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Hungary's Energy and Water Security Countermeasures as Answers to the Challenges of Global Climate Change

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Weather extremities became more significant in Central Europe from the beginning of the 21st century. More frequent and severe droughts, floods, precipitations, storms, extreme high (or low) temperatures are occurring nowadays. It has become important also for Hungary to have proper legal and scientific background to fight against these phenomena. In recent years, several legal and technical regulations were born in Hungary as strategic answers for these challenges. The goal is to ease the consequences and adapt to the changes as much as possible. The authors selected some key areas and their interactions as the energy sector, water management and security issues. After describing Hungary's situation, related environment and the history of recent years' efforts in these areas, they summarise the responses and probable benefits of the Hungarian countermeasures as a possible positive example for answering the challenges of climate change.

Keywords: *climate change, low carbon, energy strategy, water management, agriculture, security*

Introduction

The new National Security Strategy of Hungary was introduced on 21 April 2020.[4] Comparing with its predecessors, this document puts much more emphasis on the issues of energy and energy security and in connection with these, global climate change as the cause of some related challenges. The preface of the document explains its own necessity with the recent changes of security environment, and among others, it appraises the speed up of the global climate change and the depletion of natural resources. Concerning fundamental values, the Strategy defines security in a broader sense, widening the traditional military security with political, economic, social, environmental, medical,

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4 Government Resolution 1163/2020, 'Hungary's National Security Strategy', *Magyar Közlöny*, 21 April 2020.

technological, information and cyber concerns. In the part of the nation's vision for the future, it visualises the key for Hungary's safety in the realisation of sustainable development.

The World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa in 2002 created the so-called WEHAB program (Water and sanitation – Energy – Health and environment – Agriculture – Biodiversity) that identified the problematic areas. The final document of the conference stated that, among others, the proper handling of problems emanating from water scarcity are needed and immediate measures are necessary to achieve sustainable water consumption.[5]

Practice of sustainable water consumption should provide, besides the fulfilment of communal needs, the subsistence of ground water levels as a fundamental requirement for the existence of connected ecosystems and economic activities (agriculture). During the defence of the quantity and quality of our water supplies, emphasised aims are the achievement of water saving and prevention of water contamination. In order to achieve these, important actions are: waste water purification and damage relieve, that is, the collection of the maximum possible amount of waste water that formed from drinking water, its purification in conformity with the regulations and finally their release back to surface waters with strict supervision.[6]

Such factors, as the increase of population, urbanisation, economic and social conditions play a more important role worldwide concerning water management than climate change. But in economically developed regions, where the number of population and water consumption per capita is more or less constant, climate change will affect water problems more intensively.[7]

Climate change and energy security

The majority of Hungary's energy supply comes from abroad, and the ratio of the import of fossil energy sources is extremely high, so when we are talking about energy security, the safety of the energy supply chain comes into the focus because of the country's foreign energy dependence. In this situation, energy security means the capability of gaining proper amount of energy continuously, calmly and on a reasonable price.

Hungary's greenhouse gas emissions have been changed in several stages since 1990. In the beginning of the 1990s, the cessation of the former socialist heavy industry (responsible for the majority of the emission), transformation of the structure of the economy and the decreasing output of agriculture together resulted a drastic decrease in greenhouse gas emission. In the next period, the change from coal to natural gas in the

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5 Tamás Berek, 'A vízbiztonsági tervezés szerepe a fenntartható vízgazdálkodásban' [The role of water security planning in sustainable water management], *Műszaki Katonai Közlöny* 26, no 2 (2016), 35.

6 Zsolt Andrási and Lajos Franczen (eds.), *A fenntartható fejlődés indikátorai Magyarországon, 2014* [Indicators of sustainable development in Hungary, 2014] (Hungarian Central Statistical Office, 2015), 34.

7 Mária Papp et al., *Távlati vízigények elemzése – Ivóvízfogyasztás/ivóvízigények megállapítása és előre becslésük Magyarországon* [Analysis of perspective water demands – Determination of drinking water consumption and demand in Hungary] (Central Water and Environmental Directorate, 2007), 84.

industry and the efficiency increase conserved this favorable process till nowadays while the economy still could grow. The world economy crisis of 2008 had a huge negative effect also on the Hungarian economy (almost 9%) resulting a further decrease in the emission. Concerning the effects of climate change, Hungary is one of the most vulnerable countries in Europe. To avert negative natural, social and economic consequences of climate change, the tasks of adaptation and preparedness especially in the areas of water management, security of agricultural yield, protection of our natural values and human health, even in the short term are built-in to our political planning and economic decisions. Tasks of domestic decarbonisation and climate adaptation is completed with a climate approach shaping program. These aims show the commitment of the Hungarian Government to create a more secure environment putting the emphasis on the wider use of renewable energy sources with "low carbon" profile of the economy and decrease of greenhouse gas emission. Nature conservation and the safety of our environmental resources also become of paramount importance.

The majority of the released greenhouse gases is related to the energy production and consumption (burning of fossil energy sources). This means, on the one hand, electric energy production and heat production (or cooling), on the other hand, fuel consumption in transportation. In addition, the so-called "fugitive emission" in close connection with energy production, which means the seeping methane gas during its transportation. The most important emitter within the energy sector is electricity production with 30%, then the consumptions of service industries, households and agriculture with 29% and transportation with 28%. The following table (Table 1) contains the energy production and consumption values from different sources of the country for the recent years.

Table 1: Hungary's energy production and consumption from renewables in the recent years

Energy sources (GWh)	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018
Nuclear	15,649	15,834	16,054	16,098	15,733
Coal and coal products	6,114	5,908	5,758	5,098	4,834
Natural gas	4,240	5,108	6,479	7,838	7,234
Crude oil	76	77	63	85	90
Biomass	1,702	1,660	1,493	1,646	1,799
Biogas	287	293	333	348	331
Renewable communal waste	137	208	245	160	162
Water	301	234	259	220	222
Wind	657	693	684	758	607
Sun	67	141	244	349	620
Geothermal	0	0	0	1	12
Other	173	204	290	284	360
Altogether	29,403	30,360	31,902	32,885	32,004

Primary consumption from renewables (TJ)	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018
Solid biomass	98,388	103,914	101,026	99,547	90,062
Biogas	3,323	3,335	3,708	4,141	3,850
Renewable communal waste	2,249	3,123	3,482	2,766	2,907
Biofuel	7,890	7,332	7,835	6,929	8,144
Water	1,084	842	932	792	799
Wind	2,365	2,495	2,462	2,729	2,185
Sun	647	956	1,346	1,749	2,759

Source: Compiled by the authors based on the Office of the Hungarian Energey and Public Utility Regulatory Authority, *Országos éves energiamérleg, 2020* [Annual national energy balance, 2020].

An important milestone was the creation of the National Energy and Climate Plan (its background was pro0vided with the 2018/1999/EU decree of the European Parliament and Council). Its working plan was created and handed to the Committee in January 2019. The aim was that the Plan should be in accordance with the NÉS-2[8] and the First Climate Change Action Plan,[9] should be climate politically relevant, and with the help of it, a complex and diversified service pack for energy policy solutions should be created for the different consumer sectors.

The National Energy and Climate Plan[10] contains definite objectives for both the emission reduction of greenhouse gases and increased use of renewable energy sources. Emission of greenhouse gases (GHG) should be reduced with at least 40% for 2030 (in comparison with the emission values in 1990). It means that the total GHG emission value should not exceed 56.28 million tons of CO_2 equivalent. The emission in 2017 was 64.44 million tons of CO_2, so the task is a further 8.2 million tons of cutting. In order to do so, the followings are necessary:

- Termination of the traditional coal-burning in power plants and the reduction of GHG emission to 7.30 million tons of CO_2 equivalent in energy industry.
- Maximalisation of GHG emission to 15.66 million tons of CO_2 equivalent in transportation with the limitation and reversal of a presently heavily increasing trend.
- Reduction of GHG emission of buildings to 8.07 million tons of CO_2 equivalent.
- Concerning industry, our goal is that the GHG emission may grow to a maximum of 11.37 million tons of CO_2 equivalent. Within this, despite of its growing, the industrial energy sector's emission should remain under 5.05 million tons, while the process industry's value under 6.32 million tons of CO_2 equivalent.

8 Ministry of National Development, *A 2017–2030 időszakra vonatkozó, 2050-ig tartó időszakra is kitekintést nyújtó második Nemzeti Éghajlatváltozási Stratégia* [Second National Climate Change Strategy 2017–2030, covering the period up to 2050, (NÉS-2)].

9 Ministry of Innovation and Technology, *A 2020 végéig tartó Első Éghajlatváltozási Cselekvési Terv* [The First Climate Change Action Plan until the end of 2020], 4.

10 Ministry of Innovation and Technology, *Magyarország Nemzeti Energia- és Klímaterve (tervezet)* [Hungary's National Energy and Climate Plan (draft)], 2018.

- In the agriculture, the increase of the GHG emission should have a maximum of 9.28 million tons of CO_2 equivalent, with an origin of 1.59 million tons of energetic and 7.69 million tons of non-energetic emission.
- In the waste management sector our goal is to reduce the total GHG emission to a maximum of 2.97 million tons of CO_2 equivalent.
- The aim in the rest of the sectors is to limit the GHG emission to a maximum of 1.63 million tons of CO_2 equivalent.[11]

Concerning renewable energy sources, Hungary's aim is the increase of their use up to 20% until 2030. In 2018, the ratio of the renewable sources in electric energy production was 8.3% and in the heating and cooling energy consumption was 18.1%.

The development of the photovoltaic systems appears as an important element in the national plan with the aim that the 700 MW built-in capacity from 2018 should grow up to 3,000 MW to 2022–2023. Cost forecasts for this technology indicate such consequent price reduction that capacity increase can predictably run with the same dynamics until 2030. Besides the increase of the percentage of solar cell systems, also important purposes are the spreading of electricity production with geothermic sources and the electric utilisation of biological materials produced on site in a sustainable way.[12]

In recent years, serious electric power-cuts raised the attention to the vulnerability of the energy sector. Climate change affects all the critical infrastructures but to a different extent. The energy sector is in contact with almost all the others, and highly depends on other critical infrastructures, so it has a special situation. Decrease in volume or efficiency of energy production can cause serious consequences in a very short term for all the national economy.[13]

The National Energy Strategy aims the evaluation of the "nuclear–coal–green" scenario, which rests on a balanced, varied fuel and technology structure containing all types of power plants. The primary aim for the capacity development is the increase of the ratio of renewable energy sources with the maintainance of the present production values with nuclear and coal based power plants. In order to achieve this, NÉS-2 describes short and mid-term action directives.

The short term action directive is the stimulation of the use of renewable energy sources, and for its optimisation with the transportation costs' reduction, the creation of local energy self-sufficiency capabilities. In order to this, not only the technical and economic

[11] Ibid. 38.
[12] Ibid. 22.
[13] Tamás Berek, ' Adaptációs lehetőségek az éghajlatváltozás következményeihez a biztonságtechnikában a közszolgálat területén' [Adaptation possibilities to the consequences of climate change in the field of security technology in public service], in *Adaptációs lehetőségek az éghajlatváltozás következményeihez a közszolgálat területén* [Adaptation possibilities to the effects of global climate change in the public service area], ed. by László Földi and Hajnalka Hegedűs (Budapest: National University of Public Service, 2019), 645.

conditions should be created, but forming of the local regulations is also necessary with the involvement of local governments.[14]

Because of the increasing frequency and power of the meteorological extremities as consequences of global climate change, the mid-term action directive is the development of flexibility and resiliency of the energy system as the increase of peak consumptions will predictably be growing. Development of network elements will be necessary as interconnectors and electric energy storage technologies together with financial and technological measures on the consumer side.[15]

Water management – water security

Besides the territorial and timely changes of water demand, the quantitative and more importantly qualitative changes of water bases will dominantly affect the possibilities of their fulfilment.[16] For this reason, besides the necessary infrastructural developments, the long-term target of the Action Plan is the forming of a nationwide social approach. Its elements are the followings:

- evaluation of conditions for a comprehensive drinking water network reconstruction program executed after 2020
- preparations for new legal rules for the newly constructed buildings for obligatory creation of built-in rainwater collecting installation
- researches for development of sanitary rules for application of non-utility and alternative drinking water sources (e.g. rainwater)[17]

More intense droughts increase water demand and at the same time limit water uses especially irrigation activities. The task is to develop more effective irrigation technologies and increase the water retention and water storage capacities of our country and provide adequate protection to our water supplies.

According to the prognoses, we should face more extreme precipitations in the future resulting sometimes in serious floods, sometimes in longer periods of droughts. The task seems to be very simple: save and store the extreme surplus water in rainy periods for the time when there will be no precipitation for months; but putting this simple thesis into practice means a lot of research, planning, engineering work, investment and constructions to work out. In 2003, the Hungarian Government accepted the so-called "Improved Vásárhelyi Plan" on the River Tisza in order to create a better defence system against floods and also provide water storage capacities for the dry periods.[18] But not all

14 Ministry of National Development, *A 2017–2030 időszakra vonatkozó, 2050-ig tartó időszakra is kitekintést nyújtó második Nemzeti Éghajlatváltozási Stratégia* [Second National Climate Change Strategy 2017–2030, covering the period up to 2050, (NÉS-2)].

15 Ibid.

16 Papp et al., *Távlati vízigények elemzése.*

17 Ministry of Innovation and Technology, *A 2020 végéig tartó Első Éghajlatváltozási Cselekvési Terv* [The First Climate Change Action Plan until the end of 2020], 39.

18 Ministry of the Interior, General Water Directorate, *A Vásárhelyi Terv Továbbfejlesztése* [Improved Vásárhelyi Plan], 2020.

the Hungarian rivers provide ideal circumstances for such developments. For example, the River Danube, as the largest river of the country, has such a high runoff that similar solution cannot be implemented for flood protection.

Another special problem emerged recently in our urban areas. As a consequence of climate change, extreme precipitation events also became more frequent and more intense there. During extreme rainfalls, the amount of water on streets exceeds the capacity of sewage systems, and city traffic can be blocked for hours. Water usually causes damages in cars and in buildings and local fire brigades have a lot of extra pumping work for days. Local waste water treatment plants can be overloaded if they use open air installations, and sometimes waste water surplus can flow into the rivers or lakes without purification.

Our water specialists are seeking for the solution with modifying sewage systems or enlarging or using existing city parks as green surfaces which can mitigate the effect on paved road surfaces.

Water management in agriculture

Effects of climate change appear differentially in time and space and can cause different damages in the agriculture depending on natural, land-use and agrotechnical features. In Hungary, the majority of environmental damages are emanating from droughts, followed by ice and water damages. Taking into consideration that as consequences of climate change the rise of summer average temperatures are expected together with the decreasing amount of summer precipitation, it can be stated that drought will be definitely the greatest challenge for our agriculture in the future.[19]

This can cause problems especially in areas where agricultural lands cannot be irrigated from surface waters and at the same time subsurface waters are difficult to reach or the amount of their demand and consumption exceeds the rate of their natural replenishment.

It can be stated that the greatest challenge for agriculture caused by climate change is the prognosed decreasing amount of precipitation in the growing season. For this reason, the main objective of the Climate Change Action Plan was the expansion of agricultural irrigation vindicating sustainable environmental and climate protection aspects in order to adapt to the drier climate. This plan contains the evaluation of the development's casemaps and as a part of it, the formation and operation of Operative Drought and Water Scarcity Management System's monitoring stations network.

In order to take appropriate steps to answer the challenges of climate change and water scarcity, it is necessary to survey and evaluate present conditions. The key aspects during the evaluation of economic values and capacities of our surface and subsurface waters is the assurance of a proper volume of surface waters and the expedience of waters providing agricultural water use.

In the future, some plant species can be emerged in the foreground, for which the changes in the Hungarian climate are beneficial, such as tomato, paprika, cucumber,

[19] László Földi and László Halász, 'Investigation of climate vulnerability of domestic natural and artificial ecosystems', *Hadmérnök* 14, no 2 (2019), 173.

melon, cherry, apple, plum and walnut. In case of wheat or corn climate is well known for the lifetime of the plant, since it is a few months, only. But we do not know, what kind of climate scenario will be emerging in 20–40 years. It means a special uncertainty in planting a forest or fruit trees since during the lifetime of these species climate change can modify the local circumstances thus becoming inadequate for them. It can cause problems in the next decades, yields or logging masses can lag behind expectations resulting financial and other losses.

Conclusion

Concerning sustainability, the use of renewable energy sources seems to be promising, and the zero GHG emission of nuclear power plants made them already popular worldwide (despite of their risk of nuclear disaster). They can play important roles in easing consequences of climate change, but at the same time, climate change itself has its own effects on these technologies.

According to estimations, our potential renewable energy capabilities at present exceed the total energy demand. But climate change will exercise an influence on the availability of renewable sources, and the extent of the changes cannot be foreseen these days. The utilisation of sun energy will be affected with the predictably increasing global radiation and the change of clouding. The use of water energy will depend on the future runoff of our rivers and wind energy will be affected by the changes in wind speeds. The future of agricultural energy sources are extremely uncertain. Future yields and of course prices of these energy sources' raw materials (as corn, rape, straw or firewood) are extremely dependant on the future tendencies of climate change which are not known exactly today.[20]

For this reason, the Climate Change Action Plan contains the evaluation of electric energy transfer and distribution system with the consideration of the possible long-term effects of climate change with special regard to guarantee the safety of energy supply.

Within all the renewables, the utilisation of sun energy is the most important, but all the others contain a lot of further potential capabilities. But a lot of obstacles interfere with the spread of the utilisation of these energy forms: absence of social acceptance, integration into the existing network, infrastructural and economic conditions. Most of the renewables highly depend on the climate, so its change can modify their utilisation possibilities (sun and biomass energies are the most affected).[21]

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[20] János Ősz and Csilla Kaszás, ' A megújuló energiaforrások hazai hasznosításának lehetőségei és korlátai' [Possibilities and limitations of the utilisation of renewable energy sources in Hungary], in *Környezettudatos energiatermelés és -felhasználás* [Environmentally conscious energy production and use], ed. by Valéria Szabó and István Fazekas [Debrecen: MTA DAB Megújuló Energetikai Munkabizottsága, 2011].

[21] János Mika and Ádám Kertész, 'A klímaváltozás és az energiaszektor kölcsönhatásai' [Interactions of climate change and the energy sector], in *Környezettudatos energiatermelés és -felhasználás* [Environmentally conscious energy production and use], ed. by Valéria Szabó and István Fazekas (Debrecen: MTA DAB Megújuló Energetikai Munkabizottsága, 2011).

Even now, within the frames of Hungary's new National Energy Strategy, the resiliency of our energy system is under investigation. Within the process, the key points are the followings:

- integration of the production with renewables into the system
- development of additional electric energy connections and strengthening of market integration in order to improve the operation and resiliency of the national energy system
- promotion and facilitation of consumer side counter measures
- better utilisation of control capabilities on the distribution networks
- improvement of technical and regulatory conditions to be able to use innovative technologies such as electric energy storage within the system
- spreading of digitalisation and smart devices[22]

To improve climate resilience of drinking water systems, a risk management part connecting to the extreme meteorological phenomena is needed into the drinking water security plans in the future. The drinking water security plans contain a comprehensive risk assessment and risk analysis about the whole water supply system from water collection to the consumer's tap. Because of climate change, negative events are predictable concerning the elements of the system, so as part of the risk assessment we should be prepared with adequate prevention and countermeasures. The Climate Change Action Plan provides a new methodology with the aim of modifying water security plans to handle extreme weather events more effectively. The drinking water security plan should contain risk analysis, risk assessment and risk management, control measures, description of the monitoring system with supplement about repairing and predicting activities and proper intervention plan plus emergency and disaster plans if necessary guiding through the whole water utility system in a documented way.[23]

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[22] Ministry of Innovation and Technology, *Magyarország Nemzeti Energia- és Klímaterve (tervezet)* [Hungary's National Energy and Climate Plan (draft)], 2018, 29.

[23] Zsuzsanna Dávidovits, 'Az ivóvízbiztonsági tervek készítésének nehézségei' [Difficulties in creating drinking water security plans]. Fiatal Higiénikusok Fóruma VII [7th Conference of Young Sanitarians], 10–11 May 2011, Gödöllő, Hungary.

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