models shows even more significant changes in the area of the North Hungarian Mountains. The change is significant in every grid point in the country, meaning that its magnitude will exceed the degree of natural variability everywhere.

[9] Cisman, G., Hoary, A., 2008: Validation of the ALADIN-Climate regional climate model at the Hungarian Meteorological Service. Időjárás 112, 3–4, 155–177.

[10] Szépszó, G., Horányi, A., 2008: Transient simulation of the REMO regional climate model and its evaluation over Hungary. Időjárás 112, 3–4, 203–231.

A significant increase may be expected in the occurrence of days with more extreme heatwaves (when the warning or heat alarm is activated in Hungary), the two models are however more uncertain regarding its degree, than the summer days. The average value observed in the reference period was 3,4 days; the average annual number of days with heatwaves is expected to increase by 3,6-10 days in the following decades *and by 14-20 days in the farther future.* Based on the model results the strongest increase in frequency may be expected in the otherwise also hotter southern-southeastern areas, the index will have the least increase in the cooler northern areas.

	1961–1990	**2021–2050**	**2071–2100**
Days of frost	96	77-78	41-64
Summer day	66	87-89	107-120
Day of heat-wave	3,4	7-13	18–23

6.1. Table: Measured and expected future average annual Hungarian values of temperature extremity indices (day)

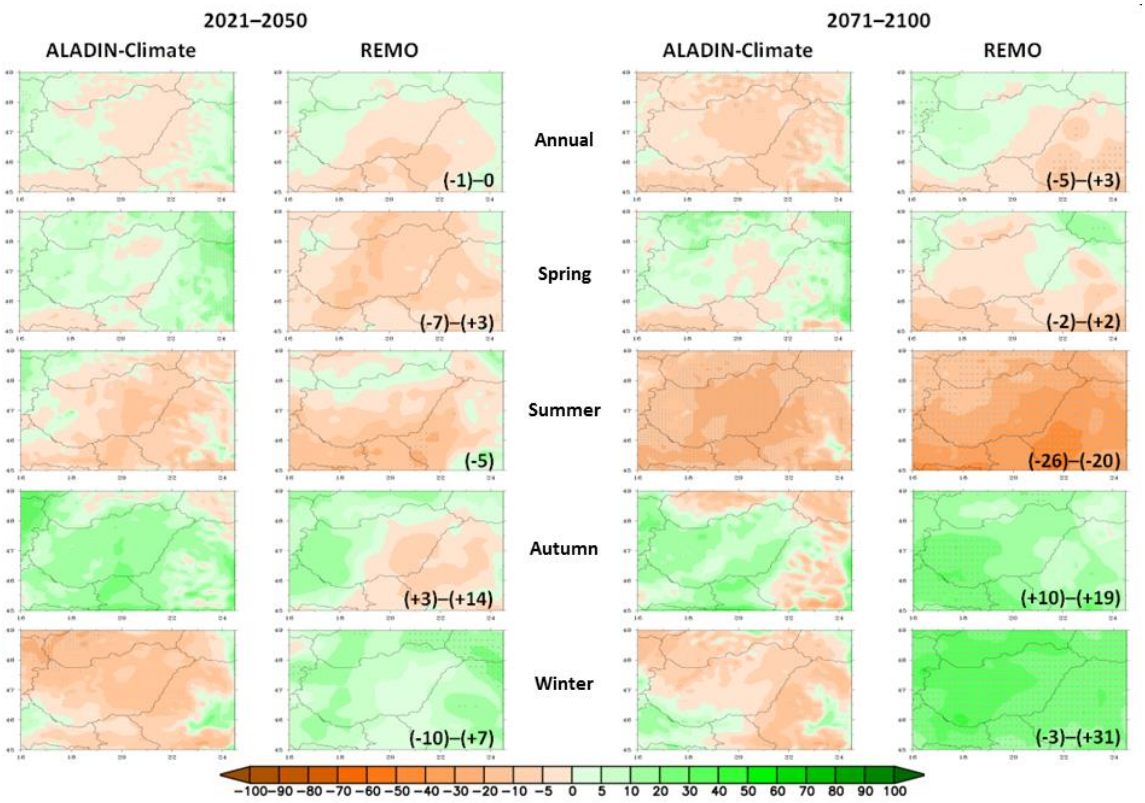
Source: Hungarian Meteorological Service

Remark: the measurements are from the measurement database of the Hungarian National Meteorological Service; the future values are based on the results of the two regional climate models applied by the Hungarian National Meteorological Service

6.1.3. Simulated precipitation change by 2071-2100

Expected future evolution of average precipitation

In terms of the change of precipitation, results of the models are identical in fewer details; moreover, the changes turn out to be statistically significant in a few cases only. The estimations are rather uniform in the unchanging annual precipitation and in the reduction of average summer precipitation by 5-10% by 2021–2050 and by 20% by 2071–2100 (6.2. Figure).



6.2. Figure: Change in the quantity of yearly and seasonal precipitation (%)
Source: Hungarian Meteorological Service

Note: based on the results of ALADIN-Climate and REMO regional climate models, and compared to the model averages of 1961–1990 (SRES A1B scenario). The numbers indicated show the lowest and highest limit of the national average change. Statistically significant changes are indicated with dots.

The typical autumn increase will be 3-14% on the country average, but the eastern parts show differences in the model results.

The two climate models, ALADIN-Climate and REMO regional climate models, adapted by the Hungarian National Meteorological Service show a completely different future for spring and winter as well: increase and decrease of similar extent are possible in both seasons (this will not exceed 10% in the subsequent decades as well, however, the models show a larger change in winter by the end of the century). The involvement of previous European model results allows for establishing the fact that one may rather expect a precipitation increase in winter, the probability of this is 60% for the period of 2021–2050, and more than 80% for the period of 2071–2100 (meaning that at least 60 and 80 percent of the studied models indicates an increase for Hungary). As for the spring season however, no clear finding may be made even if multiple models are involved: there is a somewhat higher change of increase by the mid of the century, increase and decrease by the end of the century have, however, the same probability.

Expected future evolution of precipitation extremities

The longest contiguous dry periods usually occurred during autumn in the reference period (6.2. Table). On average, the change of the index by 2021–2050 is very low and it is uncertain if it is positive or negative, a clear increase may be expected during summer only. As for the end of the century, the model results show an elongation of the dry periods during spring and autumn as well.

		1961–1990	2021–2050	2071–2100
Dry periods	Annual	29	28–30	32
	Spring	16	14–18	17–19
	Summer	15	16	20–21
	Autumn	24	23–24	25–26
	Winter	20	18– 21	19–21
Events with a precipitation exceeding 20 mm a day	Annual	3.4	4.0–4.2	4.5–5.4
	Spring	0.6	0.7–0.8	0.9–1.0
	Summer	1.6	1.8–1.9	1.6
	Autumn	0.9	1.2–1.4	1.5–1.8
	Winter	0.3	0.4	0.5–0.9
Intensity	Annual	6.1	6.3–6.4	6.5–6.8
	Spring	5.5	5.6	5.8–5.9
	Summer	7.0	7.0–7.2	7.0–7.2
	Autumn	6.5	7.0–7.4	7.6–7.8
	Winter	5.0	5.2–5.3	5.2–5.8

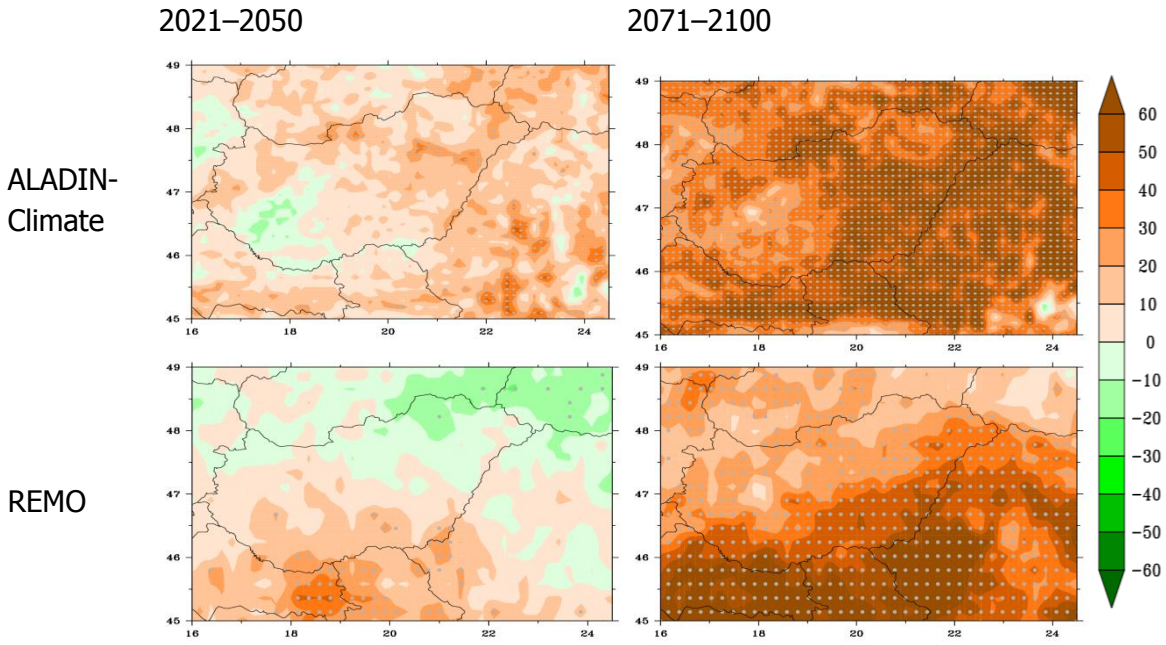
6.2. Table: Measured and expected future average annual Hungarian values of precipitation extremity indices (day, in case of intensity mm/day)
Source: Hungarian Meteorological Service

Remark: the measurements are from the measurement database of the Hungarian National Meteorological Service; the future values are based on the results of the two regional climate models applied by the Hungarian National Meteorological Service Increases in intensity that are clear, meaning that both models indicate them, are shown in green, dryings are shown in brown.

The summer elongation of dry periods will not become predominant in the entire country by the mid of the century, but will do more or less so by 2071–2100, and the extent of the change will by then exceed the level of variability (6.3 Figure). The largest increase is to be expected in the southern and eastern parts of the country, the smallest changes will occur in the Balaton-area. The national average frequency of days with a precipitation of at least 20 (1st Table) is expected to clearly increase in every season, already in the next decades. Save for summer, one can expect positive and more intense seasonal changes by 2071–2100, the models do however show a decrease in summer in comparison to the average values of the period of 2021–2050. This is because the models show a larger and significant drop in frequency in the rest of the country by the end of the century.

Expect summer, the average precipitation intensity is expected to increase in every season (1st Table). Average precipitation falling on days of precipitation will most probably increase

the most during autumn, moreover, in a statistically significant manner in every grid point. The index will not or will just slightly change during summer, both for country average and each grid point, which applies both for the next decades and the end of the century.



6.3 Figure: Average change in the maximum summer duration of dry periods (%)
Source: Hungarian Meteorological Service

Note: based on the results of ALADIN-Climate and REMO regional climate models, and compared to the model averages of 1961–1990 (SRES A1B scenario). Statistically significant changes are indicated with dots.

6.1.4. Uncertainties of climate projections

Climate model results contains uncertainties, which stem from the followings:

- Natural variability is the inherent part of the climate system causing its continuous change without any external forcing. For instance, two consecutive years can be extremely dry and wet over a region due to this quality.
- Different climate models use various numerical approximations and parameterization schemes to describe physical processes resulting in dissimilar results, as well. The largest diversity occurs in the description of cloud and precipitation processes.
- Climate change is highly influenced by the anthropogenic activity. Its global future path is not known yet and therefore different (optimistic, pessimistic) scenarios are constructed to its estimation. These hypothetical scenarios are taken into account within models through various greenhouse gas concentration pathways.

According to these, one cannot make any reasonable statements based on results of a single climate model run but only through quantifying the projection uncertainties. This could be achieved by applying the ensemble method, when more models and scenarios are considered together and future changes are expressed as probabilistic information.

In order to fulfil the abovementioned requirements, climate projections for the Carpathian Basin are performed using two regional climate models adapted at the Hungarian Meteorological Service, in which anthropogenic activity was described by an average (A1B) emission scenario. Main focus of the National Adaptation Strategy was put on the changes and impacts emerge by the near future (2021–2050). On this period, it is more important to take into account model uncertainty than scenario uncertainty since this latter appears in the model results significantly in the later decades of the 21th century.

According to the results it is obvious that mean temperature will increase in Hungary in the future. However, the amount of changes and its spatial pattern are different in each simulation. Largest increase may happen in summer and autumn: e.g. in summer, models suggest 1.4-2.6 °C warming in 2021–2050 which may exceed 4 °C by the end of the century with reference to 1961–1990. As a consequence of temperature increase it also clear that the number of hot extreme events (e.g. heat waves and hot days) will increase while thereof cold extreme events (e.g. frost days) will decrease.

Contrary to temperature, direction of future precipitation change is more ambiguous over Hungary. Annual mean precipitation seems to stay constant, but on seasonal scale larger changes may occur: in summer, models agree on less precipitation with 5-10% in the near future and 20% in the end of the century. Autumn is probably turning to a wetter season. In spring and winter model simulations provide controversial results: increase and decrease equally may happen. Therefore we investigated the available European model results to attempt to lessen uncertainty in these seasons. These suggest precipitation increase in winter in Hungary. Considering the extreme events, in summer longer dry periods are expected, while the frequency of large daily precipitation sums (exceeding 20 mm) is growing especially in autumn.

6.1.5. Summary of climate change impacts on Hungary

Based on the model calculation results shown for the 21st century, we have to expect a further increase in temperature with an extent that reaches 1°C in almost the entire country and in every season by 2021–2050, and will exceed even 4°C in the summer months, compared to the reference period of 1961–1990. It is obvious that temperature extremities are shifting significantly towards warming up: the number of frosty days will decrease and the number of summer days and heatwave days will increase, and will add up to a whole month by the end of the century.

Major changes may not be expected in the annual precipitation quantity, the seasonal distribution we have had so far will however likely rearrange itself. It seems sure that summer precipitation will reduce by 5 percent in the coming decades, and by 20 percent by the end of the century, and an increase in autumn and winter precipitation would most likely compensate that. Events characterised by large quantities of intense precipitation are expected to occur more frequently during autumn, while the length of dryer periods will most probably get longer in summer. It is however uncertain whether the changes in the next decades will be negative or positive, and these changes do not seem to be significant either, certain findings may be made for the end of the century only.

The evolution of extremities has a characteristic spatial distribution and has a negative effect primarily on the central, southern and eastern parts of Hungary, signifying the importance of territorial vulnerability assessments.

6.2. Vulnerability assessment

6.2.1. Agriculture

In Hungary, agriculture is the sector which is most vulnerable to the climate change. The effects of climate change are differentiated in time and space, and cause different damage, subject to, amongst others, the specificities of nature, land use, agro-techniques. Amongst the elemental types of damage, it is the drought that causes the highest lost in the long run in Hungary, and it is followed by frost damage and water damage. Considering the fact that we have to expect an increasing average summer temperature and a decreasing summer precipitation, it can be concluded that the largest challenge agriculture faces is the increase of the chances of drought. The vulnerability of various forms of land use, including arable crop production, to climate change were studied in detail in the National Adaptation Geo-information System to agriculture (AGRAGIS) project closed in 2016.

In addition to the process of warming and drying, unexpected meteorological phenomena can also cause significant damage. The followings can be mentioned among weather and climate-related agricultural risks:

- flood, groundwater flood;
- drought;
- flood-like rains, mud avalanches, landslides, soil erosion;
- wind storms, wind erosion;
- hails, freezing rains, fog, hoarfrost;
- snowdrift, snow barriers;
- days with heat, heatwaves, more intense UVB radiation;
- early and late frost, frost damage;
- forest, wildfires, stubble fires;
- appearance of new pathogens, pests and weeds; increasing hazardousness of certain pests that are indigenous to Hungary but have been only of minor significance so far;
- yield reduction, indirectly, due to the increasing ozone concentration.

As a consequence of climate change, the Agricultural Risk Management System (ARMS) will play an increasing role. Connecting data collected in the ARMS with the data of the Hungarian test operations will allow for the elaboration, modelling of adaptation strategies that are effective solutions for farmers against climate change.

The basis for agricultural adaptation, and a fundamental precondition to agricultural production, is water and fertile soil. The basis of adaptive intervention is adjusting land use

to the changing ecological conditions. The fundamental condition for agricultural production is water, the retention of natural precipitation in the microregional water cycle, and facilitating its filtration into the soil. The fertile soil is the largest water reservoir in Hungary, its preservation and utilisation, and the supplying of missing water, is of key importance. Retention, utilisation of water and precipitation coming on streams and irrigation do not only lay the foundation for yield security but also for the effective combatting of droughts, groundwater flood, floods and weather anomalies. Our use of land and the agricultural production structure must be revised and adjusted to the changing conditions, thus decreasing irrational, intensive, wasting and unsustainable activities. The solution for areas that are deep-lying, affected by groundwater floods and have a heavy soil could be a modern technique and technology and soil cultivation. In accordance with the findings of the Kvassay Jenő Plan, encouraging water use adjusting to water resources and elimination of the constraint of rapid water drainage is an urging task both in the short and medium run. An organisational, stakeholder and pricing system that encourages water retention must be set up.

The exploitation of the agroecology opportunities for Hungary is particularly important. Following the principles of agroecology - also known as circular agriculture -, the ecological footprint of agriculture is is decreasing and the soil's water retention and carbon capture capacity is increasing. At the same time, this can be combined with advanced instrumentation, such as using soil sensors.

In terms of agriculture, choosing a form of land use that corresponds to the current state of the growing location is an important element of adaptation to extreme water regimes. The race for water between various sectors and forms of land use will likely get more intense on areas afflicted by drought. The effect of climate change on the soil is described in detail in Chapter IV.3.2. Soil.

More than half of the arable lands of Hungary are affected by groundwater flooding, especially in the deep-lying Great Plains, Little Plain and the Dunamellék (Danube Region)[11]**.** It should be noted that storing water in the soil, the fight against groundwater floods and droughts and a transformation of soil cultivation also contribute to the prevention of floods. Areas that are deep-lying, regularly affected by groundwater floods and have defective soil should be withdrawn from field cultivation by changing the form of cultivation or the form of land use. Aid systems should be adjusted to the optimised forms of landscape, area and land use of multiple aspects.

Ice rains are a significant risk factor in agriculture. Areas most exposed to the risk of ice included Tolna, Baranya and Somogy counties, where the harmful effect of hails was significantly reduced by the soil generator hail suppression introduced in 1991. Extending this system to a country level is currently under planning, it can be implemented within short time. Hails continue to occur frequently in the Danube-Tisza Interfluve and in historical wine regions, where the application of ice webs has somewhat reduced the economic damage. As regards earlier blooming, especially in the case of fruit trees, frost damage is the largest troublemaker. The various protection solutions are to reduce and eliminate extreme weather

[11] Kvassay Jenő Plan – National Water Strategy. General Directorate of Water Management. Budapest, 2015. 3. p.

hazards: ice web, hail suppressor with soil generator, paraffin cans, irrigation against frost, foil cover.

Water reserves can considerably enhance agricultural adaptability, the establishment of multipurpose reservoirs, their use for irrigation, extension of lake fisheries, increase of biodiversity, long term integration of nature conservation and agriculture, utilisation of areas exposed to floods and protected with summer dams with flood-resistant, moreover: flood-requiring, forms of cultivation. Irrigation should be encouraged in connection with the restoration of previous systems and the creation of new ones, first of all on good production locations and valuable plantations, in case of production in foil tents and greenhouses, for certain arable crops and technological phases (irrigation for germination). Irrigation can be realistic for such forms of production that produce high added value, and can be considered as a local solution only. In most of our regions, the solution is the planning and harmonisation of the water demand, establishment of water regulation of water retention and the landscape management systems based thereon, facilitation of infiltration and involvement of cultures requiring less water into cultivation. In case of irrigation, it is advisable to consider the increasing price of food products and irrigation water. It is worth applying already forgotten traditional methods to irrigate gardens around houses, spray trees, wash clothes and clean such as the capturing, storage of the precipitation using cisterns, tanks, tubs and barrels. The application of these methods is possible on the small scale only, having regard to the fact that rainwater can be captured and used to a limited extent only.

Wherever it is possible, the cultivation procedures that can prevent the settlement of non-indigenous pests in agricultural life communities, their propagation and reduce the harm caused by them should be elaborated and applied.

Similarly to the Chapters on Human health (IV.4.1.), biodiversity (IV.3.3.) and Forests (IV.3.4.), the spreading of non-indigenous and rapidly spreading pests, pathogens and weeds, as an effect of climate change, should be expected in agriculture as well. This process can entail a significant cutting out of indigenous species. The adaptation to this phenomenon must build on the better understanding of natural processes and the application of semi-natural protection methods such as using invasive plants for grazing; succession; facilitation of the closing of disturbed areas; increasing of biodiversity; human-driven supporting of the self-protection mechanisms of indigenous communities.

The living conditions and income of rural population might be significantly influenced by the changes of environmental conditions, especially in vulnerable areas that are more exposed to droughts. It can be expected that the capacity of these regions to maintain its population will deteriorate and further migration, local population shrinkage may be expected. According to the research conducted by HAS Research Centre of Economics and Regional Studies, most of the townships of Hungary should expect population decline until 2050, and this can reach even 50% in certain townships (in the Southwestern part of Transdanubia and in

Northeastern Hungary)[12]. From our point of view it is of utmost importance that traditional farming measures can stop or at least slow the depopulation of the countryside.

Subject to the animal species and the form of husbandry, animal husbandry can react differently to the expected effects of climate change. Intensive animal husbandry is the most vulnerable. Cattle, pigs and poultry in intensive livestock farming are very sensitive and react with yield decline to certain shocks. Certain traditional animal breeds (such as the Hungarian grey cattle, mangalica, the Racka sheep, Hungarian chicken) are more adaptive thanks to their genetics and their extensive farming technology, the productivity of these animal breeds does not reach that of intensive breeds. The increasing water and shading demand of animals should also be taken into consideration. During the improvement of animal breeds, consideration of characteristics better tolerating the expected effects of climate change and the changes of farming conditions according to the expected effects come more and more into the foreground besides performance and quality, and the preparation of animal health for the effects of climate change will play an important role. The most important question and greatest challenge of the adaptation to climate change in livestock farming will be the predictable supplying of feed and wager (management of droughts, floods and extreme weather phenomena in feed production and water management). It's important that plants and animals kept in Hungary are of such species composition that is more easily adapted to expected climate change. The agroecological conditions of Hungary would allow for a varied and balanced product structure, still, the agricultural production structure has become disrupted in terms of the two main parts, crop production and livestock farming, at the detriment of the latter. Within the domain of livestock farming, cattle husbandry is in the most critical situation, due to the difficulties of the European, including the Hungarian, milk market. A significant increase of the cattle stock would be possible if our GHG emission would increase as little as possible.

It has already become typical of Hungary, that a single year can see severe river floods, groundwater floods, drought and frost damage, meaning that the expected warming and drying raises the serious question of food security. Critical years can see our dependence on food import increasing, while the demand of countries having scarce natural resource to produce food, meaning that the price of imported foodstuffs will increase sharply. Risks of food supply can be reduced by reinforcing the adaptability of Hungarian crop production and its consequences can be mitigated.

The global climate change can have a significant effect on food production and the security of food supply. In order to prevent harmful social and economic effects, the expected effects of climate change must be modelled in the field of agriculture and we must prepare for such effects[13].

The preparation of agriculture to the climate change can be supported by farming systems that align to local conditions, and are profitable and sustainable. These spare natural

[12] Tagai G. (2015): Township-level population estimation until 2051. In: Czirfusz M.; Hoyk E.; Suvák A. (editor): Klímaváltozás, társadalom, gazdaság (Climate change, society, economy) Hosszú távú területi folyamatok és trendek Magyarországon. (Long-term regional processes and trends in Hungary.) Publikon Kiadó, Pécs. 141-166. p.

[13] Draft of the Food Economy Programme of Hungary 2016–2050. Ministry of Agriculture, 2016.

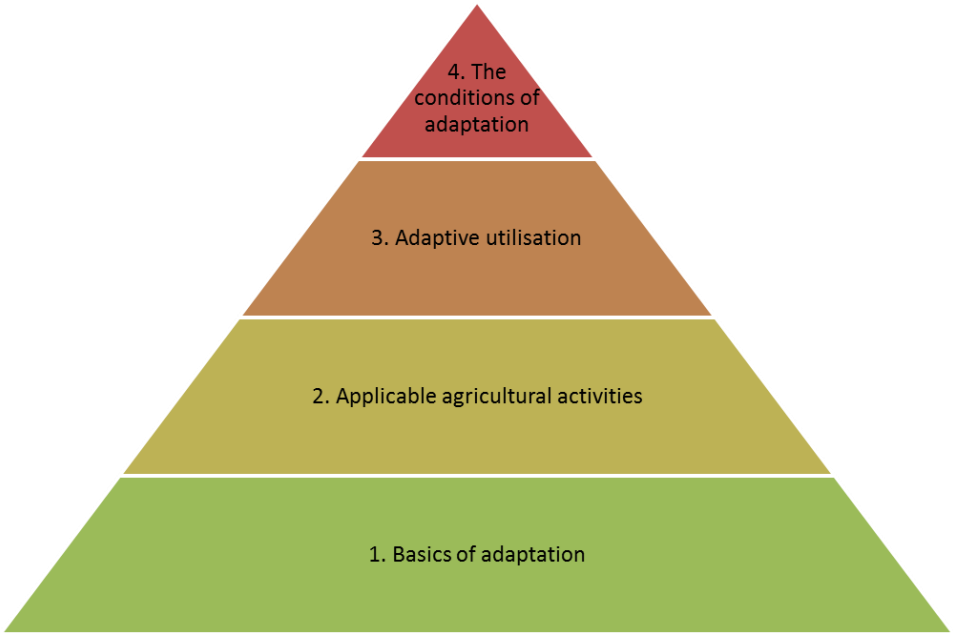
resources, do not impose loads on the environment, are water and energy-efficient, build on the knowledge of local areas and traditional knowledge, reduce carbon-dioxide, methane getting into the atmosphere from the soil, prevent erosion, thus their further development and spreading can be a cornerstone to adaptation.

Opportunities to mitigate agricultural damage caused by the climate change

- establishment of a water-retaining water regulation and landscape management, sustainable irrigation;
- increasing biodiversity, growing multiple plant species together, creation of meadow-protecting forest belts with indigenous species (trees and shrubs: hawthorn, sloe, maple, other species according to the habitat concerned);
- improvement and introduction into production of plant breeds that can adapt well and can be grown securely;
- introduction of cultures that are varied, capable of self-protection and semi-natural (fruit plantations, extensive orchards, systems of agroforestry);
- involvement of indigenous local species that are less sensitive to weather extremities into production;
- applying soil cultivation methods that imply less soil disturbance, applying mulching, composting and green manure;
- planting semi-natural biotopes, forest belts, turning pastures into groves, increase of green surfaces;
- insulation, cooling, ventilation of livestock buildings, shading around stalls;
- preparation of plant protection and animal health;
- general introduction of sustainable farming systems, with special regard to the spreading of ecological farming;
- increasing research activities to support the foregoing, supporting farmers with the necessary knowledge and advice.

The strategic framework of the applicable agriculture

In addition to the direct products, agriculture provides many particularly important services to the society, via, amongst others, employment, maintenance of landscape diversity and biodiversity. The conditionality of the applicable agriculture (6.4.Figure) can be formulated, in consideration of the strategic directions set out by the National Rural Strategy and the Kvassay Jenő Plan – National Water Strategy and the National Framework Strategy on Sustainable Development, as follows:



6.4. Figure: System of an agricultural strategy adapting to the climate and weather change
Source: Csete (2013)

Basics of adaptation

The foundation for the adaptation strategy of agriculture and the precondition and essence of every other development is water: the balance should be made between the resources that are becoming scarce and are distributed less and less evenly, and the increasing demand. An appropriate use of landscape, aligning to the changing climatic and ecological conditions, must be established, and maintenance of the water demand at a reasonable level must be ensured. Special attention must be paid to landscape-level water resupplying, establishment of microregional water cycles, semi-natural water resupplying and water storage and the farming systems based on them. Landscape mosaicism must be increased, as it decreases landscape vulnerability. Water supply to crop production, livestock farming, processing and farmers, which align with the correctly chosen form of land use, must be ensured, first of all by facilitating, preserving the infiltration of natural precipitation into the soil, the reduction of evaporation, reasonable and efficient use, satisfying the water demand with various other solutions, irrigation, storage and consideration of surface, soil and stratum waters.

Applicable agricultural activities

The most important element of the adaptation strategy of agricultural activities is the enforcement of sustainability, applying sustainable production systems and a sustainable way of farming. The second level has effects & responses related to sowings, plantations, livestock and the applied techniques and technologies (modern, water-efficient soil cultivation, transformation of production and sowing structure, application of indigenous, semi-indigenous and regional breeds that are less sensitive to extremities). It is important that the adaptation process does not only facilitate the attainment of sustainable development in environmental terms, but it should improve the capacity to retain the rural population as well.

The point of the *adaptive utilisation* strategy is to utilise the entire biomass produced, as it comprises the security, in terms of quality and quantity, of produce, products and foodstuffs produced, feeding and energy supply as well. As laid down in the National Rural Strategy, the goal is to implement a form of agricultural production that is based on environmentally sustainable small and medium sized farms and their cooperation and produces quality produce with high added value. The systems of local production, processing and local consumption play a prominent role in this.

The strategy *of the conditions of adaptation* lays the foundation for implementation with the institutional background, expert advice to foremen, preparation of residents, local preparation for the more and more frequent agricultural fire hazards, disaster prevention, insurance, and procurement of protective tools, devices, transformation of the tendering & financial system.

6.2.2. Housing and inhabitation

The most significant physical threat to the built environment and settlement infrastructure comes from the flood-like rainfalls accompanying storms and the increase in wind speed. The challenge faced by people living and working in buildings comes from the increasing frequency and intensity of heatwaves. The characteristics of the building stock and settlement structure can significantly influence the effects of climate change. Setting up the right regulatory environment, conscious urban planning can reduce the negative effects of climate change.

Building stock

As an effect of the climate change, the frequency and intensity of heatwaves is expected to increase in the future, meaning that they will appear more frequently, last longer and entail higher average daily temperatures. This phenomenon does not pose a direct threat to the condition of the building stock, but might mean a great risk in terms of public health. In terms of protection against the heat, the appropriate use of the options of active (air conditioning, ventilation systems) and passive (shading, orientation, thermal insulation) adaptation, and the consideration of thermal protection during the development of building & construction policies and the designing and construction of buildings. This need is declared in the National Building Energy Strategy as well: *"The renovation of buildings should pay special attention to ensuring the weather-resistance of buildings, and, especially, the protection against summer warming, possibly with architectural and gardening means, avoiding the consumption of electricity.*[14] The air conditioners release the heat extracted from the buildings into the environment, and this results in the further increasing of the effect of heat islands of densely built areas. Individual cooling devices mounted onto the façade increase the heat stress on the adjacent apartments as well; therefore they lead to, as some sort of a chain reaction, the mounting of further devices, the further increasing of the heat stress, and, through the significant increase of energy consumption, an increasing

[14] Government Decision No. 1073/2015. (II. 25.) Korm. on the National Building Energy Strategy

GHG emission as well. It is therefore recommended to use air conditioners carefully, to the lowest possible extent and it is practical to place the device on top of the roof[15].

The increasing wind speed and the expected increase in the frequency of wind storms means a direct, physical source of danger to the building stock, which primarily affects the external boundary structures of buildings, meaning the structures on the façade and the roof. In addition to the dimensioning of support structures, problems might be expected to occur with the mounted claddings, doors and windows and shades. As for the roof, damage of roof covering elements and water insulation sheets and elements protruding from the roof plane (lightning protection devices, chimneys, antennas) should be prepared for in the first place. Strong wind blows in the vicinity of buildings can damage street fixtures (warning lights, electric pylons, phone boxes) and the vegetation, thus causing serious damage to the buildings as well[16].

Due to the increasing frequency of extreme weather phenomena, a more frequent occurrence of sudden rainfalls with high yield in precipitation must be expected. Their harmful effect is subject to the topology of the region, the vegetation coverage of the vicinity, the condition and throughput capacity of water drainage systems and the structure and location of settlements. We can expect the emergence of flash floods in hilly regions and groundwater floods in lowlands. Sudden rainfalls might cause surface movements in certain areas; it is probable that the number of building damages will increase due to the thickening clay soil. These phenomena can cause serious damage to the building stock, the most important tasks in the avoidance of which are appropriate rainwater management and the revising, tightening of and systematic compliance with building codes and prevention.
Historic buildings, historic sites – similarly to the whole of the building stock – are endangered by river floods, floods due to extreme rainfalls and the increasing frequency of extreme wind speeds, but one must mention extreme daily and yearly temperature fluctuations, and the negative effects of rapid changes in freezing and melting as well. The changing temperature can cause cracks and ruptures. Pests mean a treat to the wooden and other organic building materials of historic buildings, and their potential propagation or the appearance of new, invasive species that have not been present in our region so far are expected. Historic buildings are often more vulnerable to the effects of climate change, moreover, architectural solutions applied on other buildings can be applied on historic buildings only to a limited extent.

It must be mentioned that the expected climatic effects might intensify certain geological sources of danger (e.g. collapse of embankment walls, landslides, mudflows) that pose a threat to the built environment as well.

Urban development, urban planning

The settlement structure has a great influence on the climatic conditions of settlements. Green surfaces can help reduce the extent of the effects of climate change and the adaptation to them: through absorbing a part of light, green surfaces restrain the (non-

[15] Urban Climate Guide. Magyar Urbanisztikai Tudásközpont Nonprofit Kft. (2012)

[16] Ministry of Home Affairs – VÁTI Nonprofit Kft. (2011): Climate-friendly cities – Manual on the tasks and opportunities of European cities, in relation to climate change, Ministry of Home Affairs – VÁTI, Budapest

greenhouse) warming of the air layer near the soil surface, evaporation during evapotranspiration cools down the microclimate, and reduces the greenhouse effect through capturing carbon-dioxide. Building density, the ratio of paved surfaces, the location, proportion and quality of plant vegetation and the morphological characteristics and physical layout of the settlement, the proportion of shaded areas and the natural ventilation of streets all play an important role in the microclimatic conditions of settlements, therefore they have a decisive role in the adaptation to the effects of climate change. The settlement structure itself is not a bearer of the effects of climate change, but the right transformation of the structures of settlements can reduce the extent of negative effects to the residents, the building stock and the infrastructure. The tools of urban development and planning can be used to make efficient adaptive measures to reduce the effects of climate change.

Reduction of heatwaves in the cities and the protection of air cleanness make it especially important to ensure such ventilation routes and wind channels in cities that allow the fresh air to get into the downtown from the outer belt areas, thus cleaning and cooling the urban air. In terms of ventilation in large cities, special attention must be paid to the building density of the settlements in the agglomeration and the preservation of undeveloped areas around the cities (forests, agricultural areas).

In addition to ventilation, shading also plays a very important role in the protection against the heat, as the proper shading methods – such as defining the location and height of buildings, planting avenues and plant vegetation, other shading solutions – can significantly reduce the effects of heatwaves.

Increasing the proportion of green surfaces and reducing paved and cladded surfaces can also be a great contribution to the mitigation of climate change effects. In addition to mitigating the heat island effect, green areas play a significant role in the water balance of the settlements as well. The city and the system of its green surfaces, and other living communities of urban life, form a single ecological system. In addition to increasing the proportion of urban green areas, improving their quality is also of special importance, not only for human use but for the ecology as well. In parallel, the cities must start to reduce paved areas and must consider the type, light reflection characteristics – such as colour – of new pavements in their selection process, so that this makes the least contribution to the urban heat island effect. The application of permeable pavements offers the opportunity of keeping precipitation "in place". The development of built environment must pay increased attention to the preservation, extension and revitalisation of semi-natural aquatic and non-aquatic habitats, as they play a significant role in urban temperature control. The planting of non-indigenous, invasive species should however be avoided during the creation of urban green areas.

Adaptation requires the development of a sustainable urban structure that is ideal in terms of climatic aspects should be striven for. Planning of area use and regulation can affect the arrangement of the elements of the built environment, therefore the distances of urban transport, the energy required for heating and cooling buildings and the vulnerability of the built environment[17].

[17] Cities and Climate Change; OECD Publishing, 2010. (http://www.oecd.org/gov/citiesandclimatechange.htm)

It is the large cities and homestead areas that are most vulnerable to heatwaves. As a result of the heat islands developing due to the typically high building density and weak ventilation in large cities, the average temperature is higher and the negative effects of this phenomenon occur more intensely. Although farmstead areas do not have the heat island effect, the weaker infrastructure of healthcare and social services and the lower income of the local population make the residents of such areas more vulnerable to the effects of heatwaves.

6.2.3. Transportation

The expected climate change has a direct negative effect on the vehicles, passengers, traffic and the transport infrastructure. Heatwaves mean an outstanding load to the participants of public transportation, as the temperature inside the transport units can be many degrees higher than in outside. Due to the copious heat forming in tunnels and the balancing of surface and underground temperature, the heat causes problems to vehicles running under the ground. In order to eliminate this issue, ventilation and air conditioning must be intensified inside the vehicles. In case of private transport, high temperature can cause issues of transport safety (such as attention disorder); therefore, special attention must be paid to the proper informing of transport participants.

An increasing frequency of asphalt damage can be expected in summer months. A long period of heat can entail a drastic acceleration of pavement rutting. This, on the one hand, adversely affects transport and makes the closing or transport limitation of certain sections necessary in extreme cases, and, on the other hand, the warm road pavement adds to the heating of the already warm air of cities. Hot days can bring about the deformation of rails as well. Planning of roads and fixed track transport systems must consider the expected increase of temperature and the increasing frequency of heatwaves. In addition, it is practical to make the pavement of roads and footways more resistant to heat and to use a more resistant pavement (pavement blocks, concrete) that does not warms up that much instead of asphalt wherever possible.

In wintertime, the occurrence of slippery roads and bad visibility conditions (fog) can increase, and this can entail the deterioration of traffic conditions. Temperature levels near to the freezing point and precipitation of changing consistency also affect the condition of road pavements negatively: humidity infiltrating and freezing in the cracks of asphalt causes potholes, and this phenomenon will become more frequent as well. If the increasing quantities of winter precipitation fall down in the form of snow, then we have to prepare for the increasing frequency of snow barriers as well.

The increasing frequency of floods and storms also poses a threat to transport. Elements of transport infrastructure on the surface can become flooded with water in lower-lying parts of cities, floodplains and along streams, but river floods can cause difficulties in underground transportation as well. One part of the road and footway network can become covered with water, and waters pouring down from higher areas can wash away roads and other structures. The various flood phenomena occurring at embankments against flood cause further problems during floods (e.g. up-warping, geysers, liquidation of the subsoil), as these

can damage the infrastructure. Sudden precipitation can was out road and railway embankments, riverbanks, and can sometimes cause landslides; durable drought can cause damage to the condition of the same structures (sinking). The climate change can negatively affect the biodiversity of plant vegetation and habitats along roads, motorways as well. Storms accompanied by fiercer, stronger wind blows can damage transport safety equipment, traffic lamps and signs. An increasing number of lightning in summer can pose a threat to railway safety equipment.

During heatwaves, the so-called Los Angeles smog can develop, which is formed by strong sunshine (UV radiation), weak air movement and pollutants emitted by transport (NO_x, hydrocarbons, CO). Change in the flow systems due to the effects of climate change makes several meteorological situations (inversion situations causing weak vertical and horizontal mixing) likely in winter time, and this can be good for the accumulation of aerosol particles[18] (PM10 and PM2.5) in the layer near to the soil. A temperature near to the freezing point will further increase the emission of aerosol particles of heating, and this can result in further air quality degradation. The prevention of the development of both types of negative air quality situations requires the reduction of air pollutant emission due to transport and residential heating (e.g. PM10, nitrogen-oxides, etc.). A similar tool for this is bringing public transport into the foreground, reducing the demand for motorised private transport, spreading alternative drivers and the relegation of solid fuels into the background in residential heating. In order to change the future trends of air quality positively in terms of public health and ecology, serious residential awareness-raising and technological changes will be necessary.

6.2.4. Waste management

Waste management itself is less affected by the effects of climate change; the greatest adaptation challenge is the existing infrastructure, especially the safe operation of landfills. Changes in the precipitation patterns due to the climate change affect the operation of landfills and wastewater treatment facilities as well. As regards waste management, health and epidemic risks can increase significantly. In addition, the various tailing management facilities and sludge reservoirs and slag heaps, where the large amount of, often dangerous, waste can cause serious issues, even disasters if the storage facilities get damaged, are a special problem. As regards hazardous operations, it can be concluded that the climate change mostly affects the infrastructure of existing facilities.

Landfills were insulated according to the local environmental conditions. The climate change can however intensify precipitation-caused erosion, changes in the groundwater-level can cause changes in soil mechanics and movements, as a consequence of which the insulation and stability of landfills can get impaired. Changes in wind speed and direction and the expected increase of the maximum wind speed can increase the load meant by airborne dust in the vicinity of landfill sites. In any case, the solution would be the assessment of risks,

[18] An important element of air pollution is aerosol (fine particle material distributed in the air, with a particle size from 10 μm to 50nm), the various types of which are classified according to particle size. The most harmful is PM2.5, because after breathing in, it does not leave the lungs, or does not leave the lungs easily, it forms sediments and causes inflammation, increasing the risk of various respiratory diseases.

implementation of the necessary individual interventions, improvement of physical protection and the development of monitoring systems.

6.2.5. Energy infrastructure

The assessment of the climate vulnerability of the energy sector cannot ignore the fact that energy supply is a basic driver of the economy and the society; therefore, minor effects can have a spill-over effect and affect the functioning of the economy on the whole.

For the power plants, the primary challenge lies within the changes in the energy demand. In wintertime, one can expect the reduction of heating energy demand (primarily the consumption of natural gas), in summertime, one can expect the increase of electricity consumption for air conditioning; even the demand for district air conditioning can appear in Hungary. The supplying of cooling water for heat and electricity generation in power plants will also change. The temperature of the available cooling water (or cooling air) has a significant technological effect, in case of power plants with gas turbines; the increase of external air temperature reduces the output. The increasing temperature and discharge of rivers – it is primarily the Danube for Hungary – can also cause problems in terms of the availability of cooling water in the appropriate temperature and quantity. It must be mentioned that climatic factors can also affect the road and rail transportation of solid energy carriers (primarily lignite, fuelwood, hay), and they might mean a risk to supply security.

The climate change will affect the availability of renewable energy sources as well, the degree of the changes (sometimes even the direction of the change) is however quite uncertain. The use of solar energy will likely be affected by the increasing global radiation and changes in the cloud coverage. The use of water energy will be fundamentally determined by the changing discharge of rivers, the output of wind power stations will be determined by the changes in the wind regime. The availability of energy carriers produced by agriculture is especially uncertain. The yield of the material for these renewable energy carriers (primarily corn, rapeseed, hay, fuelwood and trimmings) and so their acquisition price is likely to be affected by the climate change, to an extent unknown today.

Increasing risks can be identified in energy transmission systems and public utility services. The increasing frequency of storms accompanied by strong wind blows can threat air lines, current transformers, and the softening of the soil will make support structures instable. In the coldest months of the year, hoarfrost, watery snow load and freezing rain pose an increased load to air lines. Air lines are exposed to new risks due to the increasing frequency of forest fires in woodlands and floods in floodplains. The increasing frequency of hot days and days with heat alert, especially in larger cities, increase the peak load on electricity generation, and this can cause unexpected power cuts on larger areas. In addition to these realistic physical effects, the increasing temperature will also make the capacity of transmission networks drop. Both the energy providers and the consumers must prepare for the expected effects. Consumers must, on the one hand, expect increased risks of infrastructural malfunctions (longer or more frequent outages) and, on the other hand,

sometimes increased costs (e.g. insurance premiums, investments to increase individual safety).

6.2.6. Tourism

Tourism plays an important role in the global, European and Hungarian economy as well. Climate and weather may be regarded as the resources of tourism, because they define the attractiveness of a given area. Positive or negative climatic conditions can limit the scope of tourism activities; affect the development of the tourism offer. Changes in the climate can limit the capacities of tourism activities, terminate certain elements of the tourism offer or even encourage the development of new tourism products. The climatic conditions are of decisive significance primarily in outdoor tourism (summer vacation, active recreation, winter sports). Climate plays a significant role in the development of travelling customs. Tourism is integrated as a dynamically evolving, open system into the socioeconomic and natural environment, therefore it is a fundamental characteristic of the cyclical relationship of climate and tourism that tourism is, on the one hand, affected by external factors, but it does, on the other hand, affect its environment as well.

- It is, on the one hand, a direct relationship, because the climate change can modify the fundamental resources of the tourism sector: the weather, therefore affecting the demand and supply at the same time. Extreme weather phenomena, changing seasons and the related heating and air conditioning costs mean a fundamental change to the options of the tourism sector19; the changing climatic conditions lead to new business preferences and decisions. Observing the demand and supply mechanisms of tourism in combination with each other, it can be concluded that the expected changes cause the transformation of travel behaviour, affecting back in time and space to the tourism sector, where they cause a market rearrangement of the products, activities and destinations. The other aspect of this direct relationship is attributable to the GHG emission of tourism: emissions caused by travelling, accommodation, catering and other related services also contribute to climate change.
- The second group of the effects is the indirect mechanisms, i.e. the natural resources affected by the changing climate. This includes, amongst other things, the changes of biodiversity, water resources and landscape, which affect certain branches of tourism negatively. The health risk of changes must be emphasised as well, as the changing temperature conditions, extreme phenomena, drought or even floods can increase the threat that various diseases, epidemics develop and spread at an increased pace.
- The following group of effects is characterised by economic, social and political relationships. Decision makers could, on the one hand and recognising the gravity of the problems, initiate emission-reduction measures limiting tourism. On the other hand, the climate change can have the consequence that the economic and social

[19] UNWTO (2008): Climate Change and Tourism: Responding to Global Challenges (http://www.worldtourism.org/sustainable/climate/final-report.pdf)

conditions get changed. Tourism is often regarded as the driver of economic development for certain countries; its setback may therefore cause serious economic and political instability. The climate change can therefore indirectly intensify other serious global problems such as poverty or terrorism, which also affect tourism.

It is important that tourism is not affected by direct climatic parameters only (heatwaves, changing water regime, more frequent storms), but also by natural effects caused by climate change (biodegradation, spreading of non-indigenous invasive species) and their socioeconomic consequences (spreading of contagious diseases, increasing energy and drinking water prices). The climate-friendly tourism counts in and prepares consciously for the favourable and unfavourable effects of climate change, by both reducing its own GHG emission and bearing in mind the reinforcement of climate-consciousness. In regions where tourism is one of the dominant economic sectors, the adaptive responses aiming at economic diversification can be especially useful in reducing economic losses.

6.2.7. Public security

General context of the climate change and security

The extreme weather conditions subject the human civilisation and societies to more and more direct, widespread, frequent stress. The extreme weather conditions, including droughts, heatwaves, storms and the fires, floods, landslides caused by these can have such consequences that the municipalities, countries which are affected by these cannot handle alone. The situation is made even more complex by the fact an extreme natural disaster can be followed by other ones or may be accompanied by any other natural emergency, and they can, on the whole, intensify the negative effects and consequences of each other, usually in a progressive and exponential fashion. The consequences of climate change, especially the increased threats to the natural and human-made environment have made the climate change one of the central elements of defence policy.

In the European context of climate change, an often cited document is the Solana Report titled *"Climate Change and international safety"*[20] issued in 2008. It names seven security threats related to the climate change, all of them jeopardising the security of both the global community and the security of states. According to the Solana Report, the climatic factor is the multiplier in the relationship between climate and defence, meaning that it can exponentiate the existing, known defence risks, it much rather accelerates negative trends in security, escalates the current tension, conflicts in international relationships, then just appearing a single factor of threat only. Therefore, climate change makes its effect "only" indirectly onto global and regional defence policies, meaning that it usually aggravates already existing problems. It is through a fact that the threats of climate change do not afflict the regions, states equally. This is basically attributable to two reasons: the geographical location of countries makes them be differently exposed to the effects of these treats, and their level of political, social and economic development, that would make them capable of treating the consequences of climate change, is different. Both aspects affect the

[20]Climate Change and International Security, Paper from the High Representative and the European Commission to the European Council, S113/08, 14 March 2008, 11. p..

European political and economic interests and, although in an indirect manner, mean an actual and ever increasing threat to Western democracies. The position of the World Bank[21] is that the source of the potential conflicts emerging as a result of climate change can be basically three factors: the shrinkage of natural and terrestrial resources, the increasing sea level and natural disasters.

The effects of climate change on the security policy of Hungary

Regarding the climate change effects affecting our security policy, the following trends, forms of occurrence, phenomena and their direct interference should be expected in Hungary.

- *Security of health and food NAGiS supply:* Heatwaves, prolonged dry periods can intensify the emergence of diseases, infections, epidemics, which can pose a threat to the security of the whole nation in extreme cases (e.g. long-lasting and particularly high temperature). The increasing frequency and length of dry periods and heatwaves pose a risk to food supply and food security. The extreme distribution of precipitation poses a threat to irrigation systems. In lower-lying areas, crop production, livestock farming, game management, fisheries may be exposed to an increasing threat of river and groundwater floods. Climate change may entail the occurrence of new pests, and the increase of the risk of diseases spreading with foodstuffs. The strategic goals, action lines related to food chain security are included in the Food Chain Security Strategy.
- *National security:* The fact that Hungary can become a target or transit country of global climate migration from coastal areas flooded due the melting of polar ice caps and from the Near East, North Africa or even Mediterranean countries due to the prolonged heatwaves, dry periods and severe water and food scarcity.
- *Infrastructural and public utility security:* The more and more hectic changes in river stands (sometimes extraordinarily high, sometimes minimal) can accelerate changes of riverbeds, which can pose a threat to dams and protective facilities. Infrastructure built on rivers, inland navigation can get damaged, and channels can become stuck. The increasing risk of river floods, groundwater floods means a direct threat to the settlements, transport and the elements of critical infrastructure. The winter months can see the emergence of snow storms and blizzards in the Carpathian Basin, paralysing the transportation of entire regions or even the whole country. Low water levels on rivers and the lack of rain-replenishment can cause the decline of river and near-soil water resources, endangering the water supply. Extreme weather phenomena, primarily storms, risk not only the electrical network, but also certain elements of the telecommunication infrastructure, that can directly affect internet access and electronic data exchange.
- *Industrial security:* As a consequence of climate change, water scarcity, increased cooling demand, the increasing costs of CO_2 reduction and the changing consumer demand can affect certain resource-intensive industrial sectors, such as the chemical

[21]Halvard Buhaug, Nils Petter Gleditsch and Ole Magnus Theisen, Implications of Climate Change for Armed Conflict, Social Development, The World Bank, 1818 H Street, NW, Washington, DC 20433

industry, food industry, building materials industry, negatively. The flash floods caused by the suddenly pouring, flood-like rains can pose a threat to certain hazardous material storage facilities, waste management facilities, therefore, especially the facilities of hazardous waste disposal. The increasing frequency of extreme weather phenomena can increase the probability of breakdowns related to hazardous materials, increase the number and gravity of unexpected events related to hazardous material emission.

- *Ecological security:* The shifting of ecological zones, the appearance of Mediterranean, subtropical environments will have a negative effect on biodiversity. Especially the habitats and species of wetland areas, grasslands and forests will be under a threat.

6.3. Adaptation measures

6.3.1. Human health

As a result of the effects of climate change, many new risks, especially health risks, appear in our lives, and we should prepare for them. It is necessary that the aspects of human health appear in the responses of many policies, including climate policy as well. The climate adaptation tasks related to human health are included in the National Environmental Protection Programme (NEPP). The following action lines should be considered in the implementation of the NEPP:

Short-term action lines

- Obliging (social, educational) institutions providing to larger groups to compile an "action plan" for heatwave management and to elaborate the related central set of criteria.
- Introducing requirements that efficiently regulate work conditions in indoor and outdoor workplaces in order that the increasing temperature does not pose a health threat.
- In case of ticks, sandflies and other animal carriers (so-called vectors) it is particularly important to control spreading, to monitor infestation, follow-up the rate of virus-carrying and to establish a supervisory system.
- The protection of environmental health and the development of a disease-supervision system, (further) development of a climate health network should take place according to the principle of "minimum structures", meaning that it should mean the minimum necessary and sufficient modifications on the existing system. It would be practical to extend the already functioning Climate Health Network of Budapest to the entire country. Emergency situations related to climate change and variability and rapid public health responding must be prepared for. Standardised early warning systems must be set up; conditions of emergency care must be improved, with special regard to disaster situations.

- Healthcare and social workers must receive specialised training; climate-related health information must be included in the curricula of educational institutions of different levels within the framework of consciousness-raising, education and awareness-raising. It is recommended to increase public consciousness about climate health through involvement of the media and preparing educational materials. Residents must be regularly informed of possible threats via comprehensive campaigns involving NGOs, churches and municipalities.
- "Best practices", research results, data, information, technology and tools related to climate change, the environment and health must be shared with healthcare operators. The healthcare sector must receive information, instruments and advice based on the educational material of the WHO and Hungarian experience.

Mid-term action lines

- Food security measures must be extended in order to protect against the indirect effects of climate change. An environmentally, socially and economically sustainable food production, trade and food security must be warranted. To this end, relevant legislation must regularly be revised, strictly controlling compliance therewith—with the appropriate institutional background ensured.
- Reinforcing healthcare systems in order to prepare them for the threats of climate change, with special regard to extreme weather situations. Revision the internal organisational and operational structure of the public health care system in order to ensure an overall integration of the requirements of the climatic adaptation. Remodelling healthcare institutions through modernising the thermal insulation, cooling of buildings, for a successful adaptation.
- Gradual strengthening of the rule of prevention (preventive preparation) in protection, then making it predominant in comparison with interventions (rescuing, patient care, rehabilitation).
- The opportunity introducing supplementary vaccination, the practice of vaccination, the option to improve the rapid adaptability of production of protective vaccines with new, molecular genetic methods.
- Enumeration of all diseases that both exist today and will occur in Hungary in the future due to the climate change, exploration of their characteristics and access to the, probably growing, group of stakeholders with precautionary measures.
- Assessment of the spreading of animal species playing a role in spreading pathogens; elaboration of methods to slow this spreading, to reduce the number of carriers and containing epidemics.

Long-term action lines

Comprehensive integration of climate change, as a boundary condition, into policies concerning human and social resources, taking actual changes in the climate also into consideration.

6.3.2. Water management

Climate change imposes major tasks on every field of water management. The magnitude of this challenge is attributable to the complexity and uncertainty of climate change and its effects. Water management does not only face the challenge meant by the effects of climate change, but also the non-climatic effects, and their interactions that occur independently from it. Therefore, climate change means an increasing risk to water management. The degree of the risk is uncertain and depends on the probability and severity of occurrence. Adaptation to effects that have very severe consequences may be reasonable, bearing in mind the principle of precaution, even if the probability of occurrence is low. Adaptation reduces risks and allows for the prevention or minimisation of vulnerability. The efforts for adaptation may not be postponed anymore, because the effects are there even in the short run and might be significant if the negative climate scenarios apply. Adaptation also takes a lot of time, particularly if the measures must be discussed with a broad range of social stakeholders.

It would be practical to lay down the detailed water management tasks of climatic adaptation in the integrated water management and water protection concepts, national and regional programmes, plans (e.g. in the plans on water catchment area management and flood risks and in the implementation framework of the *Kvassay Jenő Plan* – National Water Strategy) taking the following action lines into consideration:

Short-term action lines

- The Programme on Further Developing the *Vásárhelyi Plan* must be continued. The water management and supporting conditions for the establishment of floodplain landscape management systems tailored to regular, shallow water flooding and permanent water storage must be ensured in every reservoir area still to be created. Farmers must be helped with trainings, expert advice, and awareness-raising in the establishment of sustainable, community use of landscape.

- Within the framework of implementing the principle of water damage prevention through risk prevention, it is necessary to plan and regulate flood protection and land use in an integrated way applying risk mapping. It is important to conduct planning while differentiated safety is ensured, to continuously re-evaluate the Significant Flood Level values, in accordance with the monitoring of environmental changes.

- The good quality and quantity of our waters require the scheduled execution of tasks derived from the Water Framework Directive (WFD). The regular revision and adjustment of the water catchment management plans to the changing climatic conditions every 6 years, as required by the WFD, is also a related task.

- Instead of a water regulation practice based on rapid water drainage, water retention should be encouraged. In parallel, it is recommended to start the development of a sustainable land use through the integration of regional, municipal, nature protection, agricultural, water management, and to create its pilot areas as soon as possible. Widespread social dialogue should be started on sustainable land use, the principles of

water management and its practical implementation. The task is to improve the relationship between the society and water.

- When it comes to managing water flows that influence the level of groundwater, then it is important to prefer solutions that prevent the groundwater-lowering effect of the active and passive lowering of the bed of channels and rivers, including the elimination of channels that, being causeless today, drain water from a certain area. The elimination of the need for rapid water drainage is a related task.
- It is recommended to study the forms of land use in terms of the changing ecological and climatic conditions. Stopping the cultivation of areas that are regularly flooded and cannot be economically utilised for agriculture due to frequent inland flood, and utilising them for purposes that fit their conditions (creation of wetland habitats), creation of semi-natural water-supplying systems, rehabilitation of microregional water cycles, increasing the role of forests, wetland habitats in the retention of waters.
- It is recommended to create model areas for floodplain landscape management on suitable areas, with special regard to areas exposed to droughts, inland-flooding and river floods.
- The spreading of water-efficient irrigation technologies, being the duty of agriculture, is an important instrument in the adaptation process. The expected increase of irrigation demand the existing water supplying system must be maintained and developed, where justified, if negative environmental effects of irrigation are avoidable and is economically feasible. The integration of nature protection aspects into the water supply system is of particular importance.
- The water quality risk posed by the effects of sudden rainfalls must be reduced. The systems of small-scale, semi-natural wastewater treatment must be rapidly spread in areas where setting up and operating large capacity systems and sewerage is not reasonable.
- Water regulation in municipal areas and solving the issue of rainwater drainage are essential in order to mitigate the effects of sudden rainfalls. Within this context, the setting up of municipal rainwater management systems, safe rainwater collection, retention and utilisation could be encouraged.
- The efficient use of water resources could be encouraged either with the means of demand management or with economic means and setting up the right water pricing policy. Involving local stakeholders into the maintenance of water flows and channels is important.
- In addition to popularising the opportunities to use water in an efficient way, researching and developing technologies that require less water is also important (innovation). Wasting water must be stopped and the reuse of the greywater generating in the households must be encouraged. The balance between water resources and water demand must be ensured while the water resources are shrinking and the demand for water is increasing; the relevant solutions and legal & economic

framework must be explored and set up22. Applying an organisational, stakeholder and pricing system encouraging water retention is recommended in both regional and municipal water management23.

- More detailed analyses that are versatile and explore the mutual relationships between effects that can be expected in water regimes, hydrological conditions must be prepared, with special regard to climate change scenarios.
- Exploring the reason for the increasing frequency of extreme floods and the increasing flood levels, and risk mapping are an important task of the preparation. In mountainous and hilly regions, the opportunities to create floodwater and rainwater reservoirs and the expected effect of reservoirs on floods must be studied. Planning the rehabilitation, in terms of environmental and nature protection, of water flows in hilly regions is a priority.
- In terms of municipal water management (drinking water treatment, wastewater treatment technologies), the task is to explore its climate vulnerability and the increased needs concerning wastewater treatment, to set out reserve water bases and to map flood risks on a settlement level.
- The adaptation measures, their possible alternatives, feasibility and costs must be explored for each climate scenario, identifying the disadvantages for the given region if adaptation does not take place or is delayed and what are consequences, losses of non-acting. It is recommended to explore measures that are justified by non-climatic considerations as well (water demand regulation, reduction of environmental load) and which contribute considerably to climate adaptation.
- An indicator and monitoring system must be set up and developed, as they allow for the following up of the effects of climate change on the water regime, water quality and water management, and can help decision-makers in a more substantiated and realistic assessment of the tasks arising from climate change and their decision-making.
- It is recommended to elaborate a drought-management plan and, in the course of elaborating it, (drought) warning systems could be set up based on the indicator and monitoring systems.
- In terms of enumerating the adaptation procedures and presenting the examples of good practices, it is particularly important to enumerate the procedures to increase available water resources and to increase water quality.
- The adaptation procedures that could be an adaptive response of both climatic and non-climatic effects and that are justified by non-climatic aspects as well, and that are useful even if the climate does not changes as forecasted or does not change according to the forecast must be explored. The knowledge of such procedure could

[22] Note: according to the order of priority recommended by the European Commission, alternative ways of water supply and the involvement of newer water resources may be planned only after the tools for demand management are exhausted

[23] Kvassay Jenő Plan, 2015

ensure greater support and security to decision-makers in their decisions concerning the planning and implementation of adaptive responses to climate change.

- It is recommended to establish bi- and multilateral forms of international cooperation in order to share the water resources that will change and will be available in case of the climate change.

Mid-term action lines

- Comprehensive introduction of a water-retaining water regulation practice in our water management. Restoration of microregional water cycle systems.
- Extending the reactivation programme of floodplain landscape management model areas, deep floodplains.
- Adjustment of land use to the changing ecological and climatic conditions.
- Forecasting expected changes in water-related needs. Transforming the regulatory conditions for demand management for the addressing of the issue of "increasing demand-shrinking resources", having regard to long-term sustainability as well.
- Achieving a good quality and quantity of our waters, according to the requirements of the WFD, by 2027, creating the means for maintaining the good condition. Establishing a form of land use that is sustainable and adapts to the climate, together with the comprehensive integration of regional planning, nature protection, agricultural and water management planning.

Long-term action lines

Comprehensive integration of a water management that is aligned to climate change, as a boundary condition, into the Hungarian water regulation, in consideration of actual changes in the climate, and into international forms of cooperation and foreign policy (bi- and multilateral international cooperation to share water resources the availability of which gets changed by climate change).

6.3.3. Agriculture

In the agriculture of Hungary, studying the responses to the expected effects of climate change is based on the concept that agriculture is facing a forced paradigm shift. In addition to the mitigation of the harmful effects of globalisation, the substitution of agricultural methods destructing our bases of existence with sustainable farming and stopping the depopulation and deterioration of rural areas, adaptation to climate change is another urging task. Sustainable farming systems that align to the conditions of the farming location spare natural resources, do not overload the environment, are water- and cost-efficient, knowledge intensive, economically sustainable in the long-run as well, reduce carbon-dioxide and methane getting into the air from the soil, hamper the erosion, are energy-efficient, thus their elaboration and spreading is one of the most significant elements of the adaptation strategy. The creation and further development of such a system assumes a profound restructuring of our current agriculture and the economic and social processes determining

life in the countryside. The framework for this, including the tasks related to climatic adaptation, is determined by the National Rural Strategy. It is appropriate to consider the following action lines during implementation:

Short-term action lines

- It is necessary to develop such a use of land and landscape that contributes to the mitigation of the effects of weather extremities, and to the adaptation to them. Production must be adjusted to the changing climatic and ecological conditions.
- In connection with agricultural adaptation, it is necessary to carefully survey, plan and regulate national drinking and irrigation water demand in connection with the increasing difficulties in satisfying the demand for water.
- Facilitating the process of natural precipitation getting into the soil and being stored and used is a priority. It is therefore recommended to apply the proper soil-loosening technique on the appropriate agricultural areas, in alignment to this need. The solution for deep-lying areas with water inundation, water regimes and a heavy soil could be the use of a cultivator, application of a rotating land use and the retention of water that builds up spontaneously in such areas.
- In areas that are characterised by water scarcity and droughts, the establishment of a near-natural water supply (storage of the water surplus from floods, floodplain landscape management schemes) and the spreading of natural alternatives capable of substituting irrigation (floodplain agriculture, oxbow lake fishery, ridging) is of key importance. Crops that require less water and are less sensitive to weather extremities gain an increasing role. The most affected areas (Danube–Tisza Interfluve, the southern part of the Hungarian Great Plains) require water retention, continuous plant coverage and the restoration of wetland habitats. Areas that often face water scarcity and drought require the replacement of water-intensive crops with other ways of utilisation.
- The increasing price of food and irrigation water make irrigation economical only for crops that produce a high added value, the condition of the existing irrigation systems must therefore be revised, and the installation of new ones should be considered for areas where it is economically reasonable. The installation of environmentally sustainable and water-efficient irrigation systems may be initiated in such areas, taking the ecological water demand of the landscape and of the industry and the residents also into consideration.
- Adaptive soil cultivation, water management and the growing of plat cultures fitting into the landscape can prevent soil salinisation.
- In areas that are prone to acidification, the planting of the right plant cultures and targeted farming can prevent over-acidification. In inherently acidic areas, growing the right plants, adaptive soil cultivation and manuring can help avoiding any further soil deterioration.

- The strategic steps of the technical-technological transformation of adaptation are linked to soil cultivation, mechanisation, via the reducing number, combination, and omission of operations, material- and energy-efficient machines and the application of precision agrotechniques. Enhancing the flexibility and versatility of the production and activity structure and the involvement of new activities can help bear the damage caused by extreme weather but could also facilitate alignment to market demand. Diversification is a precondition to more balanced and more profitable farming. It is recommended to set up an IT system to avoid drought risk, similarly to the National Adaptation Geo-information System (NAGiS). It is important to develop the system of meteorological information, forecasts, alarms and its way to the farmers.

- The township-level prognosis on the changes in soil quality, based on natural geography data, must be carried out within the framework of the NAGiS, and the necessary soil protection measures must be determined in order to facilitate the adaptation to the effects of climate change.

- Further development of the Complex Agricultural Risk Assessment System (CARAS) in order to assess agricultural damage caused by climate change; through creating an opportunity to integrate data from CARAS and NAGiS.

- Preparation of the existing expert consultant network for the handling of challenges related to climate change; training of expert consultants in order that they can help preparation, protection and damage settlement.

Mid-term action lines

- Reserves for water replenishment must be developed, its instruments could be: building of multipurpose reservoirs; extension of pond farms; utilisation of tidal reservoirs for water supply, landscape management; competent utilisation of areas affected by regular floods and protected with summer dams, through substitution of plowing, extension of grass cultivation and forestry, revival of oxbow lake fishery and creation of water habitats.

- Reinforcing the rapid adaptation to unexpected changes through the coexistence of different farming methods and organisational forms (modern technique and technology vs. traditional knowledge and landscape-conscious farming) and the parallel presence of the necessary infrastructure and institutional framework.

- Improvement of biological bases and supporting research are of key importance in order to introduce plant varieties that are drought-resistant and can stand extreme effects better. Special attention must be paid to any possible reintroduction of landscape plant varieties that are either indigenous or were introduced a long time ago into production, the basis of which is provided by our gene banks. In case of plantations, the role of the right selection of production site exposure increases.

- Adaptation changes the strategic role of the products and crops produced, i.e. the biomass. The aim is, on the one hand, to minimise the quantity of waste and, on the other hand, to reintroduce the largest possible portion to the circulation of organic materials, the soil, and that the produced organic material gets fully utilised, if

possible. Production and processing of crops should achieve the least possible amount of carbon-dioxide, methane and other harmful substance getting into the atmosphere, and renewable energy production, especially biogas production and various locally used energy production should increase within the various forms of utilisation.

- Undercapitalised farming and a production structure that often ignores landscape conditions (maintenance of which is partly supported by the aid schemes as well) often impose to high burdens onto the farmers, insurers and the state if agricultural damage occurs. The intensification of weather extremities will increase the occurrence probability of weather extremities. Insurance is therefore an indispensable element of the adaptation strategy, and it must involve multiple players, and be preventive and encouraging to self-care. Laying new foundations for the agricultural insurance system and harmonising it with the economic impulses of the aid scheme is important. It must be highlighted that the entry into force of Act CLXVIII of 2011 on Handling Weather-Related and Other Natural Risks Affecting Agricultural Production24 has launched this process.
- Inserting precision farming into the system can help adaptation, which uses GPS to reduce costs and mitigates environmental load.
- Agricultural and rural policies must give high priority to the development and extension of ecological farming, as the most sustainable farming system.
- Studying of adaptation opportunities lying within the agroecological potential must be intensified.
- Animal breeding must lay emphasis, besides performance and quality, on species adapting to the effects of climate change.
- Reducing the ultimate use of land for other purposes in order to prevent the absorbing capacity of the soil and the microclimatic effects.

Long-term action lines

- Extension of the integrated systems of local production – local processing – local consumption.
- Comprehensive integration of climate change, as a boundary condition, into agricultural and rural development policies, taking actual changes in the climate also into consideration.

The long-term goal is to establish sustainable agriculture in the entire country. Sustainable agricultural production that also helps the adaptation to the changing climate and weather conditions is such a conscious, carefully planned activity in which the farmer, pursuing the undisturbed circulation, repetition and "reproduction" of biological, natural processes, applies such interventions, equipment, materials (pesticides, manures, animal medication, irrigation water), techniques, technologies and protection that satisfies the increasing food demand of people while maintaining a positive expense-yield ratio.

[24] Act CLXVIII of 2011 on Handling Weather-Related and Other Natural Risks Affecting Agricultural Production

6.3.4. Forestry

Forestry tasks related to climatic adaptation are included in the National Forest Strategy (2016–2030), during the implementation of which it would be practical to consider the following action lines.

Short-term action lines

- According to the National Afforestation Programme, forests must increase in area, subject to the changing conditions at production locations—applying the right tree species, primarily indigenous, and Hungarian reproductive materials.
- The reduction of fire risk requires measures to prevent forest fires, and the elimination of the most flammable trees from the most flammable areas.
- It is recommended to study the future development of the effect of climate change on forests, forest habitats and forest microclimate, applying a geo-information model considering the results of Earth observation and remote sensing to display the possible scenarios of the changing climatic zones, the possible extent of the changes in the zonal forest coverage, the effect on soil types, the expected migration of forest-forming tree-species.
- Preparation of climate vulnerability analyses, in connection with the NAGiS, capable of the quantified description of the expected changes and adaptability with indicators as regards the species and production areas applied in forestry.

Mid-term action lines

- Development of models for foresters, in consideration of the requirements of long-term, sustainable forestry, specialties of 30-150 years long turns of logging, the opportunities of foresters.
- Compilation of forest planning manuals for tree species selection and forest growing, and considering the effects of climate change. Elaboration and operation of a decision-supporting system to help forestry and forest planning, while also considering the effects of climate change.
- Monitoring, adaptive management and, if necessary, replacement of the tree stock of the forest areas of vulnerable regions, based on Earth observation data and remote sensing, corresponding revision of the 10-year district forest plan, timely restoration of forest areas damaged by natural disasters.
- Water regulation of forest areas, improvement of the water retention capacity of forests, improvement of their water supply.
- Facilitation of the adaptation of trees with a long growing season to climate change within the framework of forestry, applying the supported form of migration.
- Spreading of such forestry technologies of sustainable forestry that increase the resistance and stability of forests (increased mixture) against the effects of climate change, including the reduction of the risk of drought, forest fires, pests, storms. The

aspects of climate change must be gradually integrated into the system of forest planning, including the definition of the growing site and the selection of the tree species.

- Reinforcement and development of the forestry monitoring system, with special regard to the increasing utilisation of remote sensing, the integrated assessment of information acquired with remote sensing and Earth observation, and their optimised utilisation.
- Maintenance of a sustainable stock of big game in the long run, not hampering semi-natural forest regeneration methods.

Long-term action lines

- Comprehensive integration of climate change, as a boundary condition, into forestry policies, taking actual changes in the climate also into consideration.
- Application of semi-natural forestry methods that consider natural forest dynamics, the pace of climate change and its expected effects, including the gradual implementation of forestry methods resulting in continuous forest coverage in areas capable of doing that.
- Development of a form of forestry that ensures adaptation to climate change, in consideration of natural forest dynamics. The intervention pay special attention to achieving the highest possible level of afforestation, the selection of the right species, the increasing of the mixture of species and ensuring the opportunities of restoration.
- In the wooded steppe zones, gallery forests that close in low should be sustained at places where closed stocks cannot be sustained any longer.
- Preservation of local genetic resources, relying primarily on Hungarian genetic resources, by selecting the elements that best adapt to future production trends.

6.3.5. Urban planning

The built environment and the infrastructure of settlements are most endangered by extreme weather phenomena; storms, copious amounts of precipitation and the increase of wind speed. The increasing frequency of heatwaves and the so-called heat island phenomena are chiefly public health risks, but the development of the building stock, application of the instruments of climate-conscious settlement development and planning, creation of larger and targeted green areas in the built environment, a more conscious management of rainwater can significantly reduce the effects of heatwaves as well. The determination of adaptation action lines must pay special attention to the mitigation of these effects. In addition to the specific adaptation opportunities of the building stock, construction sector and certain urban infrastructures, it is important that the regional plans and the urban development and urban planning activities provide complex and efficient responses to the entirety of urban structures and settlement systems in order to improve adaptability.

The detailed tasks of climatic adaptation related to the use of land and the built environment should be defined, amongst others, in Act XXVI of 2003 on the National Spatial Development Plan, and, in accordance with the hierarchical system of the spatial development plans, in the Acts on the Spatial Development Plan of priority regions (Act CXII of 2000 and Act LXIV of 2005), in the decrees of county governments on the county-level spatial development plans, in municipal and regional development plans, in the urban planning instruments. In addition to the foregoing enumeration, the following action lines should be considered in the implementation of the National Transport Infrastructure Development Strategy[25], and the National Waste Management Plan[26] as well:

Short-term action lines

- The integration of the aspects of climate change into the requirements and regulations on construction and area use should be given priority.
- The Climate Change Action Plan must determine adaptive measures concerning the built environment and urban development and planning in detail, through the elaboration of measures to improve the adaptability of waste management and the transport infrastructure.
- The aspects of adaptation and sustainability must be integrated into the urban development and urban planning documents, and into the strategic and planning documents of construction sector.
- The assessment of areas sensitive to surface movements and the revision of masterplans, building codes are of special importance; similarly to the avoiding of construction on areas affected by surface movements, the elaboration of measures to manage already developed land, and prevention.
- It is recommended to assess the stock of historic buildings endangered by the effects of climate change.
- It is necessary to register and check the condition of urban green areas, extend and improve the system of green surfaces, including the opportunities lying within the transformation of rust belts of transports (abandoned transport areas), transformation of brownfield areas and the banks of streams in inner belt areas through the reduction of paved surfaces, substitution (e.g. concreted streambed) or relief (e.g. rainwater drainage system) of the grey infrastructure, if possible, submission of the application of extensive green roofs and site-specific innovative urban green solutions.
- The protection and competent maintenance of existing urban wooded areas (urban forestry, municipal, institutional and residential management of green surfaces) are essential to increase adaptability.
- Within the context of regulating the built environment, rules should be elaborated in detail on the planning, establishment and elimination of green surfaces in a climate-conscious manner, and cutting of woods.

[25] Government Decision No. 1486/2014. (VIII. 28.) Korm. on the National Transport Infrastructure Development Strategy

[26] Government Decision No. 2055/2013. (XII. 31.) Korm. on the 2014–2020 National Waste Management Plan

- The thermal protection of the transport infrastructure and the reduction of the thermal island effect require the launching of a program to plant trees along road and in public spaces.
- The use of "alternative" and environmentally friendly forms of private transport, the reduction of motorised transport needs and a more efficient and more sustainable serving of the latter should be encouraged.
- Comprehensive settlement vulnerability analyses are recommended on the building stock, the transport and public service infrastructure of settlements.
- The existing landfills, tailing management facilities and slag heaps, and areas designated for disposal should be revised in consideration of the risks due to the changing climatic parameters.
- It is recommended to continuously inform the participants of the construction sector, urban development and planning on the importance and opportunities of climate-conscious planning and use of materials.
- Preparation of the public transport network for extreme weather phenomena (heatwaves, floods, storms) through the identification of points of intervention and the elaboration of action plans is of key importance.

Mid-term action lines

- Elaboration of appropriate regulations in order that pavement materials that are more resistant to the heat stress are used more widely.
- Extension of the system of green surfaces and the involvement of water surfaces to create a site-specific green infrastructure system that ensures ecological interoperability and facilitates the ventilation of the settlements and reduces the thermal island phenomena.
- Adaptation to the effects of climate change in the construction sector, development and application of new construction solutions, preparation of the building stock for the emergence of extreme weather phenomena (heatwaves, extreme weather situations, storms) and water scarcity.
- Encouraging the harmonised planning and development of settlement groups most exposed to the effects of climate change (agglomeration of large cities, agglomerating regions, farmstead regions).
- Protection of fertile soils (especially those of good quality and of valuable location) against the construction industry.
- Revision of the degree of building density in the agglomerations, agglomerating regions and significant holiday resorts, prevention of the growing together of settlements, strengthening of the development of multiple centres.
- Consideration of the aspects of a conscious adaptation to the effects of climate change in urban planning; climate-conscious setting out of areas for construction;

bearing in mind the goal of creating a compact urban structure divided by green areas and areas for the ventilation.

Long-term action lines

Comprehensive integration of climate change, as a boundary condition, into regional, urban development and building policies, taking actual changes in the climate also into consideration.

6.3.6. Energy infrastructure

The climate change has a direct effect on energy production and consumption and an indirect effect on the energy demand. It would be practical if the implementation of the National Energy Strategy and the National Building Energy Strategy considered the following action lines, and to define the detailed tasks of energy infrastructure, in relation to climate change, during the revision of these documents.

Short-term action lines

- Climatic risks must be integrated into the planning of power plants and the energy infrastructure. The climate vulnerability of energy engineering should be studied horizontally in the various industries (interaction with other sectors such as rural development and water) and in terms of vertically spreading effects (along a certain supply chain, in consideration to the effects of production and consumption) as well.
- Information-collection and impact assessment: the first thing to do in terms of the "climate-resistance of the energy distribution network is to understand the real chain of effects and to systematically evaluate them.
- Revision and renewal of the energy infrastructure must integrate the aspects of climate into the existing assessment methods (audits, ratings).
- The availability, stock and sustainable utilisation of weather-dependent renewable energy carriers (especially the sun, wind and biomass) should be revised in the light of the expected climate change.
- The sharing of experience and best practices should be encouraged within the framework of awareness-raising and knowledge-sharing.

Mid-term action lines

- Revision of action and further modification of legal criteria in the light of the progress of climate change and the effects.

Long-term action lines

Comprehensive integration of climate change, as a boundary condition, into energy policies, taking actual changes in the climate also into consideration and parallel to the increasing transport electrification and the spreading public utility infrastructure of smart cities.

6.3.7. Tourism

The effects of climate change on tourism focuses on the direct effects due to the changing of the climate as a resource and the indirect effects concerning tourism, and the consequences of the socioeconomic changes. The detailed and tourism-related tasks of climatic adaptation should be defined in detail in a single national tourism development policy, the development policy of tourism destinations and the urban and regional development plans, in consideration of the following action lines:

Short-term action lines

- Elaboration of a climate-friendly tourism-development strategy is recommended, with special regard to the topics of adaptation and sustainability, considering the relevant documents of Hungarian tourism development.
- The results of the vulnerability assessment of the Hungarian tourism destinations should be applied in practice, on the basis of the National Adaptation Geo-information System (NAGiS), focusing on the further studying of the adaptation opportunities, tools and adaptation portfolio of the stakeholders.
- Within the framework of awareness-raising, players of the tourism sector should be informed on climate change and its consequences, and their motivation to participate in the related adaptation (and mitigation) processes should be increased. In this connection, tourism and leisure activities, options with the borders of Hungary should be promoted, and the related infrastructure (educational trails, jogging paths, hiking trails) should be made and maintained. The elaboration of a climate-friendly tourism trade mark, guidance and the preparation of the guide based on the studying the adaptability of the various types of tourism offer and the results can help the achievement of the intended goals.
- The energy consumption of various events that are also tourism attractions should be reduced; carbon-neutrality should be facilitated.
- It is recommended to elaborate adaptation strategies in the Hungarian tourism destinations most endangered by the effects of climate change (e.g. Lake Balaton, Lake Tisza).

Mid-term action lines

- Elaboration and application of a risk assessment methodology focusing on the climate change in destination management.
- Conduction of studies, examinations, collection of international and Hungarian best practices and the preparation of background materials providing recommendations for the compensation of the negative climatic effects of tourism, in relation to the development of other strategic areas, in the following topics: development and encouragement of public transport related to the transportation of tourists and ensuring the access of attractions; setting up and utilisation of alternative energy systems connecting to attractions, accommodation and catering units, improvement of energy efficiency, canalisation of renewable energy sources.

Long-term action lines

Comprehensive integration of climate change, as boundary condition, into tourism development, by creating climate-friendly and sustainable Hungarian tourism destinations and in consideration of the actual changes in the climate.

6.3.8. Public safety

Researchers, experts and policy-makers have found that the climate change is a national security factor, and may become a dominant factor in the threats to security in the 21st century. Disaster management, as a law enforcement body, tends to the defence duties aiming at the handling of day-to-day emergency situations, responding to new challenges, such as the appearance of the global climate-migration, is however an additional task. In terms of disaster management, it would be practical to specify the detailed duties of climatic adaptation in the National Disaster Management Strategy and its implementation framework, in consideration of the various action lines:

Short-term action lines

- The increasing weather variability of the Carpathian Basin and the direct and indirect effects of the emerging extreme climate make it necessary to enhance the (early) forecasting and monitoring capabilities of governmental bodies, technical and academic organisations must be involved into the research of this topic. In addition, public information must be provided and the people must be prepared and protected.
- In order to handle and suppress the more and more frequent diseases, infections and epidemics, the operational framework for the cooperation between public healthcare, police, internal and national security must be set up.
- Integrated and operational collaboration between civil protection, traffic safety, energy affairs must be created in order to manage and eliminate the mass traffic accidents, national traffic jams, issues in energy supply that occur with extreme weather phenomena (heat waves, storms, snow, sleet).
- Buildings and institutes that are of top significance in terms of national security must be designed in a climate-proof manner and their water supply and energy security must be reinforced.
- It is recommended to make a planned and regular risk assessment of natural hazards in order to create a basis for the preparation of disaster management.
- Intensifying the cooperation with the neighbouring countries must become a priority in the field of joint setting up and harmonisation of defence systems.
- Preparation for global climate migration, for the appearance of masses of refugees leaving back their homeland for climatic reasons, developing of complex governmental, domestic, foreign measures necessary for handing this challenge in terms of political, police and immigration terms.

Mid-term action lines

- Reinforcing the information, capabilities and tools of disaster management, domestic security and home defence in order to efficiently manage the increasing environmental risks and for the appropriate preparation and adaptation.
- Setting up a complex protection (in terms of infrastructure, transport, rural development and home affairs) of settlements, the critical infrastructure, agriculture, forestry, game management and fishery.
- Studying the effects of climate change on the demographic processes of the Carpathian Basin and the occurrence of internal migration.

Long-term action lines

- Comprehensive integration of climate change, as a boundary condition, into national security policies, taking actual changes in the climate also into consideration.
- Preparation for the prevention and fending off of direct or indirect economic, political or even armed attacks launched in order to gain control over natural resources, especially the drinking water and arable land.

6.4- Available funds and measures for stakeholders in adaptation tasks.

Climate change gets special attention during the programming period between 2014 and 2020, since at least 20 percent of assistance from the ESI funds is to be used to this end, according to the rules.

Opera-tional Prog-ramme	Priority axis	Adaptive measure(s)
EEEOP	**Adaptation to the effects of climate change**	• Development of databases and knowledge bases related to water management and the impacts of climate change • Facilitating the social conditions for an efficient adaptation • Improving the conditions for the sustainable management of water resources • Improving resistance against damage caused by water • Improving the conditions of water management in hilly areas, reservoir construction
	Nature protection and ecosystem protection developments	• Habitat development aiming at the improvement of nature protection and the restoration of deteriorated ecosystems • Improving infrastructure conditions for nature protection • Strategic analyses establishing the basis for the long-term preservation and development of natural values of community importance and the attainment of the objectives of the EU Biodiversity Strategy 2020 in Hungary
	Increasing energy efficiency, application of renewable energy	• Awareness-raising programmes

	sources	
TOP	**Business-friendly, population-retaining urban development**	• Urban development aiming at economic stimulation and population retention (family and climate friendly renovation of public spaces, development of the urban green environment, rainwater drainage in municipal areas, awareness-raising)
	Sustainable urban development in cities with country rights	• Urban development aiming at economic stimulation and population retention
CCHOP	**Tourism and nature protection developments**	• Strategic analyses establishing the basis for the long-term preservation and development of natural values of community importance and the attainment of the objectives of the EU Biodiversity Strategy 2020 in Hungary • Habitat development aiming at the improvement of nature protection and the restoration of deteriorated ecosystems

6.3. Table Adaptive measures in the 2014–2020 operational programmes of Hungary

Source: based on 2014-2020 Hungarian operational programmes

Opera-tional Prog-ramme	**RDP action**	**RDP operation/sub-scheme**
RDP	**Fixed asset investment**	• Supporting water retention facilities through ensuring a sustainable management of water resources • Creation of meliorated roads connecting to cultivated areas within the plants • Developing irrigated farming aiming at the improvement of water efficiency • Development of irrigated farming at Young Farmers, melioration interventions • Supports not related to production investments and granted for the fulfilment of objectives related to agriculture & environmental protection, and climate change (water protection investments, • investments aimed at habitation development and non-productive investments)
	Restoration of agricultural production potential damaged by natural disasters and catastrophes and preventive measures	• Supporting investments related to climate change and preventing weather risks
	Investments aimed at developing forest areas and improving the forest vitality	• Creating agroforestry systems • Preventing forest damage to forestry potential • Restoring forest damage to forestry potential • Investments aimed at strengthening the resistance of forest ecosystems and their environmental value • Supporting forestation
	Agro-environmental and climate operations	• Payments to agriculture and environmental protection • Supporting the preservation of genetic resources of plants • Supporting the preservation of genetic resources of animals
	Organic farming	• Organic farming

Opera-tional Prog-ramme	RDP action	RDP operation/sub-scheme
	NATURA 2000 payments and payments related to the Water Framework Directive	• Compensatory payments for forest management on Natura 2000 areas • Compensatory payments provided for Natura 2000 agricultural areas
	Agricultural, environmental and climate protection payments	• Preservation and development of genetic resources of forests • Agricultural, environmental and climate services and nature preservation
	Cooperation	• Supporting joint actions implemented with the aim of climate change mitigation or adaptation thereto or joint approaches of environmental projects and environmental practices applied
	Risk management	• Supporting crop, animal and plant preservation
	Supporting LEADER local developments	• Reinforcing the local economy • Establishing a way of farming that uses natural resources sustainably; improving climate resistance

6.4. Table: Adaptive interventions in the 2014–2020 Hungarian Rural Development Programme
Source: based on the 2014–2020 Rural Development Programme and Széchenyi 2020 RDP Manual

Resources, financial instruments and aiding forms of Hungarian climate protection

The Hungarian climate protection developments have two sources basically. On the one hand, incomes from international quota sales ensure the encouraging of household energy efficiency and building energy investments, on the other hand, Hungarian operational programmes ensure funds for supporting public (state, municipal, church and civil) and private energy efficiency, renewable energy developments from the EU budget. The Hungarian framework and utilisation rules regarding EU funds is laid down by the Partnership Agreement, the fields of each development funded by each Fund are laid down in the operational programmes. The utilisation of incomes from quota sales is governed by Act XCV of 2015[27].

EU funds

In the New Széchenyi Plan, the different policies execute their support policy through the operational programmes, and this is supplemented by the environmental protection and climate protection aids of agricultural and rural development programmes. The fact that prevention and mitigation of climate change effects was not a horizontal criterion during OP planning did significantly reduce the indirect, synergic, climate change-related impact of operational programmes during 2007–13. Identification of adaptation measures did not play any decisive role during planning at that time. Renewable energy and energy efficiency schemes were in turn often over applied for (e.g. priorities 4 and 5 of the EEOP, which required a subsequent reallocation of additional funds from other operational programmes).

[27] Act XCV of 2015 on the amendment of the distribution and targeted utilisation rules of quota incomes accorded to the Hungarian state from the emission trading system

Field of intervention	Place within the OP							Total
	EEEOP I.	EEEOP IV.	EEEOP V.	RDOP II.	RDOP VI.	CCHOP IV.	CCHOP V.	
Water management and drinking water protection				16.2	7.8			24
air quality				4.8	2.36			7.16
biodiversity protection, green infrastructure development		34.33		32.4	15.7	5.38		87.81
climate change adaptation and risk management	757		4.7	8.1	3.94			773.74
Total	**757**	**34.33**	**4.7**	**61.5**	**29.8**	**5.38**	**0**	**892.71**

6.5. Table: Adaptation support in the 2014–2020 Hungarian operational programmes (million EUR)
Source: based on 2014-2020 Hungarian operational programmes

Remark: The table has been prepared on the 2014-2020 Hungarian Operational Programmes and the data of dimension codes for the fields of intervention defined therein. The Annual Development Budget documents might have differences from the amounts given in the table, due to any possible reallocations.

The European Territorial Cooperation (ETC), as one of the objectives of the cohesion policy, provides the framework for the implementation of joint actions and the exchange of policy experiences among the Member States, at national, regional and local levels. The three programme types of the ETC for the 2014-2020 programming period: supporting cross-border, transnational and interregional forms of cooperation. Concerning the involvement of Hungary, seven cross-border, two transnational and four interregional programmes have been elaborated for the programming period. All the cross-border programmes of Hungary include thematic objectives and fields of development that contribute to the implementation of the objectives of the NCCS2, such as: environmental protection, combatting the impacts of climate change, facilitating resource efficiency, facilitating sustainable transport, improving water management, cultural and natural heritage protection, biodiversity and soil protection, shifting towards a low carbon economy. Interregional cooperation programmes are also to be highlighted among the programme types, as they lay special emphasis, besides sharing best practices in innovation and urban development, on the issue of energy efficiency as well.

During the Hungarian presidency, the European Union adopted the *Danube Macroregional Strategy* (Duna Region Strategy), the aim of which is to sustainably develop the macro-region along the river and to protect its natural areas, landscapes and cultural values. Its implementation involves nine EU member states and five countries outside the EU. For the period between 2014 and 2020, the Programme disposes over 202.1 million Euros from the European Regional Development Fund, 19.8 million Euros from the Instrument for Pre-Accession (IPA) and 10 million Euros from the European Neighbourhood Instrument (ENI). The EU funds are supplemented by the national contribution and project-level co-financing of the partner countries, thus the Danube Transnational Programme will have a total budget of approximately 273 million Euros. Out of the 11 priority areas, five may be associated with

the topics set out by the objectives and action lines of the NCCS2 [1) Mobility and intermodality development; 2) Encouraging the use of sustainable energy; 4) Restoration and preservation of water quality; 5) Environmental risk management; 6) Biodiversity and preservation of the landscape, air and soil quality].

Other direct community funds available in the 2014–2020 programming period can be used for innovation and R&D projects, among which it is the Horizon2020 Programme that deals with energy and environmental protection.

The LIFE Programme28, which has supported about 4,300 successful projects since 1992 in order to implement environmental goals set out by the Member States in active cooperation of the public and private sectors, will continue during 2014–2020 as well. For the budgetary period, the European Commission allocates a total of 3.4 billion Euros for tendering so that it can support such new, innovative solutions, research projects and good practices that are exemplary in the implementation of the EU's environmental, nature and climate protection policy and represent added value at an EU level. The total 2016 budget of the Programme was 337.5 million EUR, out of which 273.9 million EUR was granted within the framework of the Sub-Programme of Environmental Protection, and 63.6 million EUR was granted within the framework of the Sub-Programme of Climate Policy.

The actual Agreements on the implementation of European Economic Area (EEA) and Norwegian Financing Mechanisms, allowing for the utilisation of about 40 billion HUF, was signed with the representatives of Norway, Iceland and Liechtenstein in 2011. Norway, Iceland and Liechtenstein provide Hungary with the funds that are available until 2016 under the auspices of solidarity; nearly 97% of the funds are provided by Norway. The agreements pay special attention to environmental cooperation. Besides research & development and capacity building for civil organisations, the largest support (about 12 billion HUF / 44.3 million Euros) can be paid for "green industrial innovation", energy efficiency, combatting climate change and renewable energy. The Adaptation to Climate Change Programme of the EEA was approved on 6 June 2013. The Hungarian Fund Manager of the Programme is the Central and Eastern European Regional Environmental Centre (REC); the budget is 7,010,000 Euros and it is implemented until 30 April 2017. The Programme intends to contribute to climate protection activities that facilitate adaptation to the changes. Its fundamental goal is to deepen the knowledge of the impacts of climate change and any issues emerging in the future, to increase social awareness and to facilitate the presentation of pilot projects capable of mitigating the negative consequences of climate change.

The following tables summarizes the available measures for stakeholders in adaptation tasks and give an overview of expected sectoral vulnerabilities and adaptation measures.

[28] L'Instrument Financier pour l'Environnement (LIFE) - Regulation (EU) No 1293/2013 of the European Parliament and of the Council of 11 December 2013 on the establishment of a Programme for the Environment and Climate Action (LIFE)

Stakeholders	Measures
Governmental organisations	• Appropriate legal framework • Applications and program structure • Institutional background • Empowerment of regulatory and monitoring organisations (authorities, offices)
Local and regional governments	• Local ordinances and financial incentives (e.g. taxes) • Climate friendly settlement organisation and area development • Climate conscious management of municipal companies • Municipal associations
NGOs and churches	• Organisation of local community respecting traditions and local values • Information dissemination, awareness raising • Demonstration of best practices
Households	• Formulation of conscious consumption patterns, purchase of local, sustainable products • Economising with resources • Preparation for expected impacts, learning to apply defense techniques and solutions
Business sector	• Climate conscious revision of business plans and business standards • Accepting and incorporating climate innovative solutions in corporate strategies • Voluntary agreements with local stakeholders for adaptation
Media	• Information dissemination, awareness raising • Advertising best practices and disseminating new sustainable behavioural patterns
Education	• Upbringing and education for climate friendly behaviour • Integration of climate change vulnerability, mitigation, and impact assessment in education • Vocational training

6.5 Table: Available adaptation measures by stakeholders

Vulnerable area	Examples/comments/adaptation measures carried out
Human health	• Vulnerability: temperature waves causing heart and respiratory problems in urbanised areas, appearance of new pests and diseases • Adaptation: preventive measures, healthcare development, formation of air conditioned shelters, vaccination and improved R&D in the field
Water management	• Vulnerability: droughts threatening freshwater supply, floods threatening water defence lines and human settlements • Adaptation: infrastructural developments, improved water management practices, utilisation of rainwater for irrigation
Forestry	• Vulnerability: droughts impairing forest development, extreme weather events causing tree loss, new diseases and pests • Adaptation: new drought-resistant species, improved forest management practices and R&D in the field
Agriculture	• Vulnerability: droughts causing irrigation problems thus hindering agricultural production, floods and inundations causing inland water • Adaptation: land use change, organic agriculture on wetlands, improved defences, improved irrigation and water use
Urban infrastructure	• Vulnerability: heat waves causing heat islands • Adaptation: urban area development, afforestation where possible increasing green cover, better engineering practices
Tourism	• Vulnerability: climate change shortening and shifting tourist seasons • Adaptation: climate friendly tourism
Public safety	• Vulnerability: migration waves, weather related catastrophes (floods, storms, blizzards) • Adaptation: improved civil defences, improved institutional background, preparation measures, preventive measures

6.6.Table: Summary of information on vulnerability and adaptation to climate change

7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Hungary does not belong to the Annex II Parties of the UNFCCC and is fundamentally not obliged to provide financial resources to developing countries, and as a transition economy it is not subject to the acquirement thereof. However as an EU member, Hungary together with the 10 new EU member states (NMS) is committed to contribute to the assistance provided to developing countries in line with the EU internal regulations.

On financial and technology support provided to developing countries, Hungary undergoes the reporting obligation under Article 16 of Regulation (EU) No 525/2013 of the European Parliament and of the Council on mechanism of monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.

7.1. Provision of 'new and additional' resources

Hungary is dedicated to provide financial support to fulfil the commitment of developed countries to jointly mobilize 100 billion USD per year by 2020 from a wide variety of sources, including public and private sources, through bilateral and multilateral channels. This also includes alternative sources of finance, in the context of meaningful mitigation actions and transparency on implementation.

Striving to the mobilization effect of public financial resources Hungary works closely with actors of the national private sector. Planning of green growth activities partly in collaboration with the Global Green Growth Institute will multiply the impact of public financial resources and their effect on the green economy.

The Balkan Regional Trust Fund, a regional financial vehicle which is being developed in collaboration with the Global Green Growth Institute, is to be launched over the course of 2019. The Fund is expected to further mobilize climate finance not only in Hungary but in neighbouring countries and in the Western Balkan region. Once operational, the Fund will serve Balkan countries to implement their Nationally Determined Contributions under the Paris Agreement in forms of bankable projects. Hungary disbursed 80 million HUF (or about 0.27 million EUR) in 2017 for the preparation and design of the Trust Fund.

7.2. Assistance to developing country Parties that are particularly vulnerable to climate change

Assistance to developing country Parties that are particularly vulnerable to climate change is ensured by continuously providing financial support through bilateral channels:

- Indonesia receives tied aid loans from Hungary provided by the Hungarian Export-Import Bank Plc. (EXIM Bank). The loan has to be paid back entirely, it is not concessional. The discount on the interest rate (the aid element) is 5771.2 M

HUF for the duration of the tenor (until the year 2042) – this aid element of the tied aid loan can be specified as Official Development Assistance (ODA).

- Uganda received 1,143,926 EUR for a sustainable tree plantation from the Ministry of National Development, the first half of the grant was disbursed in 2016 and the second half during 2017.
- 653 M HUF is to be further committed and/or disbursed during the course of 2018 for international climate finance. The recipient countries are countries of Africa, South-East Asia and countries of the Western Balkans.

Furthermore, the EIB EU Africa Trust Fund is to receive 2 M EUR in 2017 (after a contribution of 1 M EUR in 2015) from the Hungarian Export-Import Bank Plc. (EXIM Bank).

Further information is provided in the CTF tables.

7.3. Provision of financial resources

Hungary intends to provide climate finance to developing country parties through multilateral and bilateral channels in the coming years. The Hungarian Government pledged 1 billion HUF (or about 3.2 million EUR) for bilateral climate finance at the COP21 in Paris, of this amount about one third (347 million HUF) has already been disbursed for a sustainable forest plantation in Uganda, and the remaining 653 million HUF is going to be committed during the course of 2018. An additional 1 billion HUF was transferred to the Green Climate Fund in 2016. The greatest share of Hungarian international climate finance comes from an adaptation financing project with Indonesia, with over 30 million EUR in tied aid loan annually.

Hungary's public climate finance is expected to remain at a similar level in the coming years, as predicted below.

Table: 7.1. Hungary's climate-related ODA 2016 onwards *(prediction)*

(All amounts in EUR)*	**2016**	**2017****	**2018****
climate-specific (multilat)	3 320 812	3 000 000	3 000 000
climate spec (bilat)	31 963 926	32 000 000	32 000 000
TOTAL climate specific	35 284 738	35 000 000	35 000 000

**Exchange rate: 303,3 HUF/EUR*
***estimates*

- 1 billion HUF contribution to the Green Climate Fund was disbursed in 2016.
- 23,746 EUR from the Ministry of Foreign Affairs was granted to the Central European Initiative – Special Fund for Climate and Environmental Protection.
- IFC received 6 M USD core funding from the Hungarian Export-Import Bank Plc. (EXIM Bank). In the previous years they received: 7 M USD in 2014 and another 6 M USD in 2015.

7.4. Activities related to transfer of technology

Bilateral support provided to developing countries through bilateral channels focuses on sharing Hungarian know-how, expertise and available technologies. Hungary is most active in adaptive water management.

The Ministry of Foreign Affairs and Trade (MFA) organized an expo on water technologies in conjunction with the Budapest Water Summit 2016. Specifically the MFA also established a dedicated Department for Water Diplomacy, Export and the Danube Region Strategy.

Hungary is also supporting the work of the UNFCCC Technology Mechanism, through activities with the Climate Technology Center and Network.

8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1. General policy towards research, systematic observation and their funding

The chapter focuses on recent activities in climate related research, systematic observation and their funding.

One of the most important Hungarian initiatives on climate change was the VAHAVA project carried out by the Hungarian Academy of Sciences (MTA) and the Ministry of Environment and Water between 2003 and 2006. It focused on adaptation and vulnerability.

Using the scientific basis laid out by the VAHAVA project, the Hungarian Parliament adopted the first National Climate Change Strategy (NCCS I) for 2008-2025. The NCCS I was first reviewed in 2013 and later submitted to the Parliament to become the second National Climate Change Strategy for 2014-2025, but because of the anticipated outcomes of the Paris Agreement in 2015 it was withdrawn so that it could be updated in light of the new approach. The newly updated NCCS II for 2017-2030 was published and opened to public consultation in the spring of 2017. It was accepted by the Government and was submitted to the Parliament in May 2017.

One of the specific objectives of NCCS II is creating geoinformational basis for the territorial assessment of climate vulnerability. The aim is to continuously operate a geoinformational data system based on Hungarian research and the results of Earth observation, which is capable of multipurpose use, such as supporting decision preparation and decision making. Additional information on the National Adaptation Geo-information System (NAGiS) can be found in chapter 8.2.3.

It is important to mention the 4th National Environmental Programme (NEP) for 2015-2020. Chapter 6.10. "R&D, eco-innovation and environmental technology" of the 4th NEP sets the main priorities for environment-related research in Hungary. According to the NEP, the most important tasks are to financially support environmental technology, facilitate cooperation to enhance the role of informatics in the field of eco-innovation and to further develop the domestic environmental protection industry. Furthermore, the 4th National Environmental Protection Basic Plan (2015–2019) also includes a chapter on R&D relating to environmental protection and education.

8.1.1. Coordination of research policy

The framework of environmental and climate related research policy is mainly set by the documents mentioned in the introduction of this chapter.

A significant part of all research in Hungary is carried out or coordinated by the Hungarian Academy of Sciences (MTA). In the Academy there are eleven units (scientific sections) responsible for different fields of science. As stated on the Academy's homepage[29] these

[29] http://mta.hu/english/scientific-sections-105963

scientific sections "follow, promote and evaluate all scientific activities conducted within their field of science; take a stand on scientific issues as well as in matters concerning science policy and research organization; submit opinion on the activities of the Academy's research institutes and on those of university chairs and other research units that are supported by the Academy, and participate in the procedure of awarding the title of Doctor of the Hungarian Academy of Sciences". Besides these units there are also specific committees. Regarding climate change, the Scientific Committee on Meteorology –Subcommittee on Climate and the Environmental Sciences Presidential Committee – Subcommittee on Preparation for Climate Change must be noted.

The MTA has a research network[30], which comprises 10 research centres owned by the Academy, 5 independent research institutions and more than 130 research groups.

The most important governmental institute dealing with climate change and the implementation of the NCCSs is the Department for Climate Policy at the Ministry of National Development, which department is responsible for:

(1) Codification:

a. of the national regulation related to climate policy - including the preparation of acts on the implementation of the National Climate Change Strategy, the preparation of acts on the detailed operation of the national adaptation geo-information system -, regulation on the implementation of decarbonization itinerary until 2050;

b. of the regulation related to climate policy on performing community tasks;

c. of the national legislation originated from the international regulation of climate policy - particularly from the Paris Agreement -;

d. of the transposition of any other international contracts, agreements regarding greenhouse gases and professional preparation of climate policy laws in this context with the assistance of the relevant departments of the Ministry.

(2) Coordination:

a. of controlling of the implementation of the Community's climate policy decisions;

b. of preparation of national adaptation strategy, programs and information system; coordinates the tasks related to climate research, adaptation research and the operation of the National Adaptation Geo-information System;

c. of preparation of national, community and international reports based on the international and legal obligations;

d. of the Hungarian participation in the activities and research programs of the EU's institutions related to climate policy;

e. of the implementation of national tasks related to the United Nations

[30] http://mta.hu/english/mtas-research-centres-and-institutes-106085

Framework Convention on Climate Change, particularly tasks related to the flexible mechanisms of the Kyoto Protocol and the Paris Agreement;

f. of the preparation of the medium- and long term greenhouse gas emissions predictions with the assistance of the other ministries;

g. the work of the inter-ministerial working groups on decarbonisation and adaptation;

h. the use of incomes from the sales of greenhouses gas emissions units for adaptation and international climate financing purposes, and the community and international reporting tasks related to the incomes from the sale of all types of units by the Hungarian State;

i. of the NC/BR reporting and reviewing to the UNFCCC;

j. the Hungarian position in relation with the international climate financing;

k. of the preparation of the climate protection measures and climate policy concepts with the assistance of the Hungarian Adaptation Centre and the Hungarian Mining and Geological Service;

l. of reporting tasks related to regulation 525/2013 of the European Parliament and of the Council and Governmental Decree 278/2014. (XI. 14.);

m. delivers an opinion on legal drafts that concerns its competence prepared by other administrative organizations.

(3) Among their international and EU-level tasks:

a. performs the ministerial tasks related to the formation of the community climate policy decisions;

b. performs their tasks related to the EU-Emission Trading System (hereinafter referred to as EU-ETS);

c. Overviews the national operation of the EU-ETS;

d. follows with attention and controls the national implementation of the Community's decisions, legislation;

e. follows with attention the national implementation of the Community's decisions, legislation related to fluorinated gases, the formation, revision and modification of the related legislation;

f. develops and represents the Hungarian position on the EU's comitology work in relation to the climate change (CCC, WGs, in TF and TWG working groups);

g. prepares the national position in relation to the community and international climate policy negotiations and participates in the community and international climate policy negotiations;

h. represents Hungary in the international organizations dealing with climate change (i.a. UNFCCC, Intergovernmental Panel on Climate Change, OECD Climate Policy Working Group);

i. represents Hungary in the international organizations dealing with fluorinated gases (Montreal Protocol);

j. cooperates with the relevant departments of the Ministry for Agriculture during the performance of reporting, regulatory, community-level and international-level tasks under the Vienna Convention and the Montreal Protocol;

k. cooperates with the relevant departments of the Ministry for Agriculture in the harmonization of the regulation of air-protection and greenhouse gases and the related negotiations;

(4) National tasks:

a. follows up the efficiency of the national emission reduction measures based on the National Climate Change Strategy;

b. participates in the preparation of national regulation related to carbon leakage, derogation, ESD, LULUCF and other aspects of climate policy;

c. develops the harmonization of the sectors of effort-sharing decision to the carbon trading system in cooperation with the relevant ministries;

d. participates in planning, selection of tenders and controlling in relation with the Climate-policy Subprogram for the 2014-2020 financial period based on the Regulation of the European Parliament and of the Council on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation No 614/2007. The Department for Climate Policy performs national contact tasks and the representation in the permanent committee meetings related to the Climate-policy Subprogram.

e. prepares the regulation on the monitoring, verification, reporting and accreditation in relation with the EU emission-trading system;

f. prepares and makes comments on the contracts, supports provided and tenders in relation with climate policy.

(5) Functional tasks:

a. performs the national, community-level and international tasks related to climate policy in cooperation with the Department of Green Economy Development;

b. performs the reporting related to the community-level and international account of emission units on behalf of the Hungarian State;

c. prepares the National Climate Change Strategy, the related climate policy programs and coordinates the implementation of these documents and the implementing laws;

d. performs the inspection of the National Climate Change Strategy, the yearly control of the implementation of the Strategy and prepares the report on the implementation of the Strategy;

e. follows the operation of the international transaction registry and the community transaction registry;

f. watches the services of the online market systems related to climate policy and the national , community-level and international researches;

g. develops the national legal bases of the international flexible mechanisms;

h. performs the carbon market models related to sectors covered by the effort-sharing decision in cooperation with the relevant ministries;

i. cooperates with the National Climate-protection Authority during the performance of its legislative tasks.

(6) Other tasks:

a. participates in the work of the Ministry for Agriculture in developing the greenhouse gas inventory and forwarding it to the Secretary of the UN Framework Convention on Climate Change;

b. performs the reporting duties covered by the 278/2014. (XI. 14.) Governmental Decree in cooperation with the relevant ministries.

8.1.2. Funding

Funding for climate change research in Hungary mainly stems from European Union sources and the National Research, Development and Innovation Fund (NRDI Fund). There are relatively limited funds available from other national and international sources.

International programmes
In the EU Horizon 2020 Climate Change Programme 29 Hungarian organizations participate in EU-wide collaborative research projects receiving 6 million EUR funding. In bilateral scientific and technological cooperation programmes funded by the NRDI Fund, research focusing on different aspects of climate change is also supported (among others in bilateral S&T programmes with China, India, Portugal, Slovenia and Morocco).

As another example of direct EU funding, Hungary has an innovative project supported by the NER300 programme under the EU Emission Trading System (EU ETS). This project aims for building a demonstration plant of the technology called enhanced efficiency geothermal system (EGS).

Hungarian framework

The source of RDI funds in Hungary are the European Union operative programmes and the National Research, Development and Innovation Fund. A coherent portfolio of competitive calls was implemented in 2015 by the National Research Development and Innovation Office (hereinafter NRDI Office) to foster research, development and innovation (RDI) in Hungary and to support scientific research projects, corporate development as well as the realisation of innovative ideas. The total funding available for research, development and innovation until 2020 is 1 200 billion HUF, provided from both EU and domestic sources in the

framework of calls announced in cooperation with the NRDI Office. Both programme portfolios allow submitting proposals in the area of climate change. The programme portfolios are in line with the principles of the National Smart Specialisation Strategy (S3) where sustainable environment, natural resource management, advanced environmental technologies are present as a priority.

R&D&I and climate change projects in 2015-17

The timing and the budget of European-financed non-refundable and refundable RDI schemes under the EDIOP (GINOP) and CCHOP (VEKOP) programmes have been approved by the Government within the Annual Development Framework Programme based on the proposal of the NRDI Office. The calls for proposals of EDIOP programmes are related to the target areas of corporate/business RDI activities, knowledge transfer and research infrastructure. In the period of 2015 – 2017 there were 14 proposals of EDIOP funded with a budget of 11,6 billion HUF.

The budget of NRDI Fund has grown significantly every year and the budget for 2017 exceeds 90 billion HUF (295 million EUR).The calls for proposals are available in the field of corporate/business RDI activities, knowledge transfer between industries and the academia/universities, and international RDI cooperation. From the budget of this fund 23 SMEs and non-profit organisations were supported with a budget of 3,06 billion HUF.

In the table below, you may find the funds granted by the NRDI Fund for the areas related to the climate change programme.

Topic	No. of contract	Subsidy granted	Total accepted costs	Contracted amount	Actual payments
Climate change	37	2134,491	2406,601	2102,91	466,507
Renewables	6	568,225	811,755	568,225	149,26
Sustainable and livable environment	12	435,006	628,896	435,006	200,689
Greenhouse gas emissions	7	735,356	1299,216	735,356	416,415

Table 8.1. Distribution of the NRDI Fund granted by areas of applications (in million HUF) (2015-2017)

8.2. Specific research activities

8.2.1. Main institutions involved in climate change research in Hungary

Research related to climate change is carried out at various institutions across Hungary. These include the Hungarian Academy of Sciences (MTA), university and college

departments, dedicated state institutions such as the Hungarian Meteorological Service, as well as NGOs and private consultancies and think tanks.

Besides its role in coordinating and initiating research activities, the MTA also carries out research through its own institutes as well as through joint research groups attached to Hungarian universities and other scientific institutions. See Annex I for the list of specific research activities by the MTA related to climate change.

The most important specialist institution involved in climate change research is the Hungarian Meteorological Service (OMSZ). Its research focuses on regional climate modelling and it also plays an important role in systematic climate observation.

Some smaller state-funded institutions also contribute to climate change-related research, in particular the National Institute for Environmental Health, the Hungarian Forest Research Institute and the Mining and Geological Survey of Hungary.

Regarding research in Hungarian higher education institutions, one important research project is "AGRICLIMA 2" (Agrárklíma 2), which focuses on the vulnerability of certain agricultural sectors. The aim is to create a scientific background to support decision making and to prepare the foundation for establishing an Agri-Climate Center. The project takes into account the long term effects of agricultural management in relation to sustainability, natural resources and ecosystem services, energy and carbon balance and climate. The following institutions are involved: Szent István University – Faculty of Agricultural and Environmental Sciences, University of Sopron – Faculty of Forestry and Lámfalussy Sándor Faculty of Economics, Eötvös Loránd University – Faculty of Natural Sciences. The project's planned duration is 1 October 2014 – 30 September 2018.

At Szent István University – Faculty of Agricultural and Environmental Sciences researches are also being made concerning the greenhouse gas balance of ecosystems (duration: 2012-2017) and the drought risk in the Danube Region (duration 2017 – 2019). In addition, at the Faculty of Landscape Architecture climate change related researches, such as heat-island analysis, green cover intensity analysis, climate of cities, human health risks, rainwater retention with landscape architecture tools and the adaptation of tree vitality to urban climate are carried out.

The Budapest University of Technology and Economics has a heavy emphasis on technical education. At the Faculty of Chemical Technology and Biotechnology the relevant researches are the following: CO_2 capture of biogas and industrial exhaust gases (duration: 2015-2018), the creation of WO_3/semiconductor oxide nanocomposites with photocatalytic and gas sensory attributes (duration: 2013 – 2017), the development of environmental friendly processes for the efficient use of renewable energy and raw material sources and for the controlled release of their energy content, design of new types of small platinum content and increased lifecycle electrocatalysts for proton-exchange membrane fuel cells (duration: 2017-2021) and photocatalytically active hollow-structured semiconductor oxides for environmental applications (duration: 2017-2021).

A particularly strong research focus on climate change can be found at the Department of Meteorology of Eötvös Loránd University in Budapest. Being the only university in Hungary to

offer a master's degree programme in meteorology, they are involved in several national and international research projects related to climate change and jointly run observation activities at Hegyhátsál meteorological station together with the Hungarian Meteorological Service. In addition to the previously mentioned AGRICLIMA 2 project, two other recent projects are notable. One is RCMGiS (RCMtér) - New climate scenarios based on the change in radiative forcing over the Carpathian Basin, which were supported by the EEA Grant Fund and where the outcomes were fed into NAGiS (duration: 2014-2016). The second is the "AgroMo" joint project of MTA and ELTE, where the objective was to create an interdisciplinary research group for sustainable and climate-adaptive agriculture. The main objectives of the project are to achieve progress in the development of Integrated Assessment Model Systems and to support decision making. This support system will be able to manage the specific climatic and soil conditions of the Carpathian Basin and can project the effects of changing environmental conditions on the agriculture sector, on farm and national economy level (duration: 2017-2021).

Another research institution is the Centre for Climate Change and Sustainable Energy Policy (3CSEP) at Central European University (CEU), an American-Hungarian international graduate university in Budapest. 3CSEP was inaugurated in early 2008 to bundle and strengthen research activities related to climate change and energy within CEU. However, even before the creation of 3CSEP several major research projects related to climate change had been carried out at CEU.

The Regional Environmental Centre for Central and Eastern Europe (REC) is an international body headquartered in Szentendre, Hungary. It is running a number of programmes related to climate change and other environmental issues for the countries of the Central and Eastern European region. Besides developing its own programmes, it is also participating in numerous projects funded by the European Union and the European Economic Area Grant Fund (EEA Grants).

8.2.2. Hungary's contribution to the Intergovernmental Panel on Climate Change (IPCC)

The Hungarian Government aims to encourage scientists from Hungary to participate in as many IPCC activities as possible. In October 2015, Diána Ürge-Vorsatz, Director for Center for Climate Change and Sustainable Energy Policy at the Central European University, was elected as the co-chair of Working Group III (mitigation of climate change). This member from Hungary in the IPCC Bureau is committed to represent the interests of scientists from the Central-Eastern European region as Hungary generally believes that it is crucial to have adequate representation from the region in the work of the IPCC. We are continuously encouraging scientists to take part in the preparation of various reports and Hungary submitted several nominations. As a result of that several scientists from Hungary are contributing to the work of the IPCC.

To further strengthen Hungary's involvement in the work of the IPCC and to make sure that the latest scientific findings are fed back into the national climate change policy-making, an informal National IPCC Committee (NIC) has been set up. As of December 2017, the NIC

group consists of around 30 experts, mostly university lecturers and researchers, with backgrounds in natural and social sciences. The above mentioned committee is continuously informed and updated of the latest activities of the IPCC as well as questionnaires or other relevant materials issued by the IPCC. The National Focal Point of the IPCC is dr. Barbara Botos, the Head of Department of the Climate Policy Department at the Ministry of National Development.

The publications of the IPCC are officially translated only into the six official languages of the United Nations. However the Hungarian Government finds it important that up to date information regarding climate change reaches the Hungarian general public, therefore, the Climate Policy Department translated the Summary for Policymakers of the AR5 Synthesis Report into Hungarian. This was publicized in the media, highlighting the importance of climate change.

In addition, the Hungarian Government is supporting the work of the IPCC through a voluntary financial contribution to the international body as of 2017.

8.2.3. Specific research activities in Hungary

In December 2012, the Parliament amended Act LX. 2007 on the implementation framework for the United Nations Framework Convention on Climate Change and its Kyoto Protocol and defined new criteria in point of the implementation and supervision of the National Climate Change Strategy.

According to the regulated decree in the course of verification and reformation of NCCS-1 and the implementation of the second National Climate Change Strategy (NCCS-2) mitigation, adaptation and raising awareness measures must be emphasized. In order to support the mitigation strategy framework the law prescribes the establishment of the National Adaptation Geo-information System and the results of regional and sectoral climate vulnerability researches must be introduced in the climate policy strategy planning.

In 2013 the Mining and Geological Survey of Hungary (MBFSZ; former Geological and Geophysical Institute of Hungary) was awarded a grant of the European Economic Area Grant Fund for establishing the NAGiS. The EEA-C11-1 Project is one of the main elements of the EEA Grants funded Adaptation to Climate Change programme area. The fund operator for this programme is the Regional Environmental Centre for Central and Eastern Europe (REC), and the donor partner is the Norwegian Directorate for Civil Protection and Emergency Planning (DSB).

The Establishing the NAGiS Project lasted from 24 September 2013 until 30 April 2016. The promoter of the NAGiS project was the MBFSZ. The National Adaptation Centre Department (NAC), a unit of the Survey was responsible for the implementation process in cooperation with the Climate Policy Department in the Ministry of National Development.

The three main objectives of the NAGiS Project were:

- To support decision-making on the adaptation to climate change by setting-up and operating of a multifunctional, user-friendly geo-information database based on processed data derived from several other databases.
- Develop the methodology for data collection, processing practices, analytical processes and climate modelling related to the impact and vulnerability assessment of climate change and corresponding adaptation methods in line with INSPIRE requirements, accommodating to the Hungarian National Spatial Data Infrastructure.
- Operate a web-based "one-stop-shop", an information hub for all stakeholders concerned to obtain reliable, objective information, derived and processed data on climate change and other relevant policy areas.

Elements of NAGiS

The NAGiS database should not be thought of as a single database, but much more as a geo-information system that is built up of several underlying databases in the background.

NAGiS has three different user interfaces: a map view, a database interface and the basic portal. The main parts of the portal system are the following:

- *Map-visualization system*
  It has a resolution of 10×10 km, containing 650 layers which show the way different aspects of climate change can affect certain areas of the country.
  The map-based portal displays the map layers of the project at the https://map.mfgi.hu/nater/ address.
- *GeoDat*
  This is a database containing the calculation results based on modelling (exposure, sensitivity, expected impact, adaptive capacity and vulnerability – 910 data layers)
- *Meta-database*
  A sort of 'data-map' about what to find and where.
- *Nagis.hu portal*
  A basic, traditional web portal available at the http://nagis.hu or the http://mfgi.hu/nater addresses for entering the portal system.

Adaptation to Climate Change Programme Partner Projects

The NAGiS Project was pioneering in linking numerous Hungarian institutes doing research in the field of climate change. The research expert teams of diverse fields carried out a lively dialogue and formed methodologies and visualization of NAGiS together. The MBFSZ, the project promoter involved several state operated institutes as subcontractors or as partners. Workshops, conferences, discussions were effective tools of cooperation. This cooperation can be judged as one of the most important outcomes of the project in itself.

The Hungarian Academy of Sciences – Centre for Ecological Research was responsible for research on the vulnerability of natural habitats. The Hungarian Meteorological Service provided climate databases and modelling results. The General Water Directorate and the

Danube Regional Waterworks as professional partners provided data for the investigation of the vulnerability assessment of drinking water bases.

Data layers of NAGiS were elaborated by MBFSZ and the following partner projects funded by the Adaptation to Climate Change programme of EEA Grants:

Project	Project promoter	Project partner(s)	Website
EEA-C12-11, Long-term socio-economic forecasting for Hungary	Hungarian Academy of Sciences, Centre for Economic and Regional Studies (MTA KRTK)		http://nater.rkk.hu
EEA-C12-12, Extension of NAGiS to the agri-sector (AGRAGiS)	Hungarian Academy of Sciences – Centre for Agricultural Research	• Research Institute of Agricultural Economics • National Agricultural Research and Innovation Centre • Hungarian Academy of Sciences – Centre for Ecological Research	http://agrater.hu
EEA-C12-13, Vulnerability and Impact Studies on Tourism and Critical Infrastructure (CRIGiS)	Hungarian Meteorological Service	• National Center of Environmental Health • National Directorate General for Disaster Management • University of Szeged	http://www.met.hu/KRITeR/hu/kezdo/index.php
EEA-C13-10, New climate change scenarios for the Carpathian-basin region based on changes of radiation balance (RCMGiS)	Hungarian Meteorological Service	• Eötvös Loránd University, Department of Meteorology	http://www.met.hu/RCMTeR/hu/kezdo/index.php

Table 8.2. Partner projects funded by the Adaptation to Climate Change programme of EEA Grants

Application of the NAGiS results

NAGiS may directly support the implementation, supervision and evaluation of the second National Climate Change Strategy, the implementation and evaluation of the Environment and Energy Operative Programme (EEEOP), and the local and regional strategic planning.

The NCCS-2 scheme includes the vulnerability assessment results of NAGiS and its partner projects (sanitation vulnerability caused by heatwaves, vulnerability of arable farming, forests, natural habitats, drinking water supply and threat of climate change induced flash floods in hilly regions) .

The county climate strategies were elaborated based on a methodology guideline from the database and maps of NAGiS in order to have a standardized adaptation status analysis and to use scientific results. Based on the guideline the county planners got help related to vulnerability of drinking water supply, flash flood danger, drought, vulnerability of natural habitats and forests.

Further development of NAGiS

The further development of NAGiS (NAGiS-2) started in November 2016, and the expected completion is in December 2018. The MBFSZ was granted 400 million HUF from measure

1.1.0 of the 'Adaptation to climate change' priority axis of the Environmental and Energy Efficiency Operative Programme (EEEOP). The NAC is responsible for the development of the NAGiS-2 in cooperation with the Climate Policy Department in the Ministry of National Development. By improving the NAGiS-2 the aim is to elaborate a decision support toolbox for underpinning policy and municipal adaptation measures, based on the development of the databases, methodologies and evaluation modules. The expected results will help substantiating climate policy and sectoral planning, the elaboration of policy decision-support studies, settlement and regional municipal climate protection strategic planning; provide professional foundation for setting adaptation goals. Besides these, the results may contribute to the dissemination of knowledge on climate adaptation, and raising climate awareness.

Work packages of the NAGiS-2

a) Sectoral and climate policy planning, decision-making tools

In order to support sectoral and climate policy planning, decision-making, the NAGiS-2 will clarify the information on vulnerable sectors and affected parties, furthermore, ameliorate climate change impact assessment planning and evaluation methodologies.
The land use modelling methodology of the system will be developed and tested in a pilot area. The project includes underpinning and the assessment of climate adaptation tasks of agriculture, tourism and several critical infrastructure elements. A new addition to the system will be the elaboration of a method for the assessment of geological risk sources with regard to the climate change aspect and interpretation of results.

Assessments regarding water will be pronounced during the NAGiS-2 too, as it is one of the most climate impacted natural and economic resources. Extension of the results of climate models to the Danube River Basin, integration of hydrological model results into the system will be done to support the assessment of the vulnerability of surface waters. The climate vulnerability assessment of drinking water supply services and the investigation of direct and indirect impacts of climate change on shallow groundwaters will be continued. Flooding assessment and hydrological modelling of urban areas will be done within the framework of a pilot project for underpinning water management adaptation measures. The results of these will be used for the elaboration of a handbook for settlements on climate resilient water management of urban areas.

b) Government's and county's municipalities' climate policy planning

To support the government's and county municipalities' climate policy planning new tools will be elaborated and new information technology modules will be created. Such modules will be the Settlement Adaptation Barometer Module, the Adaptation Decision Support Module for Municipalities and the Online Adaptation Management Information System. In connection with these, an online calculator for settlements will be developed for the assessment of climate vulnerability of buildings.

c) Comprehensive, horizontal tools for social policy and economic development

Development of comprehensive, horizontal tools for social policy and economic development will cover the assessment of impacts of climate change on human health, presenting climate

change impact on migration trends within Hungary, and on the country's labour market processes.

d) Development of policy support system, dissemination and trainings

The goal is to create a geo-information and policy support system, which is as user friendly as possible. Therefore, dissemination of the information on new modules and on other results; spectacular and easy-to-use interfaces; trainings and education material development on new modules are important parts of the project too.

In order to manage all these developments it is essential to modernize the information technology system, increase information security level, build electronic accesses and protocols, and modernize geo-information methodological tools and digital map visualization. Therefore, the project includes the development of the hardware and software system too.

8.3. Systematic observation

The bulk of observation activities are still carried out by the Hungarian Meteorological Service (OMSZ) and the Department of Meteorology at Eötvös Loránd University (ELTE).

The Hungarian Meteorological Service is a central budget institution; being the national meteorological service of Hungary it is responsible for supplying meteorological, atmospheric environmental and climate information, and for the provision of warnings about severe weather situations in Hungary.

Eötvös Loránd University, with over 25,000 students, is one of the major universities in Hungary. MSc degree in meteorology can exclusively be obtained at ELTE. The main research activities at the Department of Meteorology include the dynamical modelling of atmospheric processes, downscaling of global climate change projections, analysis of climatological extremes, estimation of regional climate change, monitoring and modelling of regional carbon balance, greenhouse gas concentration measurements, air pollution modelling, and soil-vegetation-atmosphere transfer modelling.

Besides short-range, medium-range, and monthly weather forecasts, OMSZ provides climate projections into future with the help of two regional climate models which were adopted by the Hungarian Meteorological Service: the ALADIN-Climate model developed by Météo-France; and the REMO model developed by the Max Planck Institute for Meteorology in Hamburg. Other two regional climate models were adopted by ELTE: the RegCM model originally available from ICTP (International Centre for Theoretical Physics), and the PRECIS model developed by the UK MetOffice Hadley Centre.

The results of the projections have been applied in many national and international projects, such as the National Adaptation Geo-information System (NAGiS) project in which climate model results of OMSZ and ELTE were utilised for impact studies of hydrology, agriculture, tourism and critical infrastructure. The OMSZ is also the owner of the national climate database, and thus has participated in relevant projects such as the DMCSEE (Drought Management Centre for South-eastern Europe) project, which aimed at preparing regional drought monitoring, analysis, and early warning products. ELTE developed and disseminated

the so-called FORESEE database [31] which is an observation based climatological dataset combined with bias corrected climate scenarios covering the period of 1951-2100. In FORESEE 10 different climate model results are available to estimate uncertainty in the future projections. FORESEE is being used in different climate change related impact studies in Central Europe and is freely available to the scientific community and for decision makers

The activity of OMSZ is based on the extended national and international infrastructures including the observational network over Hungary, the running of telecommunication and informatics system for obtaining all the meteorological data from the Global Telecommunication System of the World Meteorological Organization and the intensive co-operations with various international organizations on the research, development and operative activities.

OMSZ also operates the national Air Quality Reference Centre (AQRC), which carries out field and laboratory calibrations of gas analyses of the Hungarian air quality network. Besides, it is responsible for the operation of the background air pollution monitoring stations, data submission for international organizations (WMO, EMEP), examination of the trace element concentration and their transport, air pollution transport modelling on different time and spatial scales, and expert reports for the national authorities.

8.3.1. Atmospheric observation

Hungary's most important observation site for atmospheric constituents is the Hegyhátsál meteorological station[32,] which is jointly operated by scientists from OMSZ and ELTE. Established in 1993, it was among the first European tall-tower stations to take up continuous observation of greenhouse gas concentrations from different levels of its tower (at heights of 10 m, 48 m, 82 m, 115 m) and has produced an invaluable time-series of measurement data since then. At Hegyhátsál monitoring of surface-atmosphere exchange of carbon dioxide was started in 1997 using the eddy covariance technique. Most recently the infrastructure was extended to enable monitoring of nitrous oxide emission of the surrounding agricultural region.

Apart from observation activities at Hegyhátsál, OMSZ was granted funding from the National Office for Research and Technology to establish a dedicated network of measuring stations for very precise tracking of the effects of global climate change on Hungary. These stations were being set up between 2006 and 2009 and are designed to be precise enough to make long-term coherent climate change observation possible.

In the field of satellite observation, it has been an important step for Hungary to become a full member of EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, in October 2008.

[31] http://nimbus.elte.hu/FORESEE

[32] http://nimbus.elte.hu/hhs/

8.3.2. Terrestrial observation and carbon balance

Hungarian institutions have participated in several international research efforts on terrestrial carbon balance (and greenhouse gas balance in general) in last couple of years.

ELTE and OMSZ jointly participated in the AEROCARB (2000-2002) and CHIOTTO (2002-2005) FP5 projects. The aim of the projects was to develop the existing infrastructure at the Hegyhátsál tall tower site, and to establish airborne measurements.

The Department of Meteorology of ELTE as well as Szent István University of Gödöllő were partners in the "CarboEurope-IP"[33] project which ran from 2004 until 2008. CarboEurope-IP was a huge European project with almost 100 partners that worked together on an Assessment of the European Terrestrial Carbon Balance. Goals of the project were to advance the understanding of the role of the European continent in the global carbon cycle and to significantly enhance the understanding of and the methodologies for the observation, quantification and prediction of the terrestrial carbon cycle of Europe. Key research products of CarboEurope-IP included improved quantitative estimates of the European carbon balance and new technologies to help reduce the associated uncertainties.

OMSZ and ELTE were also involved in the European project called "Carbon-Pro" (Carbon balance drafting and new resources management tools according to Kyoto Protocol) in 2006/2007. Its overall objective was to assess the characteristics of the main agricultural and forest systems in the CADSES area (Central Adriatic, Danubian and South-eastern European Space) in relationship to the strategies set up by the Kyoto Protocol for agricultural and forest systems and to evaluate their sink capacity.

More recently OMSZ and ELTE participated in IMECC EU FP6[34] (2007-2011) and InGOS EU FP7[35] (2011-2015) projects. Both projects focus on the monitoring of non-CO_2 greenhouse gases less studied formerly (e.g. methane, nitrous oxide, sulfur hexafluoride, etc.). The projects include near-real-time data reporting and support the pan-European greenhouse gas monitoring network of the European Union (ICOS – Integrated Carbon Observation System36) fully operational from 2015. Participation of Hungary in ICOS has been waiting for government approval since the preparatory phase of the network.

As subcontractor ELTE and OMSZ participated in the GHG-Europe project (run from 2010 to 2013) which was the continuation of the CarboEurope-IP projects and focused on the overall greenhouse gas budget of Europe.

Through OMSZ and the University of Pannonia, Hungary participated in COST Action 725 on Establishing a European Phenological Data Platform for Climatological Applications. The main objective of the project was to establish a European reference data set of phenological observations to be used for climatological purposes, especially climate monitoring and detection of changes.

[33] http://www.carboeurope.org/

[34] http://imecc.ipsl.jussieu.fr/index.html

[35] http://www.ingos-infrastructure.eu/

[36] https://www.icos-ri.eu

The NEESPI Regional Focus Research Centre at the University of Sopron (formerly: University of West Hungary) is likely to also contribute to terrestrial observation activities in Hungary in the future as the NEESPI initiative is focusing on the ability to measure, monitor and model processes that will provide accurate future projections of climatic and environmental changes in the Northern Eurasian region.

8.3.3. Additional related international activities

Since the 1990s, the Hungarian Meteorological Service has been providing daily data to the WMO-GAW program:

- World Data Centre for Greenhouse Gases (WDCGG): continuous tall-tower observation of greenhouse gas concentrations (CO_2, methane) from different levels (at heights of 10 m, 48 m, 82 m, 115m).
- World Data Centre for Reactive Gases (WDCRG): daily mean concentration of tropospheric ozone, nitrogen-dioxide and sulphur-dioxide from its background monitoring station.

The ISCD01 HABP climate BUFR bulletin contains 5 stations operated by the Hungarian Meteorological Service. CLIMAT messages are transmitted to Vienna (LOWM RTH) to the WMO-WIGOS (GCOS Surface Network) database. Climate analyses are regularly provided to the World Climate Data and Monitoring Programme – WCDMP.

The Hungarian Meteorological Service takes part in COST Action ES1207: A EUropean BREWer NETwork - EUBREWNET (2013-2017). This project currently involves appr. 20 European Brewer spectrophotometers. The experimental measurement network aims at detailed, quasi real-time investigation of Brewer spectrophotometers according to uniform criteria to further increase the reliability and uniform interpretation of the measurements.

OMSZ also provides daily support of measured daily total ozone value to both GAW / GO3OS centres: Atmospheric Physics Laboratory of Aristotle University, Thessaloniki and to World Ozone and UV Data Center, Downsview, Canada. Furthermore, monthly support is given of coded data file, including daily averages of measured total ozone and sulphur-dioxide, to World Ozone and UV Data Center, Downsview, Canada.

With the leadership of OMSZ the daily gridded climatological database was prepared in the Carpathian region in the frame of the CarpatClim project sponsored by the Joint Research Centre of the European Commission. The final outcome of the project is a 0.1° (about 10 × 10 km) spatial resolution homogenized and gridded dataset on daily scale for basic meteorological variables and several climate indicators, 37 in total, on different time scales from 1961 to 2010. Dataset is publicly available on the project homepage: http://www.carpatclim-eu.org

In regard to the support for developing countries to establish and maintain observing systems and related data, OMSZ has taken the following actions:

Six Turkish experts visited OMSZ in 2015 to study the methods of official air quality measurements.

In the framework of the "ICT technologies and observational requirements for SEE-MHEWS-A project", the Hungarian Meteorological Service shares the experiences on its observation network and visualization of its forecasting products with developing countries taking part in the project.

In the framework of the bilateral agreement between the Hungarian Meteorological Service and the Ukrainian Hydrometeorological Center, OMSZ shares experiences in the field of air pollution measurements, meteorology and forecasting services. There is free observational data exchange on the catchment area of Tisza river.

With 4% of its yearly WMO membership fee, Hungary supports developing countries. With this part of the membership fees, WMO supports education, water resource management, flood and disaster recovery and agricultural implementation, mainly in African and Asian countries.

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. General policy towards education, training and public awareness

The National Environmental Protection Programme defines the comprehensive framework of the environmental policy objectives and actions of Hungary. The fourth NEPP[37] identifies the environmental objectives, tasks and instruments required for their achievement in the period between 2015 and 2020. It is consistent with the 7th Environmental Action Plan of the European Union, stretching until 2020, and the National Framework Strategy on Sustainable Development, adopted by the Hungarian Parliament. Its comprehensive goal is to contribute to the assurance of environmental conditions of sustainable development.

The specified objectives are the following:

- Improving the quality of life and the environmental conditions of human health.
- Protection and sustainable use of natural values and resources.
- Improving resource saving and resource-efficiency, greening the economy.

The Hungarian Parliament adopted the Act LX of 2007 on the implementation framework of the UNFCCC and the Kyoto Protocol. The Act required the Hungarian Parliament to provide a National Climate Change Strategy and to revise it at specified intervals. The first National Climate Change Strategy was adopted by the Parliament Decree No. 29 of 2008 (III. 20.). As mentioned earlier, the NCCS was first reviewed in 2013 and little later submitted to the Parliament to become the second National Climate Change Strategy for 2014-2025, but close to the upcoming Paris Agreement in 2015 it was withdrawn so as to be updated again in light of the new approach set out in the final Agreement. The newly updated NCCS II for 2017-2030 was published and opened to public consultation in the spring of 2017. It was accepted by the Government and submitted to the Parliament in May 2017.

Beside the Low Carbon Development Strategy and the National Adaptation Strategy, the NCCS II contains a "Partnership for Climate" Awareness-Raising Plan too. The aim of climate change related awareness-raising is to integrate climate awareness and sustainability into the planning process, decision-making and actions on all levels of society.

NCCS II states that the issues of sustainability are of particular significance in the awareness-raising through education. Information that draws attention and teaches conscious thinking of sustainable development should be incorporated into the curriculum. Being committed to environmental protection, future professionals will have to implement ideas that consider the effects of their actions on the environment. Therefore, it defines the following actions:

37 https://eionet.kormany.hu/admin/download/5/64/b0000/NKP4_tervezet_K%C3%96ZIG_TS_i_Egyeztet%C3%A9s.pdf

Short-term action lines

- Climate change information must be integrated into the public and higher education. Special attention must be paid to the presentation of the economic and social side of the human made ecological crisis, in which the approach of ecosystem-services can be an important communication tool. The presentation of actions related to the mitigation of climate change and adaptation to climate change, and the related exemplary behaviour of educational institutes must be made an integral part of the educational work.
- The approach of sustainability should be integrated into preschool and school work.**38**[39] It is especially important that science, technology and sustainability have a complex interconnection within the training and education. Students and pupils should look for answers of real problems. Primary schools should be encouraged in the first place to participate in forest schools where direct practical examples can be acquired of conscious and thrifty lifeforms.
- In order to enforce the aspects of sustainability in education, the framework curricula and all their subjects need to be revised and continuously updated, so that the schools can respond with reality-based learning material to actual issues.
- Information on climate change, sustainability and awareness-raising methodology, new procedures of learning-methodology must be made an important part of teacher-training, paying special attention to the acquisition of "green" competences.
- Further reinforcement of awareness-raising about climate change and sustainability in higher education and vocational training, incorporation of programme-specific methodological elements into the training and activities aimed at their application, encouraging the spreading of good solutions.
- All these tools can be used efficiently if their implementation is supported by the coordinated support system of governmental actions.40
- Cost-efficient implementation requires the involvement of private resources, and other non-public resources, which is already urged by the international community.
- Educational institutions should be encouraged to go beyond the general issues of climate change, and to show locally relevant knowledge, issues, and possible solutions to the students. They should be involved in local nature and climate protection activities.

[38]Preschools that have been given the title "Green Preschool" do an exemplary work in the field of pedagogy about sustainability, numerous good practices can be found in schools with the title "Eco-school". Forest schools and preschools provide changes of various real learning situations.

[39]The fundamentals of the National Environmental Education Strategy provide a good basis for this. http://mkne.hu/projektek.php?projekt=9

[40]The below measure of the ombudsman of fundamental rights, published in the below report "Environmental consciousness is the basis of justice between generations" (AJB-676/2013.) also emphasizes this.

Mid-term action lines

- The inland and international experience acquisition of teachers and teacher-students must be facilitated, so that they can apply the good practices in the education of sustainability in their future work.

Long-term action lines

- Comprehensive integration of climate change, as a boundary condition, into education policy, taking actual changes in the climate also into consideration and under the requirement that the approach of sustainability must be made a basic value on all levels of education (including non-formal and informal learning as well).

9.2. Primary and secondary education

The system of Climate Change education in primary and secondary schools has not changed significantly since NC6 and is still embedded into some of the 10 integrated topics as a cross-cutting issue in the National Base Curriculum. However, Climate Change education – apart from the official educational programme - appears in many other school activities.

The 'Hungarian Ecoschool Network'[41] – already introduced in NC4, NC5 and NC6 - still continues to recruit schools to adopt the principles of sustainability within their educational programmes and throughout their other activities. Currently, the network is operating with approximately 1000 member schools nationwide. Since 2017 the network is coordinated - in strong cooperation - by the Ministry of Human Resources and the Hungarian Institute for Educational Research and Development[42] of the Eszterházy Károly University (Hungarian acronym: EKE OFI). EKE OFI carries out research, development and innovation activities and provides related services to enhance the development of education in Hungary.

EKE OFI is also responsible for the coordination of the 'Green Kindergarten Network'[43], which is financed by domestic funds and the Swiss-Hungarian Cooperation Programme (SH/4/5 project) and contains more than 900 kindergarten members. The extension of the Green Kindergarten and the Ecoschool networks – within the framework of the successful SH/4/5 project, mentioned above – aimed to maintain 540 'eternal' green kindergartens and ecoschools, to have 99000 new pupils in green public institutions, to organise 30 trainings for teachers and to elaborate 20 new teaching materials between 2012 and 2016. 'Forest Nursery Schools' and 'Forest Schools' are educational institutions that provide special environmental and sustainable lifestyle education to their pupils. They are certified by the Association of Environmental and Wildlife Conservation Educational Centers[44] (Hungarian acronym: KOKOSZ) on behalf of the Ministry of Human Resources.

Having realised the lack of simple and comprehensive educational material for teachers on the knowledge transfer about Climate Change issues, the Corvinus University of Budapest

[41] http://www.okoiskola.hu/
[42] http://www.ofi.hu/english
[43] http://www.zoldovoda.hu/ (only available in Hungarian)
[44] http://www.kokosz.hu/index.php?option=com_frontpage&Itemid=1

edited and published a book titled "Klímaváltozásról mindenkinek" ('On Climate Change for Everyone'). Many renowned scientists who had participated in the VAHAVA research project and its follow-up project called 'KLIMA-KKT' contributed to this publication as well. The book has been distributed free of charge to Hungarian schools, thanks to the generous sponsoring from a big insurance company. An online project by Eszterházy Károly University of Eger called "Földrajz Netközkészlet"[45] ('Internet Toolbox for Geography') serves a similar purpose for geography teachers offering freely accessible teaching materials in all areas of geography, including climatology and meteorology.

A new, complex series of Green Study Competitions and Programmes (in Hungarian: "Zöldkarikás Játékok") was also launched in 2016 under the coordination of the Ministry of National Development, within the framework of the Environment and Energy Efficiency Operative Programme (Hungarian acronym: KEHOP) of the EU and the Hungarian Széchenyi 2020 Programme.[46] The aim of the programme is to raise awareness concerning climate, environment and sustainability issues and to create a climate-friendly approach and lifestyle for Hungarian students at the age of 6-19 throughout the whole country. The series of programmes contain a complex study competition with the participation of small groups of students from different schools and a nation-wide media campaign. The main topics of the competition are energy conservation, climate action, conscious use of water, waste management and nature conservation. Apart from knowledge sharing and awareness-raising the programme creates precious synergies among decision-makers, civil and private actors, the scientific-educational sector and the media.

9.3. Higher education

Aspects of climate change are more and more widely taught at Hungarian universities and colleges, either as part of degree programmes on broader subjects such as environmental science, environmental engineering, earth sciences etc., or as elective courses freely available to students of any subject. However, only one university in the country offers a master's degree programme which really puts climate change at the core of the curriculum: the Department of Meteorology at Eötvös Loránd University in Budapest[47] offers Climate Research as one of two possible areas of specialization (the other is Weather Forecast) in its MSc Meteorology programme.

Hungary follows the Bologna process. As of autumn 2017, there are about 65[48] State Recognised higher education institutions in the country.

9.3.1. Meteorology and climate science

At the Hungarian higher education institutions, meteorology can be found at the faculties of natural sciences. Three scientific undergraduate/bachelors courses, namely earth sciences,

[45] http://netszkozkeszlet.ektf.hu/en/index.html

[46] https://www.palyazat.gov.hu/kehop-542-zldkariks-jtkok-komplex-szemlletformlsi-program (only available in Hungarian)

[47] http://nimbus.elte.hu/index-en.html

[48] https://www.oktatas.hu/felsooktatas/kozerdeku_adatok/felsooktatasi_adatok_kozzetetele/felsooktatasi_intezmenyek/allamilag_elismert_felsookt_int

environmental science and physics can include meteorology as a specialization, depending on the university.
Eötvös Loránd University (ELTE), based in Budapest, is the only educational institution in Hungary with a master's degree programme in meteorology. ELTE also has a meteorology specialization for all the three previously mentioned bachelor programmes. Graduates from other related bachelor programmes can apply to the MSc programme too, with the condition of completing additional courses.

The University of Debrecen also offers a meteorology branch on bachelor level in its earth sciences BSc programme, but it doesn't have a full degree programme in meteorology[49]. After being introduced to meteorology and climatology the students are taught several subjects related to climate change, such as environmental climatology, global climate change and agricultural climatology. This university has a Department for Meteorology as well.

Since 2016, the University of Szeged [50]has a meteorology specialization in its Earth Sciences Bsc course. Despite of not having a master's programme, many climatology courses are taught and the university has a department for climatology and landscape ecology.

Central European University has a strong focus on climate change and over a dozen students of its Department of Environmental Sciences and Policy[51] have been doing climate-change related work there so far. At CEU, students with an interest in climate change can do their research at the university's Centre for Climate Change and Sustainable Energy Policy .CEU is playing a special role also because it is an American-Hungarian institution offering English-language environmental MSc. and PhD programmes to a very international student body. Its degree programmes include a 1-year Master in Environmental Sciences and Policy, as well as "MESPOM" (Masters of Environmental Science, Policy and Management), a joint 2-year programme which is still ongoing with partner universities in the United Kingdom, Sweden and Greece, supported by the European Union under the Erasmus Mundus scheme. Both programmes contain several courses related to climate change and its mitigation.

At PhD level, meteorology and climate related programmes can be found at the doctoral schools of earth sciences. Six universities[52], namely ELTE, the University of Debrecen, the University of Pécs, the University of Szeged, the University of Miskolc and the Budapest University of Technology and Economics have such doctoral school, however not all institutions have meteorological and climatic research topics.

9.3.2. Climate change-related studies in other degree programmes, programmes focusing on environmental issues

Degree programmes which focus on environmental issues, at both bachelor's and master's level as well as in PhD programmes continued to be more and more widespread at Hungarian universities and colleges. These courses can be found in a wide variety of

[49] https://ttk.unideb.hu/hu
[50] http://www.sci.u-szeged.hu/
[51] http://envsci.ceu.hu/
52 https://doktori.hu/index.php?menuid=110&lang=EN

faculties, for example natural sciences, engineering, economics, agriculture in the many universities and colleges of Hungary.

Some examples are the following:

- Environmental Sciences (both BSc and MSc level), an interdisciplinary programme with a strong focus on natural and life sciences.
- Environmental Engineering (both BSc and MSc level) familiarizes students with a wide range of environmental technologies relevant for areas such as waste management or nuclear safety.
- Landscape and Garden Engineering (BSc) and Landscape Architect (MSc) programmes have the objective to train modern landscape engineers, also focusing on sustainability issues.
- Geography (both Bsc and Msc level) is an interdisciplinary programme covering many branches of social and natural sciences, with the possibility to specialize in environmental research
- Agricultural-environmental Management Engineering (MSc) combines agricultural studies with a strong focus on sustainability and protection of the environment
- Agricultural Water Management Engineering (MSc) focuses on sustainable integrated water management in the field of agriculture
- Regional and Environmental Economic Studies (MSc/MA) which prepares students to analyse ecological and social processes from an economic point of view.

The above-mentioned programmes are not specifically geared to climate change but usually include individual courses related to climate change either in the core curriculum or as elective subjects.

There are also several PhD programmes focusing on environmental research: Six[53] Hungarian universities have established specific doctoral schools in the field of environmental sciences. Eötvös Loránd University in Budapest, the University of Pannonia in Veszprém, the University of Debrecen, the University of Szeged, Szent István University in Gödöllő and the University of Sopron.

9.4. Awareness-raising

9.4.1. Churches

Churches have always played an important role in the education of the society and in forming its approach and way of life. Nowadays it is still important that religious communities convey the message to protect the environment.

The perspective of religious communities is characterized by a long-term, broad-minded and responsible thinking of our goals and actions. The values based on active faith can show a

[53] https://doktori.hu/index.php?menuid=110&lang=EN

way out of the chasing of material goods; it can provide a connection point for creating a harmonic coexistence of human and human and human and nature. This can be the basis for healing the distortion in the values of human societies, i.e. in the driving factors underlying the intertwined, global economic and social problems. The "sustainable society" and the "land of God" presume similar fundamental values, irrespective of faith.

The attention of churches was directed towards the importance of protecting creation already in the early stage of recognizing the symptoms and causes of the global environmental crisis. One of the first milestones of this process was the 1986 conference of "Association of Religions for Nature", which was attended by catholic, protestant and Jewish communities and the representatives of major eastern religions, and the participants issued the Gubbio Declaration. The churches have recognised that nature on its own is a value worth respecting, and raise the attention to the importance of respecting life and the role of caution and love in our dealings with nature. The representatives of the Roman Catholic, Orthodox and Reformed Churches and the Jewish religion have called the attention of their believers and the world of the unsustainability of our current way of living and the threats to humans in several documents.

The Gubbio Declaration launched the cooperation of global religions for nature, and from this time onwards, the attention of the churches of various countries and continents, and denominations increased towards natural and environmental problems and the responses to them. Examples are the initiative role, declarations of European Ecumenical Meetings, the World Council of Churches, the Conferences of European Bishops and the Jewish World Congress. Churches have an increasing cooperation with local communities, experts and NGOs. The aggravation of the ecological disaster makes the knowledge of the scientific background also increasingly important. At the same time, there have been many occasions when churches urged international politics to avoid global threats. In 1997, they turned to the politicians of the Kyoto negotiations. The ecological message of churches reaches non-believers through the media as well; therefore it can affect many people beyond the direct participants of religious life. We could refer to Pope Francis, who urged the avoidance of the ecological crisis (encyclical beginning with Laudato si').

In addition to providing the theoretical basis, churches, congregations and local communities can have a priority role in establishing the everyday practice of environmental responsibility. The institutional framework of religious life can be especially suitable to translate global thinking into local action. The avoidance of the global climate disaster and the adaptation to the unavoidable effects requires a complete change of values and lifestyle. This cannot be expected from the positive and negative incentives initiated by policies only. Churches offer an indispensable help in spiritual renewal.

The Hungarian churches are dealing more and more with environmental topics. The circular letter of the Conference of Hungarian Catholic Bishops "Our responsibility for the created world", the programmes of the "Week of creation" of the Calvinist Church, the exemplary eco-village of Krishna Believers in Somogyvámos are good examples of this. The importance of renewing our values, which is necessary for the prevention of climate change and adaptation, the presentation of good examples, motivating local communities to act—these must be reinforced in the practice of Hungarian churches.

For the successful cooperation with the churches, we recommend the followings:

Short-term action lines

- The foreign and Hungarian church documents calling to prevent creation must be presented to church communities and the public.
- In pursuance of the 2002 Nádasladány Declaration, the dialogue within and among denominations about the fundamental principles the society may rely on in the solving of the environmental crisis must be continued, amongst others about the responsibility for the created world and our children and grandchildren and the resulting duties.
- The preparation and education of pastors (priests, rabbis) about the connection between religion and ecology in terms of theology and practice may be necessary.
- Churches may play a direct role in awareness-raising. Ecologically conscious actions include the exercising of a responsibility for the created world.
- Congregations, religious communities and church groups may initiate and participate in local mitigation (e.g. awareness-raising about energy) or adaptation (e.g. afforestation, habitat protection) programmes, in cooperation with NGOs, municipalities.
- Finding and collection of either partly or completely climate protection programmes, both finished and ongoing, implemented by churches and their institutions.
- It is recommended to start a dialogue between the different churches and the various bodies of science, policy, public administration, and climate protection civil organisations in order to find the connection points and opportunities for activities.

Mid-term action lines

- Widespread dissemination of programmes, good practices of the churches to reinforce the connection between religion and ecology.
- Reinforcing the cooperation between churches and educational institutions.
- It is recommended to use exemplary, environmentally friendly technologies when renovating ecclesiastical buildings.

Long-term action lines

- Maintaining the opportunity for the strengthening of ideas on environmental protection and creation-protection introduced by the churches among the messages to be conveyed by the churches.
- Making sustainability, the protection and healing of the created world a general and fundamental value in the message conveyed by churches and in their operational practice.

9.4.2. NGOs

It is important to create networks with the involvement of academic institutes, NGOs, economic operators, politicians, and trade unions, participants of public administration and representatives of the churches.

Short-term action lines

- The base provided by governmental background institutes should be used to create the network of NGOs, academic and ecclesiastical organisations, institutes, networks dealing with sustainability and climate change. This platform can ensure the possibility for the intense share of knowledge of the experts and of the model project network. Their cooperation with similar foreign and international initiatives must be ensured.
- Connection, obtainment of information must be made available to the society as regards the functioning of the network described in the foregoing. The network should include cooperation in the field of research and the implementation of sustainability initiatives.

Mid-term action lines

- Reinforcing and making network operations national and regular.
- Systematic channeling of network recommendations into legislation.

Long-term action lines

Climate protection receives formal and pronounced role in legislation and governmental decision-making (e.g. through the setting of planning directives, regular technical control).

9.4.3. Partnership with the media

Climate change affects everyone; therefore activities of awareness-raising must address every social group—in a different way. The broadest possible levels of society must be made aware of the challenges that our civilization faces. Special attention must be paid to prevention. The stakeholders must be encouraged to take action by emphasising the advantages of timely action and the risks of not-acting. To do so, the efficient use of the press and the innovative channels of mass communication is unavoidable. We recommend the followings to efficiently convey the messages:

Short-term action lines

- A partnership should be established with the media. The journalists of the printed and electronic press must have the chance to easily access up-to-date scientific and non-technical information in connection with climate change, sustainability, environmentally conscious alternatives available to residents as well (trainings to journalists, information campaigns, knowledge-sharing, professional information forums, and websites). The public media and the opportunities and specificities of internet social media must receive special attention, due to the increasing role of the latter in acquiring information and awareness-raising.

- The efficiency of climate change communication must be increased by involving the stakeholder groups into the elaboration of its tools, applying procedures based on participation, regularly receiving feedback during use, and to continuously improve the communication tools based on these results.
- The transformation of legal regulation tools should be used to achieve an increasing proportion of messages related to sustainability and climate-change in the public media. An expert background should be set up to ensure that messages related to sustainability and climate change are based on scientifically sound information.
- The proper legal setting should be created to encourage the media to increase the share of messages concerning sustainability in the commercials and paid advertisements.

Mid-term action lines

- The forming of the legal regulations, training of programme-makers should be used to achieve that the issues of climate change and sustainability are not put into a separate "green box" in the media, but appear regularly and as integrated into the daily flow of information and entertainment.

Long-term action lines

- The role of information-conveying channels (e.g. local awareness-raising actions ensuring direct access) that are based on local information and a more living relationship with the direct environment and are more personal should be increased in contrast to the mass media.

9.4.4. Complex campaigns for climate-consciousness

Environmental consciousness and climate protection begins in the homes of individuals. To encourage this process, it is recommended to make complex campaigns to convey significant, actual sustainability messages. Awareness-raising, which in this case includes the active participation of citizens, cannot be reduced only to individual energy consumption, but also the GHG emissions and the ability to improve adaptability.

Short-term action lines

- It is practical to make polls before communication campaigns on climate-consciousness, sustainability among the identified target groups. A poll can concretize the image of the target group and lay the foundation of a more targeted and more efficient communication campaign, while also providing basic data for the assessment of communication efficiency at a later stage.
- It is necessary to identify technological, economical and community-organizing responses and to elaborate palpable, feasible, realistic adaptation packages for social, economic groups, institutions of different characteristics. The achievement of sustainable development should be facilitated by presenting adaptation packages and direct advice to individuals or communities.

- The Climate-friendly Hungarian decade campaign should be launched, as it can achieve complex awareness-raising in the priority areas of adaptation and mitigation (reduction of energy consumption and the use of renewable energy, environmentally conscious consumption, preparation of households and workplaces to the negative effects of climate change, agriculture, use of land, nature conservation). Nationwide knowledge about the action lines of the NCCS2 should be set as a goal, and communication should help the activities of stakeholders through conveying new knowledge and solutions. In the given period, central developments, communication resources must be focused and harmonized on the given area.54

Mid-term action lines

- It is recommended to increase the complexity of campaigns and the depth of knowledge conveyed on the basis laid down by the Climate-Friendly Hungary Decade. Sustainability campaigns concerning energy consumption should be combined with waste management, water management, food procurement and other consumption-forming programmes emphasising prevention, because this can give a complex system and setting to the education on environmental consciousness. Complex campaigns valorize the residents' understanding of the role of consumption behaviour in the emergence of environmental problems and the necessity of adaptation to climate change.
- Strengthening the role of NGOs, charities and non-profit organizations, churches, trade advocacies, chambers in awareness-raising is especially important. These organizations can reach out to the various layers of the concerned social groups through the organization of events, community programmes, appearance at community programmes and the preparation of publications.
- It would be practical to strengthen the role of municipalities, which can contribute to the improvement of climate-consciousness, amongst others, through the participation of their own institutes.

Long-term action lines

- Representing climate change, as a boundary condition, in every governmental campaign activities, in consideration of the actual changes in the climate.

[54]In the awareness-raising campaigns, it is practical to give a role to already functioning national public and civil information networks (e.g. eHungary spots, Integrated Community Service Spaces, library federations, Network of Environmental Consultancy Offices). Experts of NGOs with great traditions and a lot of experience in environmental education should be involved into the planning of campaigns and they should be entrusted with the conduction of one or two campaigns. These organisations are in direct connection with the preschools and schools, therefore they effect can multiply.

9.4.5. Regional and local level

According to Annex II. to Government Decree No. 1084/2016. (II. 29.), in the framework of the 2014-2020 Environmental and Energy Efficiency Operational Programme (EEE OP), call EEE OP 1.2.0., climate strategies for all counties and for the capital will be prepared. In addition climate platforms will be established.

Supported by call EEE OP 1.2.1., local authorities will have the possibility to submit tenders in connection with adaptation to the effects of climate change, risk prevention and improving public climate-consciousness. Within its framework municipal climate strategies, reaching out to 3 million people, will also be prepared.

9.5. Training

Several organisations in Hungary offer trainings related to climate change and a large number of conferences and expert workshops are taking place to address such topics. These are geared towards the general public, professionals and members of local authorities. Some major institutions and activities addressing this need are introduced below, but there are many more one-off or smaller-scale training activities taking place in addition to these.

Climate Policy Thematic Trainings – LIFE Capacity Building in Hungary (LIFE14 CAP/HU/000010 - LIFECapHUN)

In 2015 Hungary was awarded with a Capacity Building Project within the framework of the EU's funding instrument for the environment and climate action (LIFE). The coordinating beneficiary of the project is the Ministry of National Development, which is responsible for climate policy in Hungary. In line with the signed Grant Agreement, six thematic climate policy trainings already took place in the Ministry of National Development, three in 2016 and three in 2017. Another two trainings are scheduled for 2018.

These were the following:

- 1st Climate Policy Training – General knowledge sharing on LIFE Climate Action sub-programme (28th April 2016)
- 2nd Climate Policy Training – Brainstorming on project ideas (30th June 2016)
- 3rd Climate Policy Training – Thematic training on Climate Change Adaptation (1st September 2016)
- 4th Climate Policy Training – Knowledge sharing on Climate Change and awareness-raising and LIFE Climate Governance and Information projects (16th February 2017)
- 5th Climate Policy Training – Knowledge sharing on LIFE Climate Change Mitigation projects and brainstorming on project ideas (13th April 2017)
- 6th Climate Policy Training – Changes and novelties in the new LIFE Multiannual Work Programme for 2018-2020 (11th December 2017)

Mining and Geological Survey of Hungary

In the near future, the Mining and Geological Survey of Hungary is planning to have two training projects. One is an educational programme about NAGiS, which will be held for local authorities, policy makers and registered users. The other will be aimed at mayors and is connected to the climatic aspects of municipal strategic planning. In the latter, NGOs with relevant experience will be involved as well.

Energia Klub (Energy Club)

Its main goal is to provide information to the public and plays a role in education, be it trainings related to civil service, elementary school education or presentation of a project arranged according to the requirements of the actual administration.[55].Energia Klub also had a training for members of local governments addressing the issues of climate change on a municipal level.

Hungarian Green Buildings Council (HuGBC)56

Provides trainings for engineers with the main message of environment and energy friendly design, also on building evaluation.

KÖVET (Association for Sustainable Economies)

One of the main goals of KÖVET, a non-profit organisation and Hungarian member of the International Network for Environmental Management (INEM), is training and education for companies about sustainable development, including climate change mitigation, through conferences, seminars and publications. One of their most successful programmes is "Green Office", which comprises of distance learning materials on improving workplace sustainability and a yearly competition among offices for the most successful greening efforts. This scheme is supported by the Leonardo da Vinci programme of the European Union.

[55] http://energiaklub.hu/szolgaltatasok

[56] www.hugbc.hu

ANNEX I. Specific research activities of the Hungarian Academy of Sciences (MTA) related to climate change

I.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Centre for Agriculture Research	Agricultural Institute	1	The basis of physiological, genetic and production biological tolerance against abiotic stress caused by climate change	2005	2021.
		2	The genetic foundations of environmental adaptation and its correlation with fruiting	2008	2015.
		3	Identifying epidermal traits suitable for identifying the drought tolerance of wheat	2010	2013.
		4	Effect of drought and heat stress on fertilisation and grain development of wheat	2014	2019.
		5	Research on improving climate change adaptability of wheat	2016	2018.
		6	Effect of heat stress on meiotic stabilisation and fertilisation of wheat	2017	2021.
		7	Effects of climate change related extreme weather events on agriculture and the possibilities for compensation in the upcoming centuries	2012	2015.
		8	Research on maize drought tolerance – DROPS project	2011	2015.
		9	Studying the genetic background of chilling tolerance of maize	2017	continuous
		10	Studying the effects of UV-B radiation on the physiological properties of maize	2000	continuous
		11	Effects of heat and drought stress on the content and composition of wheat fiber	2010	2014.
		12	Effects of drought stress on the content and compositions of wheat/Aegilops additive lines fiber	2014	2018.
		13	Plants that can be utilized in multiple ways as alternatives in the service of sustainable agriculture which can adapt to the changing climate	2017	2021.
		14	Developing strategies to improve the sustainability of agricultural productivity under changing environmental and economic conditions	2017	2021.
	Plan Protection Institute	15	Alien invasive species appearing due to climate change	1985	continuous
		16	Effects of heat and drought stress	2017	continuous
		17	Studying diseases brought in by vectors which appear due to climate change	2017	continuous
	Institute for Soil Science and Agricultural Chemistry	18	Greenhouse gas emission (CO_2, N_2O)in different cultivation systems	2013	2019.
		19	Greenhouse gas emission (CO_2, N_2O) during biochar treatment under different land use	2015	2018.
		20	Effects of the utilisation of liquid swine manure and the used technology on the emission of air pollutants (ammonia, nitrogen oxides)	2016	2017.
		21	Developing the necessary methodological and soil database for developing an irrigation strategy	2017	2018.
		22	The effects of climate change on water movement and basin-level integrated modelling	2013	2017.
		23	Demonstration of plans stress response to extreme drought by measuring the electrical capability of roots	2015	2017.

II.	Project	Number	Subject of the research	Start of research period	End of research period
MTA Institute for Nuclear Research	Isotope Climatology and Environmental Research Project/ Climatology-paleoclimatology	24	Besides CO_2, other components like carbon monoxide, methane and aerosol will be investigated focusing on the 13C and 14C isotope composition.	2016.	2020.
		25	High precision carbon isotope analyses of tree rings sequences of thousands of years		
		26	The reconstruction of climatic events and human impact in the past 15 kyr preserved by the sediments, accumulated in high mountain lakes.		
		27	Water temperature reconstruction for the late Miocene Pannonian Lake.		
		28	Paleoclimate analysis of carbonate formations from caves		
		29	Analysis of detrital materials from cave ice deposits and polar ice cores		
		30	Exposure age dating of rock surfaces using in-situ produced cosmogenic C-14 nuclide for a better understanding of past landscape evolution and laboratory development		
		31	Research on buried paleosoils- the reconstruction of climatic and environmental changes occurred during/around the termination of the last glacial period and early Holocene.		
		32	Relation between extinction times of the megafauna members and environmental and climate changes.		
		33	Reconstruction of the changes in the Tethys Ocean during the Triassic, Jurassic and Cretaceous period.		
	Isotope Climatology and Environmental Research Project / Hydrology-paleohydrology	34	Paleoclimate reconstruction using groundwater as an archive		
		35	Changes in the age distribution of the water bases of Great Plain influenced by the extraction of water.		
		36	Examining the parallel diagnosis of the analogue phenomena and precipitations found in the layers of geographic history and manifested through the recent natural processes creating thermal water.		
		37	Investigations of geomorphology and the water supply of oxbows along the River Tisza		
	Isotope Climatology and Environmental Research Project / Geochemistry-Environmental Geochemistry - Geology	38	Identification and characterization of atmospheric aerosol sources and their contributions.		
		39	Studying the subsidence and exhumation history of the crystalline basement of the Great Hungarian Plain		
		40	Studying upper mantle rocks – exploring the small- and large –scale heterogeneity and defining their origin, consequences and evolution of volatiles		

III.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Research Centre for The Humanities	Institute of Ethnology	41	International Arctic Science Committee; International Permafrost Association; Permafrost and Culture Action Group	2014.	2016.
		42	The role of traditional ecological knowledge in natural resource management	2009.	2020.

IV.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Research Centre for Astronomy and Earth Sciences	Geography Research Institute	43	Biosphere lithosphere interaction (MTA CSFK FTI Biosphere lithosphere Interactions research group 2013-2016, Geography research group 2016-2019)	2013.	2019.
		44	Quaternary and evolution of the surface (MTA CSFK FTI Research group for Quaternary and evolution of the surface 2013-2016, 2016, 2018)	2013.	2018.
		45	Recent climate research related to the role of the atmospheric mineral powder (MTA CSFK FTI Quaternary and evolution of the surface research group 2013-2016, 2016, 2018)	2013.	2018.
	Institute for Geological and Geochemical Research	46	Application of the geochemistry in palaeoclimatology	2013.	2018.
	Geodetic and Geography Institute	47	Geophysical Research related to climate change	2013.	2018.
	Konkoly Observatory	48	Solar physics	2013.	2018.
	Research action carried out under the direct management of the research center	49	Global environmental problems	2016.	2018.

V.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Regional Studies of the Hungarian Academy of Sciences	Institute of Regional Studies	50	Long-term socio-economic forecasting for Hungary	2015.	2015.
		51	Conducting of social science expert studies-including the development of three sub-topics	2017.	2018.
		52	SEERISK – (Joint Disaster Management Risk Assessment and Preparedness in the Danube Macro-Region SEE/C/0002/2.2/X SEERISK	2012.	2014.
		53	Danube-Tisza canal , visions and reality	2008.	2009.
		54	Providing a scientific basis for a climate smart urban policy, the examination of the society of	2008.	2008.
		55	REGPHOSYS Photovoltaic systems as Actuators of Regional Development IPA HUHR 1101/2.1.3/0002	2007.	2014.
		56	REPAiR H2020 Resource Management in Peri-urban areas: Going Beyond Urban Metabolism	2017.	2020.
		57	Activities related to the Hungarian participation in the Strategy of EU Danube Region	2009.	2010.
		58	Depopulating areas in Bulgaria and Hungary – impacts of depopulation on the changes of rural settlements and their environment	2016.	2018.
		59	Development trends of the riverside countries along the Danube	2009.	2009.

VI.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Centre for Ecological Research		60	Experimental study of the ecological effects of extreme droughts and long-lasting precipitation change	2014.	
		61	The effect of the drought and soil disturbance in terms of the success of invasive plant species	2016.	continuous
		62	The ecological effect of the drought and warming in a sand steppe	2001.	continuous
		63	The effect of climate change on the interact of plant arthropod along a European biodiversity gradient	2012.	2016.
		64	The effect of different forestry management on micro-climate	2014.	2024.
		65	The experimental field study of the green grass stability against extreme droughts along a European gradient	2012.	2016.
		66	The examination of phytoplankton in Danube	1979.	continuous
		67	Modelling of the effects of climate change on surface waters	2018.	continuous
		68	An endangered cold-adopted reptile in the warming Mediterranean: Vipera graeca in the captivity of climate	2015.	2019.

VII.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Centre for Social Sciences		69	Study of the population and elite of Tisza	1999.	2003.
		70	Water supply of Balaton	2002.	2002.
		71	Climate-friendly municipalities	2005.	2015.
		72	Climate change and societal resilience	2005.	continuous
		73	Strong sunlight and societal resilience	2005.	continuous
		74	Climate Change – Budapest	2007.	2007.
		75	Climate respond	2015.	2016.
		76	The risk of strong sunlight and heat, and the possibilities of their prevention in Hungary	2015.	2016.
		77	Impacts and risks from higher-end scenarios: Strategies for innovative solutions	2013.	2018.

VIII.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Research Centre for Natural Sciences	Institute of Materials and Environmental Chemistry	78	The examination of the kinetics of important elemental chemical reactions with experimental and theoretical methods in the atmospheric chemistry	2014.	2021.
		79	Structure of cave carbonates - Mineralogical and geochemical analyses of carbonate polymorph formation processes in speleothems	2017.	2021.

IX.	Research Institute	Number	Subject of the research	Start of research period	End of research period
MTA Office of Supported Research Groups	Evolution Ecology Research Group	80	Effects of urbanization, climate change and social surroundings on the evolution of behavioural and reproductive characteristics	2017.	2022.
	Atmospheric Chemistry Research Group	81	Expected effects of climate change on air quality	2017.	2022.

ANNEX II. THIRD BIENNIAL REPORT

1. Information on greenhouse gas emission and trends

Information on greenhouse gas emission trends and on inventory arrangements are presented in chapter 3 of 7th Hungary's National Communication

2. Quantified Economy-wide Emission Reduction Targets (QEWER)

2.1. The EU's target under the Convention

Hungary's emission reduction target under the Convention is part of the joint target of the European Union.

In 2010, the EU submitted a pledge to reduce its GHG emissions by 2020 by 20% compared to 1990 levels, in order to contribute to achieving the ultimate objective of the UNFCCC: 'to stabilise GHG concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system'[57], or, in other words, to limit the global temperature increase to less than 2°C compared to temperature levels before industrialization (FCCC/CP/2010/7/Add.1). The EU had also committed to raising this target to a 30% emission reduction by 2020 compared with 1990 levels, provided that other developed countries also commit to achieving comparable emission reductions, and that developing countries contribute adequately, according to their responsibilities and respective capabilities. This offer was reiterated in the submission to the UNFCCC by the EU-28 and Iceland on 30 April 201458.

The definition of the Convention target for 2020 is documented in the revised note provided by the UNFCCC Secretariat on the 'Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention' (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011). In addition, the EU provided additional information relating to its quantified economy wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1).

The EU's accounting rules for the target under the UNFCCC are more ambitious than the current rules under the Kyoto Protocol, for example, including international aviation, and adding an annual compliance cycle for emissions under the Effort Sharing Decision (ESD; see section 2.2.1 of the EU's 3rd Biennial Report) or higher Clean Development Mechanism (CDM) quality standards under the EU Emissions Trading System (EU ETS) (FCCC/TP/2013/7). Accordingly, the following assumptions and conditions apply to the EU's 20% target under the UNFCCC:

[57] First steps to a safer future: Introducing the United Nations Framework Convention on Climate Change http://unfccc.int/essential/_background/convention/items/6036.php

[58] European Union, its Member States and Iceland submission pursuant to par 9 of decision 1/CMP.8' http://ec.europa.eu/clima/policies/international/negotiations/docs/eu_submission_20140430_en.pdf

- The EU Convention pledge does not include emissions/removals from Land Use, Land Use Change and Forestry, but it is estimated to be a net sink over the relevant period. EU inventories also include information on emissions and removals from LULUCF in accordance with relevant reporting commitments under the UNFCCC. Accounting for LULUCF activities only takes place under the Kyoto Protocol.
- The target covers the gases CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.
- The target refers to 1990 as a single base year for all covered gases and all Member States. Emissions from international aviation to the extent it is included in the EU ETS are included in the target[59].
- A limited number of CERs, ERUs and units from new market-based mechanisms may be used to achieve the target (see section 2.2.2.3): in the ETS, the use of international credits is capped (up to 50% of the reduction required from EU ETS sectors by 2020). Quality standards also apply to the use of international credits in the EU ETS, including a ban on credits from LULUCF projects and certain industrial gas projects. In the ESD sectors, the annual use of international credits is limited to up to 3% of each Member State's ESD emissions in 2005, with a limited number of Member States being permitted to use an additional 1% from projects in Least Developed Countries (LDCs) or Small Island Developing States (SIDS), subject to conditions.
- The Global Warming Potentials (GWPs) used to aggregate GHG emissions up to 2020 under EU legislation were those based on the Second Assessment Report of the IPCC when the target was submitted. In accordance with the CMP Decision to revise the GWPs to those from the IPCC Fourth Assessment Report (AR4) revised GWPs from AR4 were adopted for the EU ETS. The revised GWPs were taken into account for the revision of the ESD target. For the implementation until 2020, GWPs from AR4 will be used consistently with the UNFCCC reporting guidelines for GHG inventories.

[59] In the EU, the sum of emissions covered by categories 1.A.3.a 'domestic aviation' and memo item 'international bunkers - aviation' go beyond the scope of the EU target, as emissions from international aviation are included in the EU Climate and Energy Package and the EU target under the UNFCCC to the extent to which aviation is part of the EU ETS.

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Parameters	Target
Base Year	1990
Target Year	2020
Emission Reduction target	-20% in 2020 compared to 1990
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
Global Warming Potential	AR4
Sectors Covered	All IPCC sources and sectors, as measured by the full annual inventory and international aviation to the extent it is included in the EU ETS.
Land Use, Land-Use Change, and Forests (LULUCF)	Accounted under KP, reported in EU inventories under the Convention. Assumed to produce net removals
Use of international credits (JI and CDM)	Possible subject to quantitative and qualitative limits.
Other	Conditional offer to move to a 30% reduction by 2020 compared to 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

Table A. Key facts of the Convention target of the EU-28

2.2. The EU's target compliance architecture

2.2.1. The 2020 climate and energy package

In 2009 the EU established internal rules under its "2020 climate and energy package"[60] - these underpin the EU implementation of the target under the Convention. The package introduced a clear approach to achieving the 20% reduction of total GHG emissions from 1990 levels, which is equivalent to a 14% reduction compared to 2005 levels. This 14% reduction objective is divided between the ETS and ESD sectors. These two sub-targets are:

- a 21% reduction target compared to 2005 for emissions covered by the ETS (including domestic and international aviation);
- a 10% reduction target compared to 2005 for ESD sectors, shared between the 28 Member States (MS) through individual national GHG targets.

Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), and there are no further individual caps by country. Allowances allocated in the EU ETS from 2013 to 2020 decrease by 1.74% annually, starting from the average level of allowances issued

[60] http://ec.europa.eu/clima/policies/package/index_en.htm

by Member States for the second trading period (2008–2012). For more information on ETS and on the recent changes please see section 3.2 of the EU's 3rd Biennial Report.

The vast majority of emissions within the EU which fall outside the scope of the EU ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009/EC). The ESD covers emissions from all sources outside the EU ETS, except for emissions from domestic and international aviation (which were included in the EU ETS from 1 January 2012), international maritime emissions, and emissions and removals from land use, land-use change and forestry (LULUCF). It thus includes a diverse range of small-scale emitters in a wide range of sectors: transport (cars, trucks), buildings (in particular heating), services, small industrial installations, fugitive emissions from the energy sector, emissions of fluorinated gases from appliances and other sources, agriculture and waste. Such sources accounted for 55% of total GHG emissions in the EU in 2013[61].

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While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State (see Figure 3-2). Under the Effort Sharing Decision, national emission targets for 2020 are set, expressed as percentage changes from 2005 levels. These changes have been transferred into binding quantified annual reduction targets for the period from 2013 to 2020 (Commission Decisions 2013/162/EU and 2013/634/EU), denominated in Annual Emission Allocations (AEAs). At country level, 2020 targets under the ESD range from -20% to +20%, compared to 2005 levels.

The target levels have been set on the basis of Member States' relative Gross Domestic Product per capita. In addition, different levels of development in the EU-28 are taken into account by the provision of several flexibility options. Up to certain limitations, the ESD allows Member States to make use of flexibility provisions for meeting their annual targets: carry-over of over-

[61] European Commission. Commission Staff Working Document - Accompanying the document: Report from the Commission to the European Parliament and the Council on evaluating the implementation of Decision No. 406/2009/EC pursuant to its Article 14. (SWD(2016) 251 final). 2016. https://ec.europa.eu/transparency/regdoc/rep/10102/2016/EN/10102-2016-251-EN-F1-1-ANNEX-1.PDF

[62] European Commission. Commission Staff Working Document - Accompanying the document: Report from the Commission to the European Parliament and the Council on evaluating the implementation of Decision No. 406/2009/EC pursuant to its Article 14. (SWD(2016) 251 final). 2016. https://ec.europa.eu/transparency/regdoc/rep/10102/2016/EN/10102-2016-251-EN-F1-1-ANNEX-1.PDF

achievements to subsequent years within each Member State, transfers of AEAs between Member States and the use of international credits (credits from Joint Implementation and the Clean Development Mechanism). MS exceeding their annual AEA, even after taking into account the flexibility provisions and the use of JI/CDM credits, will face inter alia a penalty – a deduction from their emission allocation of the following year (excess emissions, multiplied by 1.08).

Under the ESD Hungary can increase its emissions by 10% compared to the 2005 level.

Country	Annual Emission Allocation (tonnes of carbon dioxide equivalent)							
	2013	2014	2015	2016	2017	2018	2019	2020
Hungary	50 398 977	51 516 636	52 634 296	53 751 955	50 064 250	50 986 355	51 908 461	52 30 567

Table B. Annual Emission Allocation in Hungary (2013-2020)

2.2.1 Monitoring on progress to 2020 targets

For the monitoring of GHG emissions at the EU and the Member State level, the Monitoring Mechanism Regulation has been adopted. Also for the effective operation of the EU ETS, robust, transparent, consistent and accurate monitoring and reporting of greenhouse gas emissions are essential, therefore an annual procedure of monitoring, reporting and verification (MRV) at the installation level is implemented. For a description of the requirements contained therein, please refer to the EU's second Biennial Report. Installation and aircraft operators have to monitor, report and verify their annual emissions in accordance with two EU Regulations, the Monitoring and Reporting Regulation (MRR) and the Accreditation and Verification Regulation (AVR). For a description of the requirements contained therein, please refer to the EU's second Biennial Report.

Monitoring, reporting and verification of the ESD targets mainly takes place through the submission of the national GHG inventories by MS. Chapter III of the Commission Implementing Regulation 749/2014 sets out strict criteria by which MS national GHG inventories GHG emissions are reviewed annually at the EU-level. Based on this review, the European Commission issues an implementing decision on MS ESD emissions in the given year, which might lead to MS inter alia facing penalties as described above.

2.2.1.1 Use of international market-based mechanisms

The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. In the ESD sectors, the annual use of carbon credits is limited to up to 3% of each Member State's ESD emissions in 2005. Member States that do not use their 3% limit for the use of international credits in any specific year can transfer the unused part of their limit to another Member State or bank it for their own use until 2020.

2.3. Other EU emission reduction targets

In addition to the EU target under the Convention, the EU also committed to a legally binding quantified emission limitation reduction commitment for the second commitment period of the Kyoto Protocol (2013 - 2020).

3. Mitigation actions and their effects

3.1 Policies and measures

Information on implemented, adopted and planned policies and measures can be found in chapter 4 of Hungary's 7th National Communication.

3.2 Changes in domestic institutional arrangements

No significant change has happened since Hungary's last biennial report in the matters of responsibilities and processes in climate policy making.

As Hungary is a Member State of the EU, the monitoring and evaluation of progress towards the GHG targets is driven by the Monitoring Mechanism Regulation[63], adopted in 2013. The monitoring and reporting of GHG emissions under the EU ETS prescribed in two Commission Regulations, which were introduced for Phase III of the system starting on 1st January 2013.[64] Since the last biennial report no changes were made in these legislations.

In 2015, the division responsible for inventory compilation within the Hungarian Meteorological Service was renamed to Unit of National Emissions Inventories. Apart of that, there have been no other changes since the last submission.

Due to reorganization of governmental institutions, the former registry administrator organization (National Inspectorate for Environment and Nature - NIEN) had been abolished. Successor of NIEN as the registry administrator is the National Climate Protection Authority (NCPA). NCPA is a department of the Ministry of National Development.

Directive 2003/87/EC is transposed by Law 2012/217 which defines the National Emission Trading Registry (2§ 7.) as the registry system defined by Article 4 of Regulation 389/2013/EU, and the National Administrator (2§ 25.) as defined by Article 3 (22) of Regulation 389/2013/EU. Governmental decree 410/2012 is an implementing regulation of Law 2012/217 (government is mandated to establish the implementing regulation by 39§ 1. g. of Law 2012/217). Decree 410/2012 nominates NCPA as the National Administrator of the Hungarian Emission Trading Registry, serving as the EU-ETS and the KP registry.

63 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0525

64 For more information please see the 6th National Communication and 3rd BIennial Reporrt of the EU.

3.3 Information on the assessment of the economic and social consequences of response measures

Information on how Hungary as a Party included in Annex I of the Convention is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement its commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention.

In accordance with Article 3, paragraph 1 of the Kyoto Protocol Hungary is committed to limit its anthropogenic carbon dioxide equivalent emissions of greenhouse gases listed in Annex A of the Protocol to such level that they are in line with Hungary's reduction targets while aiming at further emission reduction. Hungary is guided by the principle that ambitious national reduction targets shall be supported by a climate policy ensuring that adverse impacts on developing countries, such as carbon leakage are avoided. Hungary fully supports the endeavours, measures and implements regulations of the European Union targeting the avoidance of such impacts and fostering sustainable development, while in the same time also a specific policy framework has been put into practice.

The 2007 Climate Change Act (no. LX) provides a mandate for the government to develop a strategy on climate change in Hungary. In 2008, the former Ministry for the Environment and Water developed Hungary's First National Climate Change Strategy for 2008-2025, which entered into force via the Parliamentary Resolution 29/2008. This strategy covered three major areas of action: mitigation, adaptation and awareness-raising. Compared to mitigation, considerations for adaptation played only a minor role and the chapter was mostly descriptive and theoretical.

Successive revisions of the National Climate Change Strategy, and global climate policy developments (leading i. a. to the Paris Agreement), eventually led the Hungarian Government to revise the second strategy and also updated its timeline. The updated Second National Climate Change Strategy for 2017-2030 was published, open to public consultation and submitted to the Parliament in 2017. The updated strategy includes a National Decarbonisation Roadmap, a National Adaptation Strategy and a "Partnership for Climate" Awareness-Raising Plan The strategy guarantees that in accordance with the principle of integration, climate policy is integrated into development policy as well, safeguarding that emission mitigation projects, cooperation fostering technological transfer and enhanced funding options for climate change related projects will play an integral role among future development projects. Climate research shall be integrated into other scientific studies and research activities and the business sphere shall be involved in climate friendly investments in developing countries.

For the time being Hungary alone does not take part in large scale development projects relating to climate change, however as a Member State, it fully supports the EU's activities in this regard.

3.4. Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

As Hungary is a Member State of the European Union, our target is set on the EU level, consequently we refer to 1990 as our base year in this report. LULUCF is not included in the EU target. Therefore, concerning the information required under points (a–c) of paragraph 9 of 2/CP.17, only point a) is relevant, which we have provided under the CTF table No. 4.

In the period 2014-2017, no AAU, CER, ERU, RMU units were sold or bought by Hungary.

Concerning the intra-EU market based mechanism under the Effort Sharing Decision (ESD – Decision No 406/2009/EC), which is operating since 2013, for the compliance years 2013-2015, no AEA units were sold or bought by Hungary. The compliance cycle for 2016 and 2017 is not finished yet because of the absence of the relevant National Inventories, but Hungary is projected to have a significant surplus of allowances for these years.

4. Projections

In this section only significant methodology changes compared to Hungary's 2nd Biennial Report are presented. Detailed information on emission projections can be found in chapter 5 of the 7th National Communication.

Changes in methodology:

- *1.A.1.a Public electricity and heat production:* For the current submission in the WEM scenario the "nuclear-coal-green" scenario of the National Energy Strategy was used instead of the "nuclear-green" scenario.
- *1.A.2 Manufacturing industries and construction:* In the 2016 submission we used only bivariate regression and extrapolation.
- *1.A.3 Transport:* The 2016 submission calculated future emissions as the extrapolation of aggregated transport emissions and the share of the different modes of transport were kept constant.
- *1.A.4.b Residential:* In the 2016 submission no government program were considered in the WEM scenario after 2015.
- *2. Industrial processes and product use:* In the 2016 submission only bivariate regression models and extrapolation was used.
- *Agriculture:* In the 2016 submission emissions other than those related to the swine population was projected as an aggregate.
- *LULUCF:* In the 2016 submission the CASMOFOR model was not used instead sinks and emissions from the LULUCF sector were extrapolated.
- *A Solid waste disposal*: In the 2016 submission in the WEM scenario we assumed a 30% share of landfilling in municipal solid waste treatment for 2020 in accordance with the National Waste Management Plan. This value was kept for years after 2020. In the WAM scenario we assumed that the share of landfilling will continue to decrease in a linear manner.

5. Provision of financial, technological and capacity-building

Financial, technological and capacity building support to developing country Parties was provided as described in the National Communications 7, chapter 7. The methodology used is according to the MMR report of the European Union in accordance with the Common tabular format for "UNFCCC biennial reporting guidelines for developed country Parties" as contained in FCCC/CP/2012/L.12.

LIST OF ABBREVIATIONS

3CSEP Centre for Climate Change and Sustainable Energy Policy

AAU Assigned Amount Units

ACCCT Accurate, complete, consistent, comparable and transparent

AD Activity Data

ADCS Agrarian Damage Compensation System

AEA Annual Emission Allocation

AQRC Air Quality Reference Centre

AR Afforestation

AR 4 IPCC Fourth Assessment Report

AR 5 IPCC Fifth Assessment Report

AVR Accreditation and Verification Regulation

B+R Bike and ride

BAT Best Available Technology

BCM Billion cubic metre

BSc Bachelor of Science

CADSES Central Adriatic, Danubian and South-eastern European Space

CAI Current Annual Increment

CARAS Complex Agricultural Risk Assessment System

CASMOFOR Carbon Sequestration Model for Forestations

CCC Climate Change Committee

CCHOP Competitive Central Hungary Operational Programme (VEKOP - Versenyképes Közép-Magyarország Operatív Program)

CDM Clean Development Mechanism

CER Certified Emission Reduction

CEU Central European University

CFB Clean Fuel Box

CIS Commonwealth of Independent States

CLRTAP Convention on Long-range, Transboundary Air Pollution

CNG Compressed natural gas

COST European Cooperation in the Field of Scientific and Technical Research

DMCSEE Drought Management Centre for South-eastern Europe

DOC Degradable Organic carbon

DSB Norwegian Directorate for Civil Protection and Emergency Planning

EAFRD European Agricultural Fund for Rural Development

EAGF European Agricultural Guarantee Fund

EC European Commission

EDIOP Economic Development and Innovation Operative Programme (GINOP-Gazdaságfejlesztési és Innovációs Operatív Program)

EEA Grants European Economic Area Grant Fund

EEEF European Energy Efficiency Fund

EEOP Environment and Energy Operational Programme (KEOP - Környezet és Energia Operatív Program)

EEEOP Environment and Energy Efficiency Operational Programme (KEHOP - Környezet és Energiahatékonysági Operatív Program)

EF Emission factors

EFA Hungarian Institute for Educational Research and Development - Eszterházy Károly University

EGS Economy Greening Scheme

EIB European Investment Bank

EKE - OFI Hungarian Institute for Educational Research and Development - Eszterházy Károly University

ELTE Eötvös Loránd University

EMEP European Monitoring and Evaluation Programme

ERDF European Regional Development Fund

ERU Emission Reduction Unit

ESIF European structural and investment funds (ESB – Európai strukturális és beruházási alapok)

ESD Effort Sharing Decision

EU European Union

EUA EU Allowance Unit

EUAA EU Aviation Allowances

EUBREWNET European Brewer Network

EU ETS European Union Emission Trading System

EUMETSAT European Organisation for the Exploitation of Meteorological Satellites

EUR Euro

EXIM Bank Hungarian Export-Import Bank Plc.

FDI Foreign direct investment

FM Managed Forest

GCOS Global Climate Observing System

GDP Gross Domestic Product

GEFS Green Economy Financing Scheme

GHG Greenhouse Gas

GIS Green Investment Scheme

GWP Global Warming Potential

HCSO Hungarian Central Statistical Office

HDV Heavy-duty Vehicle

HEA: Hungarian Energy and Public Utility Regulatory Authority (Magyar Energetikai és Közmű-szabályozási Hivatal)

HMS Hungarian Meteorological Service

ICOS Integrated Carbon Observation System

ICTP International Centre for Theoretical Physics

IEA International Energy Agency

IED Industrial Emissions Directive

IPCC Intergovernmental Panel on Climate Change

IISI International Iron and Steel Institute

INEM International Network for Environmental Management

ITOP Integrated Transport Development Operational Program

JU Fuel Cells and Hydrogen Joint Undertaking

KÁT Compulsory take-over of renewable based power at subsidized prices (Kötelező Átvételi Rendszer)

KOKOSZ Association of Environmental and Wildlife Conservation Educational Centers

KP Kyoto Protocol

KSH Hungarian Central Statistical Office (Központi Statisztikai Hivatal)

Kt Kiloton

KTI Institute for Transport Sciences Non-Profit Ltd. (Közlekedéstudományi Intézet)

LDCs Least Developed Countries

LCNG Liquefied-compressed natural gas

LIFE Programme for the Environment and Climate Action

LNG Liquefied natural gas

LULUCF Land Use, Land-Use Change and Forestry

M Million

MAC Mobile Air Conditioning Systems

MAVIR Hungarian Transmission System Operator Company (Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság)

MBFSZ Mining and Geological Survey of Hungary (Magyar Bányászati és Földtani Szolgálat)

MCM Million cubic metres

MEE Hungarian Electrotechnical Association (Magyar Elektrotechnikai Egyesület)

METAR Hungarian support scheme for renewable electricity

MESPOM Masters of Environmental Science, Policy and Management

MFA Ministry of Foreign Affairs and Trade

MMR Monitoring and Reporting Regulation

MNB Central Bank of Hungary (Magyar Nemzeti Bank)

MRV Monitoring, reporting and verification

MS Member State

MSc Master of Science

MTA Hungarian Academy of Sciences (Magyar Tudományos Akadémia)

Mtoe Million tons of oil equivalent

MW Megawatt

MWe Megawatt electrical

NAC National Adaptation Center

NAGiS National Adaptation Geo-information System

NARIC National Agricultural Research and Innovation Centre

NBEPS National Building Energy Performance Strategy

NDGDM Disaster Management, Ministry of the Interior

NC4 Fourth National Communication to the UNFCCC

NC5 Fifth National Communication to the UNFCCC

NC6 Sixth National Communication to the UNFCCC

NCPA National Climate Protection Authority

NCCS I First National Climate Change Strategy

NCSS II Second National Climate Change Strategy

NFCSO FD Forestry Directorate of the National Food Chain Safety Office

NFR Nomenclature for Reporting

NEEAP National Energy Efficiency Action Plan

NEESPI Northern Eurasia Earth Science Partnership Initiative

NEP(P) National Environmental Protection Programme

NES 2030 National Energy Strategy 2030

NIEN National Inspectorate for Environment and Nature

NGO Non-governmental Organization

NIC National IPCC Committee

NIF National Infrastructure Development Corporation (Nemzeti Infrastruktúra Fejlesztő Zrt.)

NMS New EU Member States

NRDI Fund National Research, Development and Innovation Fund

NRDI Office National Research Development and Innovation Office

NREAP National Renewable Energy Action Plan

NUTS Nomenclature of Territorial Units for Statistics

NWMAP National Waste Management Action Plan

NWMPSP National Waste Management Public Services Plan

NWP National Waste Management Plan

ODA Official Development Assistance

ODS Ozone Depleting Substances

OECD Organisation for Economic Co-operation and Development

OGY Hungarian National Assembly (Országgyűlés)

OMSZ Hungarian Meteorological Services (Országos Meteorológiai Szolgálat)

OMKT-HMBC Hungarian Monitoring and Certification Body

PaMs Policies and Measures

PDA EU Project Development Assistance

PhD Doctor of Philosophy

PJ Petajoule

PMO Prime Minister's Office

PPS Purchasing Power Standards

PWR Pressurized Water Reactor

R&D Research and Developments

RDI Research, development and innovation

RDP Rural Development Programme (VP - Vidékfejlesztési Program)

REC Regional Environmental Center for Central and Eastern Europe

REKK Regional Centre for Energy Policy Research (Regionális Energiagazdasági Kutatóközpont)

RMU Removal Unit

SIDS Small Island Developing States

SME Small and Medium Enterprise

TEN-T Trans-European Transport Networks

TF Task Force

TFC Total Final Consumption

TNA Transitional National Aid

TPES Total Primary Energy Supply

TSDOP Territorial and Settlement Development Operational Programme (TOP - Terület- és Településfejlesztési Operatív Program)

TSO Transmission system operator

TWG Technical Working Group

TWh Terawatt-hour

UNFCCC United Nations Framework Convention on Climate Change

USD United States Dollar

VAHAVA Változás-Hatás-Válaszadás (Change-impact-response) Research Project

VAT Value-added Tax

WCDMP World Climate Data and Monitoring Programme

WDCGG World Data Centre for Greenhouse Gases

WDCRG World Data Centre for Reactive Gases

WEEE Waste electrical and electronic equipment

WAM With additional measures

WEM With existing measures

WFD Water Framework Directive

WG Working Group

WHO/ECEH World Health Organization - European Centre for Environment and Health

WMO World Meteorological Organization

WMO GAW WMO Global Atmosphere Watch

WMO WIGOS WMO Integrated Global Observing System

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