Energy Strategy Reviews 40 (2022) 100817

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.elsevier.com/locate/esr

The Hungarian utility cost reduction programme: An impact assessment

Csaba Weiner [a], Tekla Szép [b,*]

[a] Institute of World Economics, Centre for Economic and Regional Studies, Eötvös Loránd Research Network, Tóth Kálmán utca 4, Budapest, H-1097, Hungary
[b] Institute of World and Regional Economics, Faculty of Economics, University of Miskolc, Miskolc-Egyetemváros, H-3515, Hungary

ARTICLE INFO

JEL classification:
P22
P28
Q41
Q48

Keywords:
Utility cost reduction
LMDI decomposition
Residential energy consumption
Energy policy
Consumer spending
Hungary

ABSTRACT

In Hungary, regulated energy prices fell by a quarter in 2013–2014 due to a state intervention. The objective of this article is to measure the effects of this change on the Hungarian residential energy consumption and assess the rationale, the policy context and other consequences of such an intervention. We decompose residential energy-use change in 2010–2018. We calculate 13.2 PJ of excess consumption relating to the programme, and find that the higher income deciles benefited the most from the lower prices compared to low-income households using market-priced lower-quality fuels and living in inefficient homes. The intervention lacked a strong policy background. The energy policy documents were later adjusted to the situation and finally the programme was linked to energy poverty. We point to price-setting failures and discrepancies between energy-efficiency goals and measures as well as negative effects of these and the programme itself. In the future, the policy emphasis should be on energy efficiency and supporting those really in need.

1. Introduction

The current energy transition cannot take place without the active involvement of the household sector, which accounts for a significant share of final energy consumption. In addition to the growth of renewables, energy efficiency is a key tool in reducing carbon dioxide emissions and thus mitigating climate change. In the mid-2010s, the European Union shifted its focus to environmental sustainability from other dimensions of security of supply, such as availability and affordability. Although favourable international energy prices between 2015 and 2020 may have diverted attention from the latter two dimensions, the sharp surge in energy prices in 2021 – on top of the Covid-19 pandemic – has again refocused decision makers on the issue of residential energy prices.

High energy costs, inadequate household income and obsolete housing stock often pave the way for energy poverty, generally referring to both the too-high share of energy costs relative to total household expenditure[1] and the inability to heat the home adequately. The concept of energy poverty first appeared in EU documents in 2009 due to the Third Energy Package, and is currently affecting tens of millions of people in the EU, with a wide variation of situations across the member states. In 2018, 6.1% of EU population (more than 31 million people) were unable to keep their homes adequately warm [2,3], 13.9% lived in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or the floor, and 6.6% of households had arrears on utility bills [4,5]. Around 100,000 deaths each year are believed to be caused by living in cold homes [6]. On the other extreme, 19.1% of EU population could not properly cool their homes in the summer [7]. Also in 2018, 20.0% of household consumption expenditure was devoted to housing and water and 3.9% to electricity, gas and other fuels [8].

Different indicators point to the prevalence and complexity of energy poverty. There is a need for simultaneous management of social problems, energy efficiency and other issues. Energy poverty also has country-specific characteristics that require differentiated interventions [9]. Nonetheless, there are three key points of intervention to reduce the ratio of energy expenditure to overall household income: to reduce high energy prices, to increase the relatively low disposable income and to enhance the energy efficiency of residential buildings. At these three points, available government tools and the timeline of expected impacts

* Corresponding author.
E-mail addresses: weiner.csaba@krtk.hu (C. Weiner), szep.tekla@uni-miskolc.hu (T. Szép).

[1] 'Household expenditure' corresponds to 'household final consumption expenditure' that consists of the total outlay on individual goods and services by resident households. Classified according to the Classification of individual consumption by purpose (COICOP), in this article, utility costs refer to the sum of the groups '04.4 Water supply and miscellaneous services relating to the dwelling' and '04.5 Electricity, gas and other fuels' (the latter hereinafter referred to as energy expenditure). These are expenditure subcategories of the expenditure division '04 Housing, water, electricity, gas and other fuels' (hereinafter, housing expenditure) [1].

https://doi.org/10.1016/j.esr.2022.100817
Received 25 June 2021; Received in revised form 19 January 2022; Accepted 26 January 2022

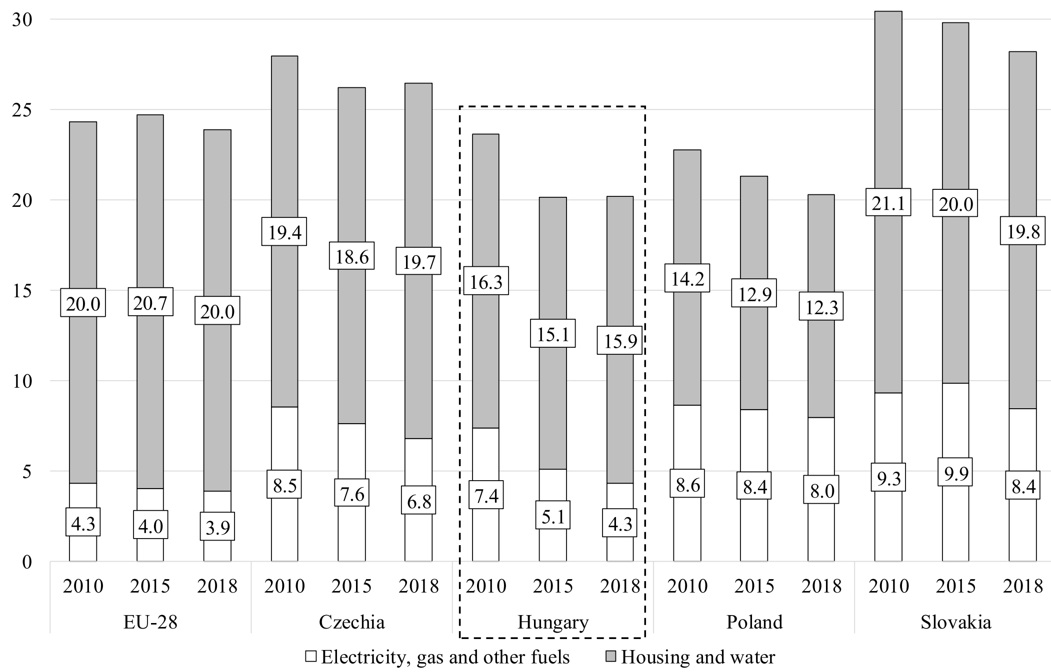


Fig. 1. Share of utility expenditure in total household expenditure in the Visegrád countries, 2010, 2015 and 2018 (%).
Source: Own compilation based on Eurostat [8].

are, naturally, very different. Decreasing energy prices is a very quick and dramatic way to change the situation.

Since the adoption of the Third Energy Package, significant steps have been taken to liberalise electricity and gas prices in the EU in order to achieve well-functioning retail energy markets. However, several EU nations have maintained some sort of price intervention in the household segment [10]. In 2016, the European Commission proposed that regulated (fixed) electricity prices should be phased out within five years, with certain derogations, but a number of member states – with Hungary having perhaps the loudest voice among them – insisted on preserving such price intervention. Finally, a compromise was reached in the Council at the end of 2017, allowing regulated prices to be kept in place for a limited time under certain circumstances, but this is to be followed up by the Commission in 2022 and 2025.

With fewer than 10 million people, Hungary is a relatively small Central and East European EU member state which came to international attention in the 2010s through its illiberal/authoritarian turn, Eastern opening towards Russia and China and quarrels with EU institutions. Prime Minister Viktor Orbán, who served first from 1998 to 2002, returned to power in 2010 after eight years of leftist/liberal governments. Since 2010, Viktor Orbán and his party Fidesz have dominated the Hungarian political landscape, winning three parliamentary elections in a row with a constitutional majority. An insistence on sovereignty is a particular attribute of the current Hungarian government.

In the 2010s, Hungary achieved positive social and economic results backed by EU funding and a favourable international financial market environment. After experiencing a contraction in 2009, Hungary's GDP per capita, expressed in purchasing power standard (PPS), stood at around only 67–68% of the EU average in the early 2010s [11]. Between 2010 and 2018, the economy delivered an average GDP growth rate of 2.6%, including both a 1.4% decrease in 2012 and a 5.4% increase in 2018 [12], which has helped reach a GDP per capita figure equivalent to 71% of the EU average, though only 11% points higher than in 2007. While improvements have been reflected in wage increases, poverty reduction and the growth in actual individual consumption per capita (a measure of material welfare of households), such indicators place Hungary in a poor position in an EU or even a Visegrád comparison, with the latter comprised of Czechia, Hungary, Poland and Slovakia.[2]

In terms of gas and electricity prices for households measured in current prices, Hungary belonged to the middle range of EU countries and also of the OECD in 2010. But the picture changes dramatically if figures are expressed in PPS. In this case, in 2010, the highest gas and electricity prices were reported in Hungary but the other three Visegrád countries also ranked in the first half of the list (Figs. 2 and 3) [13,14]. In 2010, the share of utility payments in the total annual household expenditure in Hungary amounted to 23.7% and that of energy expenditure 7.4%. However, a high share of energy expenditure is not unique in the European Union. In 2010, it was much higher in the Visegrád countries than in Western Europe or compared to the EU average (Fig. 1) [8]. In the early 2010s, the unemployment rate was high in Hungary and many households were burdened by foreign-currency mortgage loans, which had been very popular before the global economic crisis of 2007–2009, but whose payments had become difficult to meet after the exchange rates depreciated markedly. For large segments of society, the payment of utility bills had become an everyday challenge. In the worst year, 2013, 25.0% of households had arrears on utility bills. The share of population at risk of poverty (below 60% of national median equivalised disposable income) having arrears on utility bills reached 60.7% that year [5].

In Hungary, the residential sector has the largest final energy demand [15] and the greatest potential for energy savings lies here, with a need to make both energy efficiency and energy conservation a very high priority. Both despite and due to its poor socio-economic indicators in an EU or even a Visegrád comparison, Hungary has one of the highest levels of household energy consumption per dwelling after climate correction in the EU, and it reported some of the worst progress in energy efficiency in the periods of 2000–2014 and 2014–2019. Energy efficiency barely improved in the latter period [16]. With a hydrocarbon-dominated energy mix [17], Hungary has a high energy import dependency rate [18]. Therefore, domestic energy prices are to a large extent reliant on factors determined outside the Hungarian borders.

[2] These sources are cited where they occur in the text.

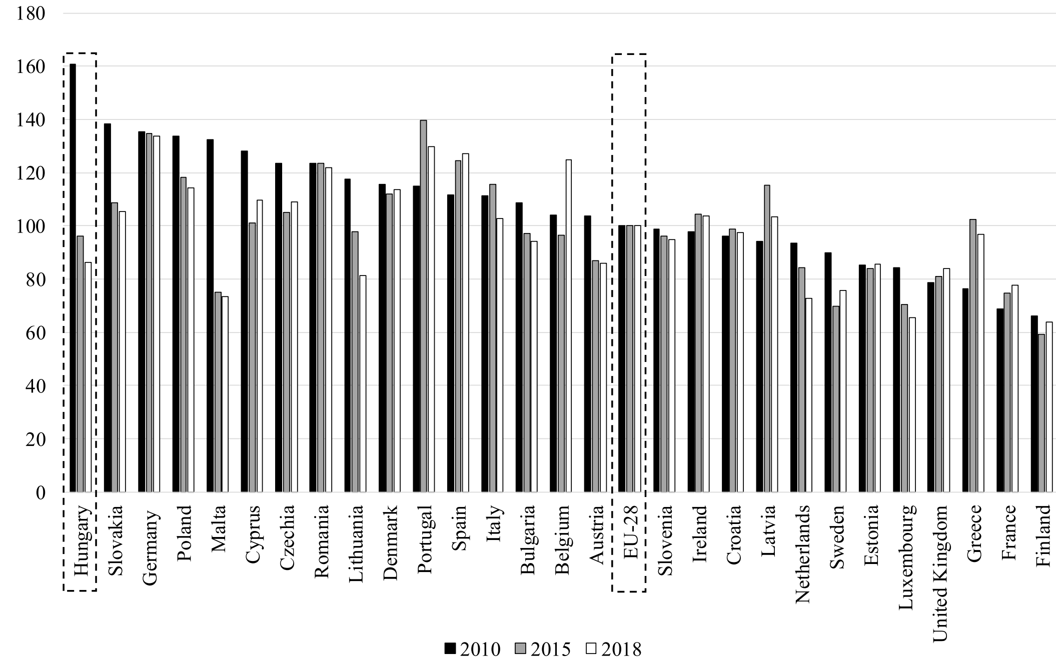


Fig. 2. Electricity prices (including all taxes and levies) for medium-sized household consumers (with an annual consumption of between 2500 and 5000 kWh) in the EU member states, 2010, 2015 and 2018 (EU-28 = 100; EUR, PPS per kWh).
Source: Own compilation based on Eurostat [13].

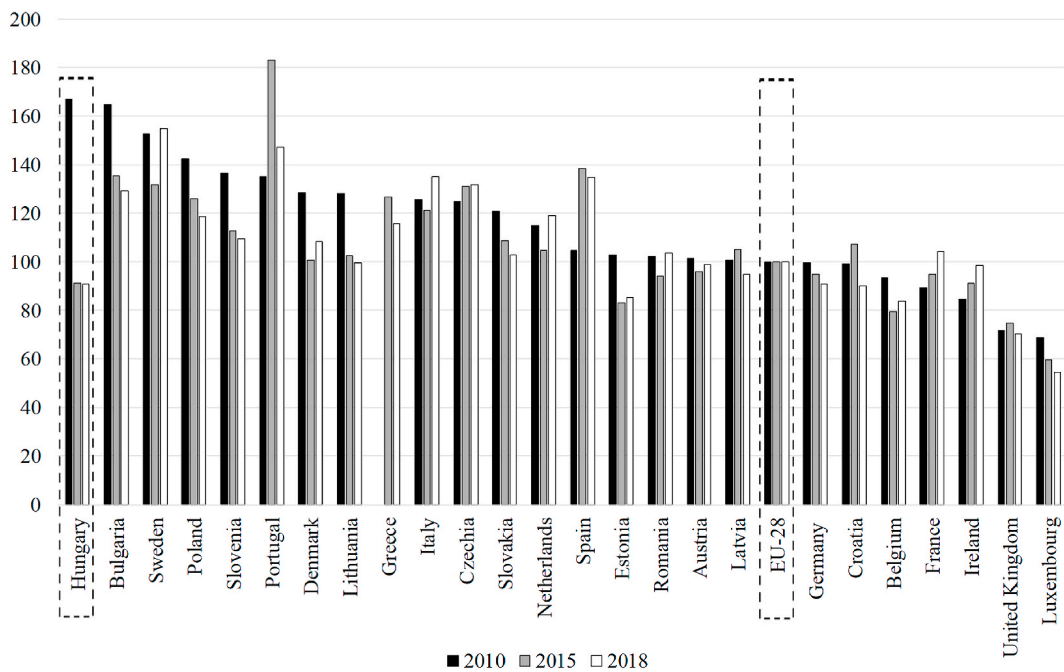


Fig. 3. Gas prices (including all taxes and levies) for medium-sized household consumers (with an annual consumption of between 20 GJ and 200 GJ) in the EU member states, 2010, 2015 and 2018 (EU-28 = 100; EUR, PPS per GJ).
Source: Own compilation based on Eurostat [14].

Nevertheless, the fragile economic situation of Hungarian households and the large share of utility costs in household budgets in conjunction with agenda-setting purposes prompted the Hungarian government to launch a comprehensive and significant utility cost reduction campaign in 2013, also involving non-energy utility costs,[3] which fall outside of the focus of this article. Natural gas, electricity and district heating prices were reduced permanently in the household sector in three consecutive steps between 2013 and 2014:

– In the first phase, between January and October 2013, the price decline was 10% for the three energy sources;
– In the second phase, starting from November 2013, a further 11.1% price cut was made for the three energy sources;

[3] The programme has affected water supply and sanitation as well as waste collection and chimney sweep costs.

– As part of the third phase, residential consumer prices for natural gas were decreased by 6.5% from April 2014, for electricity by 5.7% from September 2014 and for district heating by 3.3% from October 2014.

Consequently, prices paid by households fell by a total of 25.2% for natural gas, 24.6% for electricity and 22.6% for district heating, while liquefied petroleum gas (LPG) prices were also reduced by 10% in this period. Residential prices for natural gas, electricity and district heating have been fixed and remained unchanged for everyone since then. The price reduction is unified; it is not differentiated according to the income levels of households. On top of these points, one can argue that a 'hidden utility cost reduction' has also taken place because since the start of the utility cost reduction programme, these energy prices have not been adjusted for inflation, which means that they have been decreasing in real terms.[4]

The programme started less than a year and a half before the April 2014 parliamentary elections, and utility prices ended up being one of the major campaign points for the ruling party. Prior to the parliamentary elections in April 2018, the government decided on a further but small one-off subsidy of HUF 12,000 (some EUR 40), called the winter utility cost reduction. This focused on heating, and ultimately households using piped gas, district heating, firewood, coal and LPG became part of the campaign. The subsidy was provided as a price compensation payment credited into the customers' accounts, an in-kind transfer or cash support depending on the availability of piped gas and district heating services and on the household fuel usage profile. Those who were eligible to receive an in-kind subsidy had to apply for the fuel. In this case, the deadline was longer; thus, these consumers gained access to the fuel later.

The programme has been occupying a high-profile place on Hungary's political agenda for almost a decade. It has received great attention abroad not only because of the programme itself, but also because of its impacts on both the national and European Parliament elections in 2014 as well as Hungary's relations with the European Union. In contrast to the 2014 elections, the programme was no longer the main campaign point in 2018, as the issue of migration took its place as the exclusive agenda setter. However, in 2020, the government made the programme the main official tool in the fight against energy poverty, and high energy prices of 2021 have led to the resurgence of the issue of utility cost reduction. The government even capped motor fuel prices for three months from November 2021, and in December 2021 it allowed small and medium-sized enterprises to opt for regulated electricity and gas tariffs for half a year. The residential energy cost reduction programme has, therefore, not lost its relevance and has remained one of the defining regulatory features of the domestic energy market, buffeted by political emotions.

This article is a continuation of our previous work [19], which provided a first attempt to analyse the effects of the utility cost reduction. Despite the importance and consequences of the programme, no other study has yet been conducted that thoroughly examines this Hungarian issue, although when the measures were introduced, calculations were made as to who would ultimately fund the programme [20,21].

This article is more than a kind of a monitoring or follow-up. It has two main goals. The first is the same as before: using the logarithmic mean Divisia index (LMDI) to determine the effects of suddenly falling residential energy prices in Hungary on household energy consumption and to quantify what factors (intensive structural effect, extensive structural effect, expenditure effect and population effect) offset or reinforced this price effect. However, we are now relying on an adjusted methodology for evaluating a longer period, 2010–2018, also including the low-impact 2018 one-time subsidy, instead of 2010–2015. There are five methodological changes which prompt us to reconsider previous results and conclusions. The first is a significant change in official statistics for measuring Hungarian renewable energy consumption. In Hungary, 50–60% of the firewood consumed is of unknown origin and potentially sourced from illegal logging. This is highlighted by the sum of domestic firewood, energy crops production and firewood imports, which does not match the total for firewood used. Therefore, in order to capture the real size of biomass consumption, statistical data were significantly modified in 2017. The national energy regulator moved from using supply-side statistics to statistics referring to household energy consumption, resulting in drastically increased residential biomass (firewood) consumption and thus total final energy consumption, consequently reflected in the share of energy from renewables. For example, the final consumption of renewables for energy use in 2013 – the year when the utility cost reduction programme was introduced – increased from 49 PJ to 102 PJ, and the total final consumption for energy use from 641 PJ to 681 PJ. This suggests that the results of the 2017 article can only be accepted with reservations (Fig. A1 in the Appendix) [22–26].

The other four methodological changes include those we introduce to improve the methodology. The first three of the four are related to climate corrections. First, we calculate individual heating shares for each energy source.[5] Earlier a reference value was applied to the heating share for normal year in the decomposition analysis. However, Hungary is in a special situation regarding heating. Compared to the EU average, gas is overrepresented, electricity is underrated, and the dispersion of the heating share by energy sources is relatively high. Thus, the calculation of individual heating shares for each energy source helps capture these Hungarian peculiarities. Second, we involve the so-called 'share of heating dependant on degree days' for more accurate climate corrections. We take into account the technical characteristic that energy use for heating depends not only on the weather. Most devices, such as boilers, also consume energy when operating in summer mode. To handle this, the above new factor is introduced, and applied in the climate correction. Third, this time, we use climate-corrected data not only for residential energy consumption but also for energy expenditure in order to ensure the balance between the two sides of the decomposition formula.[6] Fourth, we set up an adjusted price effect component for those energy sources included in the utility cost reduction so as to separate the price effect of the energy sources falling outside the scope of the programme. We call this effect the intervention price effect. Previously, we used the total price effect to determine the effect of the utility cost reduction, but due to methodological changes in renewable data collection, firewood constitutes a notable part of residential energy consumption, the separation of which significantly improves the reliability of the results. For example, in 2013–2014, prices for electricity, gas and district heating fell, but those for firewood went up. Price effects with opposite signs partly cancel each other out, i.e. offset each other, but the new methodology makes these processes visible (Table 4). Fifth, in addition to these, on this occasion, a more sophisticated interpretation is provided due to analysing the price, intensive structure, extensive structure and expenditure effects in Hungary also by income deciles and energy sources for the first time.[7] While the first four points make our calculations more accurate, the fifth point, and in part also the fourth point, makes them more detailed. As for the fifth point, the original methodology was adequate to perform an impact analysis on the society as a whole, while the new methodology allows us to measure changing energy consumption of the lower, middle and upper classes, and to put a focus on energy poverty, a topic that became a key government argument in favour of the utility cost reduction programme years after the original paper. Table A1 in the Appendix shows the differences between calculations based on (1) the old methodology, (2) the old methodology

[4] *Olivér Hortay* brought this point to our attention (26 October 2020).

[5] This is based on a suggestion by one of our anonymous reviewers.

[6] This was proposed by *László Szabó* from Hungary's Regional Centre for Energy Policy Research (2 December 2020).

[7] The price and intensive structure effects can be examined both at the levels of income deciles and energy sources, but, by implication, the extensive structure and expenditure effects only by income deciles.

with adjusted renewable energy consumption statistics and the inclusion of the 2018 winter utility cost reduction programme and (3) the new methodology with adjusted renewable energy consumption statistics and the inclusion of the 2018 winter utility cost reduction programme.

The second goal of this article, which was not addressed in the original paper, is to provide a complex understanding of Hungarian residential energy consumption patterns and price regulation and the policy perspective in which the research results and thus the antecedents and the consequences of the programme can be interpreted. Without this, real conclusions and policy implications cannot be ascertained. The overview of the residential energy consumption is given through the lens of the intervention points available to reduce the ratio of energy expenditure to overall household income. The discussion of the policy perspective is divided into three parts. First, we assess Hungarian energy policy documents released since the formation of the new government in 2010 in order to understand the Fidesz-led government approach towards regulated prices and, in relation to these, the issues of energy efficiency, energy poverty and security of supply. The key documents reflecting current trends in government thinking are Hungary's National Energy and Climate Plan (NECP), the National Energy Strategy (NES) 2030 with an Outlook to 2040 and Hungary's Long-Term Renovation Strategy (LTRS). The NECP and the NES were released in January 2020 and the LTRS in July 2021. Second, we assess how regulated prices relate to market fundamentals and the consequences of the prevailing situation. Third, goals, measures and achievements are evaluated in residential energy consumption and energy efficiency. Therefore, in this article, a quantitative method is combined with qualitative analytical tools to obtain a broad analysis.

We can find examples for applying the LMDI method to EU countries in examining energy efficiency, but the literature lacks analyses similar to our work. However, we can identify such LMDI studies for emerging markets and developing economies, such as China, Kazakhstan, Hong Kong or Iran. These papers tend to reveal the effects of the elimination of regulated prices, but examples also exist for the effects of cuts in regulated prices. They find that price changes affect income groups differently, and many households respond by switching to other forms of energy. A common and obvious conclusion is that energy prices have an impact on household energy consumption [27–32]. Our paper also makes an empirical contribution by documenting a textbook example of how the theory applies to practice in an EU member state. Considering both the positive and negative consequences, Hungary can set an example for other countries in the future.

The rest of the article is organised as follows. Section 2 explains the residential energy consumption patterns and price regulation in Hungary. Section 3 describes the methodology and data. It introduces the LMDI method and considers international experiences related to the topic. Section 4 presents the index decomposition results and the processes which lie behind these figures. Section 5 discusses the policy perspective. Finally, conclusions and policy implications are offered at the end of the article (Section 6).

2. The Hungarian residential energy consumption patterns and price regulation

In 2018, Hungary's gross inland and final energy consumption reached 1118 PJ and 747 PJ, respectively, whereas residential final energy consumption was 244 PJ, or 271 PJ if corrected by climate (Table 1) [23]. The climate-corrected final energy consumption of the Hungarian household sector declined between 2012 and 2014, but growth was seen in the period of 2015–2017.

Most household energy consumption (71.7% in 2018) goes on heating homes. The remaining share of energy is almost exclusively for water heating (12.8%) and the use of lighting and electrical appliances (excluding the use of electricity for powering the main heating, cooling or cooking systems) (10.4%). Space cooling accounts for a negligible proportion of residential final energy consumption (0.2% in 2018), but the share for cooling continues to increase [33,34].

The largest part of the residential final energy consumption is covered by natural gas (48.6% in 2018), followed by renewables (23.5%), electricity (16.8%), district heating (8%), solid fossil fuels (1.6%) and oil and petroleum products (1.3%) (Table 2). Gas (56.3% in 2018) and renewables (32.0%) cover the bulk of the energy needs for space heating. District heating accounted for 8.3% of space heating in 2018, but gas provides close to 70% of total derived heat production (such as district heating), which put additional emphasis on the importance of gas [33]. The residential sector takes the largest share of Hungary's gas consumption [35]. Piped gas is available almost all over the country and is frequently used. More than 90% of the Hungarian settlements are supplied with piped gas, and around three-quarters of the households use it [36]. Subsidised domestic gas prices significantly contributed to the massive penetration of gas in households. In contrast, solid fossil fuels, electricity and oil and petroleum products (including LPG) represented only 2.3%, 0.8% and 0.2% in space heating, respectively [33].

As mentioned, the ratio of energy expenditure to overall household income is mainly determined by the energy prices, the amount of disposable income and the level of energy efficiency of residential buildings, but other factors, such as energy conservation, also come into play.[8] In 2000, Hungarian households spent only 17.7% of their total expenditure on housing, compared to over 25% in 2010, as reported by the Hungarian Central Statistical Office (KSH) [37].[9] The shift between the two items can be explained by decreasing food-related expenses of households. Generally, stagnating or declining incomes force consumers to change their buying habits in favour of cheaper products. However, since housing expenditure is inelastic in the short term (and only relatively elastic in the long term), households face a great burden to adapt to such challenges [38]. Since 2013, the two ratios seem to have been moving in opposite directions. Consequently, between 2014 and 2018, the expenditure on food and non-alcoholic beverages accounted for the biggest item, with 24.6% share of the total in 2018, while the share of housing expenditure declined to 19.3% (the share of utility costs was 15.8% in 2018 and that of energy expenditure 11.4%) [37]. The share of energy expenditure in the total annual expenditure had decreased in the Visegrád region by 2018 (Fig. 1), but while such expenditure in current prices increased by more than 17% in Slovakia and Poland and remained almost unchanged in Czechia, it decreased by 26.4% in Hungary between 2010 and 2018 [8].

Due to the high share of gas in residential energy consumption, the rise and fall of gas prices is the most critical for the Hungarian population, but prices of firewood, electricity and district heating are also important issues. In contrast to firewood, regulated prices provide an opportunity to reduce utility costs in the cases of natural gas, electricity and district heating. Currently, only households and other selected consumers, such as small businesses, have the right to purchase gas and electricity at regulated prices in the so-called 'universal service', introduced for electricity in January 2008 and for gas in July 2009. Residential gas and electricity customers served with market-priced supply are a rare phenomenon in Hungary, but they have the option to buy gas and electricity in the unregulated segment. The change in the universal service pricing came after Fidesz won the parliamentary elections in spring 2010, ending a system in place between January 2008/July 2009 and June 2010, when prices were calculated by service providers, and their proposals were submitted to the energy regulator, who then

[8] However, residential energy consumption is affected by many other factors, such as energy structure (mix); urbanisation; type, size and conditions of buildings; type, number and energy efficiency of household devices; household size and type; employment status and medical conditions of household members; other consumer habits. In this article, we cannot address all these points.

[9] In total terms, there is only a slight difference between housing expenditure data from Eurostat [8] and KSH [37]. However, on the level of subcategories, significant differences can be found due to varying data collection methods.

Table 1
Energy consumption in Hungary, 2010–2018 (PJ).

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gross available energy	1113.4	1091.2	1037.1	1001.5	997.4	1055.2	1068.5	1116.0	1118.0
Gross inland consumption	1113.4	1091.2	1037.1	1001.5	997.4	1055.2	1068.5	1116.0	1118.0
Gross inland consumption (Europe 2020–2030)	1113.4	1091.2	1037.1	1001.5	997.4	1055.2	1068.5	1115.7	1117.6
Primary energy consumption (Europe 2020–2030)	1030.7	1021.2	968.6	938.1	920.9	975.4	990.4	1024.2	1024.9
Final energy consumption (Europe 2020–2030)	730.6	732.4	689.7	694.4	679.1	728.5	744.3	773.8	775.1
Available for final consumption	789.7	778.8	744.6	734.9	723.4	776.1	791.0	829.9	832.3
Final consumption for energy use	706.7	708.3	670.0	680.6	660.5	704.6	724.6	747.7	746.7
Households	278.4	275.1	266.9	260.0	229.7	249.9	258.4	263.5	243.6
Households (climate corrected)	277.2	281.6	276.1	274.3	268.0	269.5	271.4	274.5	270.9

Note: In the article, we use the term 'final consumption for energy use' and not 'final energy consumption (Europe 2020–2030)' when referring to final consumption. 'Gross available energy' is equal to 'gross inland consumption' because of the lack of international maritime bunkers in Hungary.
Source: Eurostat [23] and own calculations.

Table 2
The structure of residential energy consumption and expenditure by energy sources in Hungary, 2010–2018 (PJ, %).

Year	Unit	Energy source							
		Gas	Total petroleum products	District heating	Solid fossil fuels	Primary solid biofuels	Other renewables	Electricity	*Total*
2010	PJ	136.5	5.6	23.9	6.2	65.6	0.2	40.3	*278.4*
	% (PJ)	49.0	2.0	8.6	2.2	23.6	0.1	14.5	*100.0*
	% (HUF)	37.0	2.8	10.7	12.2[a]		–[b]	37.3	*100.0*
2011	PJ	124.2	4.4	22.1	7.2	76.2	0.3	40.7	*275.1*
	% (PJ)	45.2	1.6	8.0	2.6	27.7	0.1	14.8	*100.0*
	% (HUF)	36.6	3.2	11.2	13.3[a]		–[b]	35.8	*100.0*
2012	PJ	113.2	3.3	22.5	6.4	83.0	0.3	38.2	*266.9*
	% (PJ)	42.4	1.2	8.4	2.4	31.1	0.1	14.3	*100.0*
	% (HUF)	35.1	3.2	11.3	15.4[a]		–[b]	35.0	*100.0*
2013	PJ	105.2	3.6	21.9	5.6	85.3	0.4	38.1	*260.0*
	% (PJ)	40.5	1.4	8.4	2.1	32.8	0.1	14.6	*100.0*
	% (HUF)	34.0	3.1	11.4	16.1[a]		–[b]	35.4	*100.0*
2014	PJ	97.2	3.1	18.1	4.3	69.1	0.4	37.5	*229.8*
	% (PJ)	42.3	1.3	7.9	1.9	30.1	0.2	16.3	*100.0*
	% (HUF)	33.6	3.1	10.7	18.4[a]		–[b]	34.1	*100.0*
2015	PJ	109.9	3.1	19.6	4.0	73.9	0.4	39.0	*249.9*
	% (PJ)	44.0	1.2	7.8	1.6	29.6	0.2	15.6	*100.0*
	% (HUF)	33.6	3.2	10.0	19.2[a]		–[b]	34.0	*100.0*
2016	PJ	117.8	2.5	20.6	5.0	72.0	0.5	39.4	*257.8*
	% (PJ)	45.7	1.0	8.0	2.0	27.9	0.2	15.3	*100.0*
	% (HUF)	35.1	3.0	9.5	19.0[a]		–[b]	33.5	*100.0*
2017	PJ	124.4	3.1	20.9	5.9	68.0	0.9	40.5	*263.7*
	% (PJ)	47.2	1.2	7.9	2.2	25.8	0.3	15.4	*100.0*
	% (HUF)	36.5	2.8	9.2	18.4[a]		–[b]	33.2	*100.0*
2018	PJ	118.5	3.2	19.6	4.0	56.6	0.8	40.9	*243.6*
	% (PJ)	48.6	1.3	8.0	1.6	23.2	0.3	16.8	*100.0*
	% (HUF)	35.5	2.6	9.0	19.7[a]		–[b]	33.2	*100.0*

[a] The Eurostat [8] and KSH [16] databases are compatible with each other, and only a small difference can be seen. KSH [16] merges expenditure data of solid fossil fuels and primary solid biofuels into one category called solid fuels. Therefore, these data show the share of residential energy expenditure on solid fuels.
[b] The ratio of residential energy expenditure on other renewables is 0% because these renewables, such as solar, have zero or negligible marginal costs of production.
Source: Own calculations based on Eurostat [8] (for data in PJ) and KSH [16] (for data in HUF).

approved them. In 2010, more intense governmental control started in Hungary. With effect from July 2010, the energy regulator was demoted to carry out only preparatory tasks for ministerial decrees on regulated electricity and gas prices, and Hungary's National Development Ministry became the price-setting authority. Presently, the Ministry for Innovation and Technology performs this task.

In the 2010s, the government introduced certain taxes burdening the energy sector, while the energy regulator started to undertake a special role, characterised by strong government control and in some cases unquestionable decisions.[10] The latter is related to the centralised decision-making that can be observed at policy level.

Under the new government, regulated gas prices remained unchanged in the second half of 2010, while electricity prices decreased in July 2010, with the latter still being approved by the energy regulator. However, in 2011 and 2012, the two years before the utility rate cuts, regulated gas and electricity prices both increased, though in 2011 there was no price increase for consumers using under a certain amount of gas, and discounts on gas prices for large families (those with at least three children) were introduced that year. Regulated gas and electricity prices in the universal service are not uniform across the country, but differ across distribution companies.

In contrast to electricity and gas, there had not previously been central price regulation for district heating; this was a municipal competence, though between 2009 and 2011, district heating prices were subject to price control by the energy regulator. Accordingly, district heating providers submitted their requests for price changes to the energy regulator before municipalities made their decisions on prices capped by the energy regulator. In the new situation, as a first step, prices were frozen in March 2011, and with effect from April 2011 district heating also brought under central price regulation. However, in the end, in 2012, district heating prices rose. Therefore, the utility cost reduction programme was preceded by price increases for gas, electricity and district heating, made by the same government.

The LPG market is a special case because steps have been taken in a

[10] *András Deák* provided some background information on these issues (16 December 2019).

free market to achieve price reductions via the utility cost reduction programme. In the case of the concerned products, price regulation as part of the utility cost reduction programme refers to price decreases as of July 2013 compared to market prices on 1 December 2012. Prices charged by suppliers entering the market after 1 December 2012 are set by the energy regulator.

In parallel to the utility cost reduction programme, the Hungarian energy landscape went through a major renationalisation campaign, expanding both state assets and 'special domestic private property', the latter having close and intensive coordination with the government and typically referring to assets owned by Lőrinc Mészáros, a former gas-pipe fitter and later a mayor in Viktor Orbán's quasi-home village, who is perceived by the public as having become a billionaire due to his friendship with Viktor Orbán and winning contracts from the government.

In the mid-2010s, multinational companies dominated gas and electricity distribution and retail, while state-owned companies led the gas and electricity wholesale market after the government acquired the dominant gas wholesaler from one of the multinationals. Recent new dynamics refer to exiting multinationals and entering state-owned and domestic private companies in gas and electricity distribution and retail, with a single state-owned player in the regulated prices segment of the gas retail market because other players withdrew from the universal service in gas.[11] Meanwhile, district heating systems are owned by the municipalities.

In Hungary, between 1995 and 2012, prices of food and other commodities, including fuel for vehicles, have generally moved with the inflation index, but prices of services, especially those of residential energy, increased at a rate higher than the inflation rate. The utility cost reduction programme largely contributed to lower inflation that went negative in 2014 (−0.2%) and 2015 (−0.1%) from the high of 5.7% in 2012 [39], though it has been rising again since 2016. By 2018, Hungary had drastically improved its position in the EU ranking of residential gas and electricity prices in PPS, moving into the middle third range of countries both in terms of electricity prices (18th highest) and gas prices (19th) (Figs. 2 and 3) [13,14]. Gas and electricity prices had become more favourable in Hungary than in the other three Visegrád countries. While there is no price regulation for gas and electricity in Czechia, in 2019 almost all or all households in the other three Visegrád countries were supplied with gas and electricity under a price intervention mechanism [10].

Since in Hungary most household energy is used for heating, also the largest utility cost item, a particular issue for households is whether their heating is among the beneficiaries of the utility cost reduction. Just under two-thirds of the energy used has been subsidised under the permanent price cut, i.e. those customers who heat their homes with natural gas, district heating, LPG and electricity. However, the cost of the remaining roughly one-third of energy, i.e. firewood- and coal-heating households, has only been supported by the winter utility cost reduction programme. At the same time, firewood and coal prices increased 1.5 times between 2010 and 2018 [40]. Naturally, a household can combine multiple energy sources for heating, but in practice this is often unfeasible for the poorest households. These customers have only benefitted from the permanent programme by other types of end use, as subsidised electricity is used for lighting and other electrical appliances, or these households may consume subsidised energy sources for cooking and water heating. However, firewood and coal use is overrepresented among low-income households and is most prevalent in districts having a worse social situation [41]. As early as September 2013, it was announced that there were plans to reduce the burden on families using wood and coal for heating, but the 2018 winter utility cost reduction was all that was achieved [42]. The 2018 winter utility cost reduction programme should not be confused with the issue of the 'social fuel' programme introduced in 2011 for receiving firewood or brown coal. The financial support is claimed by the municipalities from the Ministry of the Interior and then the purchased fuel is distributed by local governments on the basis of social criteria. Although increasing in the 2010s, the programme has a low budget, despite the fact that heating subsidies are important because of the effects of poverty on health and environment. Ambient (outdoor) and household (indoor) air pollution is a palpable problem during the heating season in Hungary due to the combustion of low-quality fuels and waste in old, inefficient and unmaintained heating appliances, ignoring guidelines for proper use [41]. However, special attention is paid to the 'social fuel' programme in the Hungarian Long-Term Renovation Strategy. Together with the regulated prices, it serves as a background to managing the problem of energy poverty and related health issues [43].

In the early 2010s, the low level of gas consumption, the declining share of gas and, conversely, the increase in the role of firewood were mainly explained by affordability reasons, while only a minor role was played by other aspects (including energy conservation and efficiency or foreign employment and emigration) [44]. Household gas consumption peaked at 164.5 PJ in 2005 and was at 118.5 PJ as of 2018 [23,45]. This is a much lower level, but since 2015 an upward trend has been observed, with 21.9% higher demand in 2018 than in 2014. These good years for gas have strongly been linked to the utility cost reduction programme, and are partly due to consumers switching back from firewood to gas. The consumption fluctuations of renewables signal that households consider biomass an alternative source for heating. Its share in residential energy consumption was still over 30% in each year between 2012 and 2014, compared to just above 23% in 2018. Between 2014 and 2018, the share of firewood decreased and that of gas increased [23]. It cannot be excluded that the importance of natural gas would have declined further without the utility cost reduction programme. The volume of electricity consumption decreased slightly during the period of 2012–2014, but it has been growing again since 2015 (Table 2).

According to the calculations of Hungary's Ministry for Innovation and Technology, the utility cost reduction programme resulted in a total of HUF 1700 billion savings to Hungarian households during the period of 2013–2019 [46]. We estimate a much lower figure of HUF 632.5 billion for that period. This represents an average of 0.3% of annual GDP between 2013 and 2018. Between 2010 and 2018, per capita adjusted gross disposable income of households and actual individual consumption per capita, both measured in PPS, grew in real terms at average annual rates of 3.1% and 2.6%, respectively, though in absolute terms, the other three Visegrád countries are better off than Hungary [47,48]. Gross debt-to-income ratio of households fell from 67.9% in 2010 to 33.4% in 2018 in Hungary [49]. In 2018, only 11.1% of households had arrears on utility bills, compared to 22.1% in 2010 [5]. In parallel, the share of the total population at risk of poverty or social exclusion dropped from 31.5% or 2.9 million in 2010 (34.8% or 3.3 million in 2012) to 19.6% or 1.9 million in 2018. In 2018, this ranked Hungary in the middle range of poverty across EU member states, while Czechia (12.2%) and Slovakia (16.3%) had among the lowest poverty rates, and Poland was also better placed (18.9%) than Hungary. Nevertheless, this rate has improved the most in Hungary since 2010 [50]. In contrast, the drastic decline in extreme poverty in Hungary from 3.4% or 331,000 in 2010 (and 4.9% or 481,000 in 2013) to 1.2% or 119,000 in 2018 is in significant part attributable to statistical measurement in relation to those employed in the Public Works Scheme [51,52].

Since households have the largest potential for final energy savings, they are critical in reaching final energy consumption and savings goals. Buildings are at the heart of energy savings. The largest potential lies in the renovation of existing residential homes. The 2015 National Building Energy Performance Strategy set the target for primary energy savings from renovation of residential buildings to be achieved at 38.4 PJ per year by 2020: 17.6 PJ from single-family detached homes, 12.8 PJ from prefabricated apartment blocks and 8.0 PJ from traditional multi-

[11] *Balázs Felsmann* provided valuable comments on this part of the paper (2 December 2020).

family residential buildings [53]. Nearly 80% of Hungarian homes fail to meet modern functional technical and thermal engineering requirements. The energy efficiency of buildings built between 1946 and 1980 is particularly poor, among which single-family detached houses are the least efficient [54].

According to Eurostat [2], the share of the Hungarian population having difficulty obtaining the necessary energy in their home to meet basic needs decreased from 10.7% in 2010 to 6.1% in 2018, compared to the EU average of 7.3% in 2018. The other three Visegrád countries registered better figures, with Czechia having 2.7%, Slovakia 4.8% and Poland 5.1% in 2018. However, a composite indicator has been formed by OpenExp [55], whose European Energy Poverty Index (EEPI) for scoring and ranking the member states' progress in alleviating energy poverty shows that despite the positive tendency, the effectiveness of the utility cost reduction programme is only relative in Hungary. Irrespective of the Hungarian government's efforts, Hungary ranked last among EU members in 2018, while Czechia came in at 11th place, Poland at 12th and Slovakia at 24th.

Wasted energy is also a relevant factor that exists in parallel to energy poverty. In Hungary, there is a bad habit of overheating residential, public and commercial buildings in the winter. Therefore, in many cases, there is a possibility for energy conservation by reducing the internal temperature. One survey, involving France, Germany, Hungary, Spain and Ukraine, asked about the average temperature of a home during the winter when residents are at home. Although the answer to the question is likely to be largely a subjective estimation, the difference between Hungary and the other countries is quite striking. Nearly 65% of Hungarian households heat their homes to 22 °C or above and 24% to 24 °C or more, and there is no clear relationship between the controllability of the temperature and the declared temperature levels [56].

3. Methodology and data

The main goal of decomposition analysis is to quantify the effects of various factors on a dependent variable. A dependant variable can be a unit cost indicator or an aggregate indicator (e.g. a quantity or an intensity indicator) and can be connected to an energy-related variable or an environmental impact (e.g. emission) [57–59]. In energy research, two broad categories of the decomposition techniques can be distinguished: structural decomposition analysis (SDA) and index decomposition analysis (IDA). Both of these techniques have many types. Typically, the SDA approach is used when data are at a lower disaggregated level (such as data based on input-output tables), while the IDA utilises data mainly at higher level of aggregation [60,61]. With IDA, both absolute (additive approach) and relative (multiplicative approach) change can be decomposed, and the effects can be quantified on different levels (e.g. income groups, geographical areas or sectors). Ang and Choi [62], Liu and Ang [63] and Ang [64,65] provide a comprehensive overview of IDA models.

Since the pioneering work of Haas [66] in 1997, there have been a number of studies on the decomposition of residential energy consumption [27–32,61,67–70]. Generally, the following factors are calculated: population, income, prices, energy intensity and energy mix (structural change). In most cases, energy consumption is climate corrected, though sometimes weather is an independent factor in the index decomposition analysis [68]. In this article, four effects are identified and measured: price, (intensive and extensive) structure, expenditure and population effects. We use the same methodology, i.e. the additive approach of IDA and the LMDI[12] method, as we did for earlier data [19]. Here, only the main steps of the analysis are presented.

Let V be an energy-related aggregate. We assume that it is affected by n variables, so $x_1, x_2, \ldots, x_n$. The aggregate can be divided into i subsectors (here income deciles) where the changes take place. The connection among the subsectors can be described by:

$$V = \sum_i V_i = x_{1,i}x_{2,i}\ldots x_{n,i}. \tag{1}$$

By the additive method, we decompose the absolute changes:

$$\Delta V_{tot} = V^T - V^0 = \Delta V_{x1} + \Delta V_{x2} + \ldots + \Delta V_{xn}, \tag{2}$$

where

$$V^0 = \sum_i x^0_{1,i}x^0_{2,i}\ldots x^0_{n,i}, \tag{3}$$

$$V^T = \sum_i x^T_{1,i}x^T_{2,i}\ldots x^T_{n,i}, \tag{4}$$

and *0* is the base year, *T* is the actual year.

The LMDI method [63] is employed:

$$\Delta Vx_1 = \sum_i L\left(V_i^0, V_i^T\right)^* \ln\left(x^T_{1i}/x^0_{1i}\right), \tag{5}$$

$$L(a,b) = (a-b)/(\ln(a) - \ln(b)),\ for\ a \neq b\ and = a, for\ a = b. \tag{6}$$

This method has several major advantages, such as the ability to handle zero values, path independency, consistency in aggregation and perfectness in decomposition (the calculation does not result in residual terms) [31,61,64,70]. In a similar way to Zhao et al. [29], the identity of the decomposition analysis in this article is as follows:

$$E = \sum_i \sum_j \left(E_{ij}/Y_{ij}\right)^* \left(Y_{ij}/Y_i\right)^* \left(Y_i/L_i\right)^* \left(L_i/P_i\right)^* P_i, \tag{7}$$

where

E is the climate-corrected final energy consumption of the household sector (PJ),
Y is annual per capita household expenditure on electricity, gas and other fuels (HUF),
L is the annual total household expenditure (HUF),
P is the population (capita),
i is the income decile, and
j is the type of energy consumed by residents, such as solid fuels, total petroleum products, gas, electricity and district heating.[13]

Zhao et al. [29] examine the urban residential energy consumption and apply data with regard to energy-using activities and energy-using products as subcategories. However, in our case, income deciles and the type of energy sources are the levels of aggregation. These choices are justified by both the available data and our preliminary assumption that changes in the residential energy consumption between 2010 and 2018 were influenced mainly by the prices and disposable income. Here, regional differences between Hungarian counties or urban and rural areas are not taken into consideration, which is primarily justified by the objective of the research. This level of aggregation would go beyond the scope of this study.

For a clearer presentation, we introduce five new intermediate terms to present the five previous terms in Eq. (8), respectively, so:

$$E = \sum_i \sum_j PR^* S1^* S2^* EP^* PO. \tag{8}$$

Applying the additive form of LMDI, changes in residential energy consumption between any two years (*t* and *t-1*) are:

$$\Delta E_{tot} = E_t - E_{t-1} = \Delta E_{PR} + \Delta E_{S1} + \Delta E_{S2} + \Delta E_{EP} + \Delta E_{PO}, \tag{9}$$

[12] It is called the LMDI-I method in Kaltenegger [59].

[13] To be precise, derived heat is listed here, but this refers to district heating in this case.

where

ΔE_{PR} is the price effect,
ΔE_{S1} is the intensive structure effect,
ΔE_{S2} is the extensive structure effect,
ΔE_{EP} is the expenditure effect, and
ΔE_{PO} is the population effect.

Each of these five effects shows the impact of a specific factor on the residential energy consumption by income deciles. They quantify how much the specific component would have contributed to changes in the dependent variable (assuming other factors were fixed). However, it is important to highlight that the methodology is suitable only for measuring these impacts on the final energy consumption of the selected sector, and does not provide detailed information on the energy use by different energy sources. The *price effect* represents the impact of energy price change; the *intensive structure effect* refers to the change in the composition of energy expenditure; the *extensive structure effect* is the change in the share of energy expenditure in total household expenditure; the *expenditure effect* means the change in per capita total household expenditure; and, finally, the *population effect* is the change in population size.

To determine the direct effect of the utility cost reduction programme, the price effect is divided into two main parts: price effect for energy sources that are covered by the programme (natural gas, electricity and district heating) and for those that are not (solid fuels and petroleum products[14]). We call the former effect the intervention price effect.

The sample period is from 2010 to 2018, which is justified by the limitation in data availability. Annual data collected from Eurostat and KSH as listed below are applied in the calculations:

– final energy consumption of the households by energy sources, such as solid fossil fuels, total petroleum products, gas, electricity, district heating, primary solid biofuels and other renewables[15] (unit: PJ; source [23]),
– heating degree days by NUTS 2 region, which include actual heating degree days and mean heating degree days over the period of 1980–2004 (unit: day; source [71,72]),
– annual per capita expenditure by COICOP and income deciles (unit: HUF; source [37]), and[16]
– number of persons by income deciles (unit: capita; source [73]).

Nevertheless, the annual per capita expenditure data by COICOP classification do not contain separate information on renewables. The available subcategories are electricity, gas, liquid fuels, solid fuels and district heating, but the category of solid fuels also includes household expenditure on solid fossil fuels and primary solid biofuels (the latter referring essentially to firewood) [37]. In contrast, in energy statistics provided by Eurostat, solid fossil fuels are not merged with 'solid biomass' (primary solid biofuels) [74]. Because of this limitation, energy use data should be harmonised with household expenditure data categories. In doing so, energy sources are grouped as follows: electricity, gas, total petroleum products, solid fuels (including both solid fossil fuels and primary solid biofuels) and district heating. Consumption data on primary solid biofuels contains illegally collected and/or traded firewood, but in this article, only legally harvested and traded firewood is considered, because expenditure data could cover only that.

[14] Although LPG prices have been affected by the utility rate cuts, we could not include this energy source into the calculation of the intervention price effect due to lack of detailed data.

[15] The category 'other renewables' is given if 'primary solid biofuels' are subtracted from 'renewables and biofuels' [23].

[16] Note that coherent time series for such data are available only for the period of 2010–2018.

The final energy consumption of the household sector is climate corrected, so the heating degree days are used to normalise the energy consumption. In making these calculations, the following formula was applied (similarly to Enerdata and Eurostat):

$$E = E_{wc} * 1 / (1 - K * (1 - DD / DD_n)) \tag{10}$$

and

$$K = k * a, \tag{11}$$

where

E is the climate-corrected energy consumption,
E_{wc} is the energy consumption,
K is the corrected heating share for normal year,
k is the heating share for normal year,
a is the share of heating dependant on degree days (i.e. 90%),
DD is the heating degree days, and
DD_n is the average number of heating degree days for the 25-year period of 1980–2004.

DD_n is calculated as a long-term average of the number of heating degree days over a period of time in the past. The number of years taken into account depends on the data source; Eurostat takes into consideration 25 years (i.e. 1980–2004) [75].

Introduction of a is necessary. The climate correction is applied only to 90% of the space heating energy consumption due to the fact that 'some losses are not dependent on the number of degree days' [76]. The k reference value is determined on the basis of the 2020 NECP and NES. They consider 2017 as the base year for the heating share in the final energy consumption of the household sector [34,77].[17] Following this methodology, the k reference value is calculated by energy sources (Table 3).

The annual per capita expenditure by COICOP and income deciles, especially the energy expenditure, is also affected by milder winters, so these data also require corrections. The climate-corrected household expenditure indicator is calculated in a similar way to energy consumption. Thus, data bias is avoided.

4. Results

The climate-corrected final energy consumption of the Hungarian household sector, excluding illegal firewood operations, declined between 2011 and 2013, but growth was seen in the period of 2014–2017. Fig. 4 illustrates the main drivers of these changes, i.e. the impact of the five different types of effects. In the following, possible explanations of the effects are discussed in a broader context.

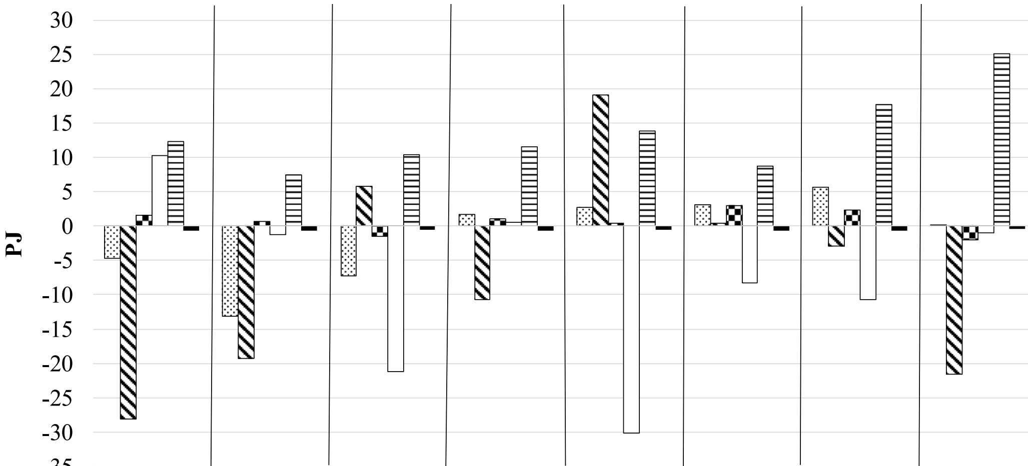
The *price effect* shows that the higher price environment had a negative impact on the residential energy consumption between 2011 and 2012, but the situation was significantly changed from 2013 onwards as a result of the utility cost reduction programme and thus decreasing energy expenditure. These changes are in line with the

Table 3
The k reference value by energy sources, 2017 (%).

Energy source	Reference value
Electricity	3.7
Gas	83.5
Total petroleum products	12.7
Solid fuels	98.8
District heating	76.6

Source: Own calculation based on Eurostat [33].

[17] This point was brought to our attention by an anonymous reviewer.



	2011	2012	2013	2014	2015	2016	2017	2018
ΔEtot	-4.7	-13.1	-7.3	1.7	2.7	3.1	5.7	0.0
ΔEPR	-28.1	-19.2	5.7	-10.7	19.1	0.4	-2.9	-21.5
ΔES1	1.6	0.6	-1.6	1.0	0.4	3.0	2.4	-2.0
ΔES2	10.2	-1.3	-21.2	0.6	-30.1	-8.3	-10.7	-1.0
ΔEEP	12.3	7.4	10.3	11.6	13.9	8.7	17.7	25.1
ΔEPO	-0.7	-0.6	-0.6	-0.7	-0.6	-0.7	-0.7	-0.4

Fig. 4. Decomposition results of residential energy consumption in Hungary, 2010–2018 (PJ).
Source: Own calculation.

economic expectation that higher energy prices motivate households to reduce energy consumption to save money, while lower prices encourage greater demand. Without taking structural, expenditure or population effects into account, figures reveal that the price effect itself would have increased the dependent variable by 5.7 PJ in 2013, 19.1 PJ in 2015 and 0.4 PJ in 2016 (from the previous year, respectively). However, in 2014 and 2017–2018, the size of the price effect was negative at −10.7 PJ in 2014, −2.9 PJ in 2017 and −21.5 PJ in 2018.

The picture is considerably more nuanced if the price effect is split into two and the intervention price effect of the three energy sources covered by the state intervention is separated (Table 4). In 2013, the intervention price effect was 6.6 PJ (the sum of 2.1 PJ, 3.7 PJ and 0.9 PJ), −1.3 PJ in 2014, 18.9 PJ in 2015, 1.8 PJ in 2016, −2.0 PJ in 2017 and −10.8 PJ in 2018. Overall, the utility cost reduction programme generated an extra energy use of 13.2 PJ in the residential sector during the period of 2013–2018.

Except a slight rebound in 2014, the intervention price effect was on a declining trend over the examined period. The Hungarian households adapted to the lower price environment, leading to the results of the intervention price effect being diminished and thus the utility cost reduction programme being exhausted. During this adaptation, the residential energy mix was restructured, with many households switching from firewood to gas. In 2014, the third phase of the programme started only in April; therefore, it could not affect energy consumption in the winter of 2013/2014, reflected in the negative intervention price effect. Meanwhile, firewood prices, which are not affected by the state intervention, went up significantly during the period of 2010–2018 [40]. The importance of firewood in the Hungarian residential energy mix is also evidenced by the fact that the total price effect was mainly driven by changes in the price of solid fuels. This is particularly striking in 2014 when the price effect of solid fuels amounted to −9.0 PJ, compared to the total price effect of −10.7 PJ.

When examining the intervention price effect by income decile (Table 5), the absolute values for each year are found to be much lower in deciles 1–5 than in 6–10. The different income deciles have not benefitted equally from the price fall, with the size of the intervention price effect varying by income decile. This may confirm our assumption that the state intervention had a smaller effect on the lower deciles, and it favoured mainly the upper-middle income class and the wealthiest. The largest difference occurred in 2015, with the intervention price effect being more than double in deciles 6–10 than in 1–5 and the difference being 7.4 PJ.

The development of the total price effect and especially that of the intervention price effect uncovers three major findings. First, the utility cost reduction programme had a tangible impact on Hungarian residential energy use by significantly increasing it. Second, the role of solid fuels is still considerable and the price growth for firewood is clearly reflected in the price effect. Third, although the poor have also benefited from the programme, these benefits have been far less than the positive effects experienced in the upper income deciles.

The *structural effect* can be divided into two main parts, intensive and extensive. The intensive part (the change in the composition of energy expenditure) is affected by two factors, the price change between various energy sources and the structural shift in the energy mix (the so-called basket effect). The extensive part shows the energy intensity development, i.e. the energy expenditure per unit of annual total expenditure.

Between 2011 and 2012, the *intensive structural effect* was positive (Tables 6 and 7). This suggests that during these years there was an increasing demand for cheaper energy sources, and many families switched to the less modern but more favourably priced firewood as fuel. In 2013, some restructuring took place as a result of the utility cost reduction programme. An increasing demand for higher quality energy sources can be observed, which is most evident in higher gas consumption. What natural gas lost in popularity in 2012–2013, it actually gained back in 2016–2017. Solid fuels are slowly losing importance, but are still considered as fuels for the poor.[18]

The *extensive structural effect* was positive in 2011, which could be attributed to the increasing share of energy expenditure in the total annual expenditure. At that time, approximately 36% of the households used solid fuels for heating, compared to only 14% in 2005 [78]. This phenomenon is called energy degradation, referring to replacing higher

[18] No pattern can be discerned in Table 7. Therefore, this table is not analysed in the text.

Table 4
The price effect by energy sources, 2010–2018 (PJ).

	2011	2012	2013	2014	2015	2016	2017	2018
Electricity	−0.5	−2.1	2.1	2.7	1.6	0.0	0.0	−1.2
Gas	−19.3	−8.1	3.7	−2.3	14.3	0.2	−2.4	−7.9
Total petroleum products	−2.2	−1.1	0.6	−0.4	0.0	−0.5	0.7	0.1
Solid fuels	−2.1	−7.7	−1.4	−9.0	0.2	−0.8	−1.6	−10.9
District heating	−4.1	−0.3	0.9	−1.8	3.0	1.6	0.4	−1.7
Total	*−28.1*	*−19.2*	*5.7*	*−10.7*	*19.1*	*0.4*	*−2.9*	*−21.5*
Intervention price effect			*6.6*	*−1.3*	*18.9*	*1.8*	*−2.0*	*−10.8*

Source: Own calculations.

Table 5
The price effect by income deciles, 2010–2018 (PJ).

	1	2	3	4	5	6	7	8	9	10	*1–5*	*6–10*	*Total*
2011	−1.3	−1.8	−2.0	−2.3	−2.7	−3.1	−3.3	−3.4	−3.8	−4.3	*−10.2*	*−17.9*	*−28.1*
2012	−1.3	−1.5	−1.6	−1.8	−2.0	−2.1	−2.2	−2.2	−2.1	−2.3	*−8.2*	*−11.0*	*−19.2*
2013	0.2	0.3	0.4	0.4	0.6	0.5	0.7	0.7	0.8	1.1	*1.9*	*3.9*	*5.7*
2014	−0.9	−0.9	−1.0	−1.0	−1.2	−1.1	−1.3	−1.1	−1.1	−1.1	*−5.0*	*−5.7*	*−10.7*
2015	0.7	0.9	1.1	1.5	1.7	2.0	2.2	2.7	2.9	3.3	*5.9*	*13.2*	*19.1*
2016	−0.1	−0.1	0.0	−0.1	0.1	0.0	0.0	0.0	0.3	0.3	*−0.2*	*0.6*	*0.4*
2017	−0.1	−0.2	−0.2	−0.3	−0.3	−0.4	−0.3	−0.3	−0.6	−0.3	*−1.1*	*−1.9*	*−2.9*
2018	−1.3	−1.4	−1.7	−1.9	−2.2	−2.4	−2.6	−2.5	−2.7	−2.7	*−8.6*	*−12.9*	*−21.5*
Intervention price effect													
2013	0.3	0.4	0.5	0.5	0.6	0.6	0.8	0.9	0.9	1.1	*2.2*	*4.4*	*6.6*
2014	0.0	0.0	0.0	−0.1	−0.2	0.0	−0.2	−0.2	−0.3	−0.4	*−0.2*	*−1.2*	*−1.3*
2015	0.7	0.8	1.1	1.5	1.7	2.0	2.2	2.7	2.9	3.3	*5.8*	*13.1*	*18.9*
2016	0.0	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.4	0.4	*0.5*	*1.3*	*1.8*
2017	−0.1	−0.1	−0.1	−0.2	−0.2	−0.2	−0.2	−0.2	−0.5	−0.2	*−0.7*	*−1.3*	*−2.0*
2018	−0.5	−0.5	−0.7	−0.9	−1.0	−1.2	−1.4	−1.4	−1.5	−1.8	*−3.4*	*−7.3*	*−10.8*

Source: Own calculations.

Table 6
The intensive structure effect by energy sources, 2010–2018 (PJ).

	2011	2012	2013	2014	2015	2016	2017	2018
Electricity	−2.7	−1.3	−0.2	−5.0	2.7	0.4	0.0	−2.6
Gas	−0.9	−5.2	−3.4	0.3	−1.7	4.8	4.5	−1.6
Total petroleum products	0.5	0.0	−0.1	−0.2	0.2	−0.1	−0.1	−0.5
Solid fuels	3.8	6.9	2.0	7.2	0.7	−1.0	−1.1	2.8
District heating	1.0	0.2	0.2	−1.3	−1.6	−1.1	−0.9	−0.2
Total	*1.6*	*0.6*	*−1.6*	*1.0*	*0.4*	*3.0*	*2.4*	*−2.0*

Source: Own calculations.

quality energy sources with lower ones. Many households were forced to adopt coping strategies to avoid or at least limit energy poverty. In our case, generally, electricity or natural gas was substituted by firewood. In 2012, the extensive structural effect became negative (even if no price cuts occurred at that time). In this year, the opposite changes observed among the income deciles highlight serious social inequalities. Energy expenditure increased in deciles 2, 7 and 10, and decreased in deciles 1, 3, 4, 5, 6, 8 and 9, which signals that these latter households restrained their consumption and used cheaper energy sources. Typically, expenditure increased on solid fuels, especially firewood. Probably, high energy prices hit these households the hardest. Due to the utility cost reduction programme, energy expenditure declined in each income decile, i.e. energy intensity fell, so the effect was negative during the period of 2013–2018, except 2014 (Fig. 5). However, as Table 8 illustrates, the magnitude of the extensive structural effect exhibits large variations across years, with highest values in 2013 and 2015.

The year 2014 was an outlier, with a small rebound occurring again (0.6 PJ). This can be explained by the starting date of the third phase of the programme (as described in relation to the intervention price effect) and soaring firewood prices. The results reveal opposite effects for the upper (4.8 PJ) and lower income deciles (−4.2 PJ). The climate-corrected annual per capita energy expenditure on solid fuels increased by 25.6% in 2014, but its magnitude varies widely across income deciles, and this affected mostly those in the ninth income decile where the growth rate was as high as 61.1%.

Table 8 also confirms the two main points of our arguments: the higher income deciles are the main beneficiaries of the programme and firewood is still an important fuel in the residential energy mix. Except 2014, the absolute values of the extensive structural effect were highest in deciles 6–10 during the programme. However, the share of solid fuels (mostly including firewood) exceeded 20% of the energy expenditure in 2018 not only of those households in the bottom deciles (i.e. the poorest families) but also even in income decile 6 (i.e. the upper-middle class). The *expenditure effect* had a positive impact on residential energy consumption in each year investigated, which can be explained by the rising income and standard of living. In practice, this means that households buy more electronic devices, which they use more frequently, the average floor area per person increases (at the same time, larger areas need to be heated and cooled), they raise the heating temperature, and so on. Similar to the price effect, the expenditure effect is higher in the middle class and top income deciles than in the lower ones (Table 9). The largest difference in the expenditure effect between the income deciles can be observed in 2014 with 4.3 PJ, while the lowest in 2016 with 1.9 PJ.

Finally, Hungary's constantly declining population (by an average of 26,600 people per year during the period of 2010–2018) can be detected in the *population effect*. In all of the examined years, this had a negative impact on residential energy consumption. The values are similar to

Table 7
The intensive structure effect by income deciles, 2010–2018 (PJ).

	1	2	3	4	5	6	7	8	9	10	*1–5*	*6–10*	*Total*
2011	0.3	0.3	0.0	0.0	0.2	0.3	0.2	0.2	0.2	0.0	*0.8*	*0.8*	*1.6*
2012	0.0	0.0	−0.1	0.2	0.0	0.0	0.1	0.4	−0.2	0.5	*−0.1*	*0.7*	*0.6*
2013	−0.1	−0.1	0.0	−0.3	−0.1	−0.2	0.0	−0.2	0.3	−0.7	*−0.7*	*−0.9*	*−1.6*
2014	0.1	−0.1	0.6	0.4	0.4	−0.1	−0.3	0.3	−0.7	0.5	*1.3*	*−0.3*	*1.0*
2015	0.5	0.1	−0.3	0.2	−0.2	0.5	0.3	−0.6	0.4	−0.6	*0.3*	*0.0*	*0.4*
2016	0.7	0.1	−0.1	0.3	0.3	0.0	0.9	−0.1	0.2	0.8	*1.2*	*1.8*	*3.0*
2017	−0.7	0.0	0.8	0.0	−0.1	0.8	0.4	1.1	−0.1	0.2	*0.0*	*2.4*	*2.4*
2018	0.5	0.9	−0.2	−0.1	0.4	0.2	−1.0	−0.9	−0.7	−1.2	*1.5*	*−3.5*	*−2.0*

Source: Own calculations.

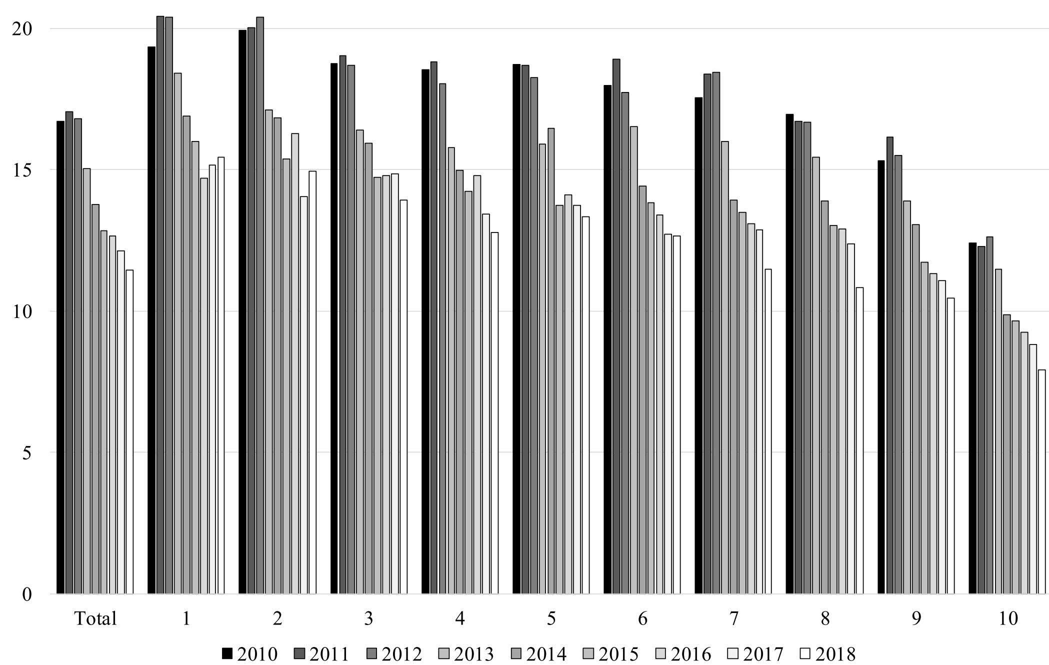


Fig. 5. Share of energy expenditure in the annual per capita expenditure in Hungary, by deciles, 2010–2018 (%).
Source: Own compilation based on KSH [37].

Table 8
The extensive structure effect by income deciles, 2010–2018 (PJ).

	1	2	3	4	5	6	7	8	9	10	*1–5*	*6–10*	*Total*
2011	0.9	0.5	0.7	0.8	0.5	1.9	1.9	0.3	2.3	0.5	*3.3*	*6.9*	*10.2*
2012	0.1	0.4	−0.2	−0.7	−0.4	−1.4	0.3	0.2	−1.0	1.3	*−0.7*	*−0.6*	*−1.3*
2013	−0.9	−2.3	−1.9	−2.1	−2.5	−1.3	−3.3	−1.7	−2.8	−2.5	*−9.6*	*−11.6*	*−21.2*
2014	0.0	0.9	0.9	0.5	2.5	−1.1	−1.3	−0.6	0.8	−2.0	*4.8*	*−4.2*	*0.6*
2015	−1.3	−2.0	−2.3	−2.0	−5.1	−2.5	−2.6	−3.9	−5.3	−3.1	*−12.7*	*−17.4*	*−30.1*
2016	−1.1	0.4	−0.3	0.3	0.1	−1.3	−1.4	−0.9	−1.8	−2.3	*−0.6*	*−7.7*	*−8.3*
2017	0.3	−1.9	0.0	−2.0	−0.7	−1.4	−0.7	−1.4	−0.9	−1.9	*−4.4*	*−6.3*	*−10.7*
2018	0.8	1.6	−0.1	0.2	0.6	1.3	−1.5	−2.2	0.0	−1.6	*3.0*	*−4.0*	*−1.0*

Source: Own calculations.

each other, scattering around −0.6 PJ, except for 2018 when it declined to −0.4 PJ. Perhaps this figure is already an early result of the government's family policy, providing incentives to increase the fertility rate and stop population decline. Among these measures, a new family tax regime has been in place since 2011, and a governmental subsidy for the construction or purchase of dwellings for families with children was also introduced in 2015. Although it would certainly change the results of our analyses to consider the international emigration of Hungarians – a palpable phenomenon in the analysed period, with one estimate of 505,000 Hungarians living in other European countries in 2017, compared to the 215,000 of 2010 [79], the lack of data on emigration by income decile prevents us from making precise calculations. Further, different sources give varying data on even the number of Hungarians living abroad.

5. Discussion of the policy perspective

5.1. The utility cost reduction in the Hungarian policy documents

An evolutionary development can be observed in the discussion of state intervention, utility cost reduction and, in relation to these, the issues of energy efficiency, energy poverty and security of supply in the

Table 9
The expenditure effect by income deciles, 2010–2018 (PJ).

	1	2	3	4	5	6	7	8	9	10	*1–5*	*6–10*	*Total*
2011	0.1	1.4	1.1	1.6	2.0	0.5	0.0	2.3	1.7	1.5	*6.2*	*6.1*	*12.3*
2012	0.6	−0.9	−0.2	−0.3	0.4	1.6	1.7	1.5	2.0	1.0	*−0.5*	*7.9*	*7.4*
2013	0.4	1.6	2.2	1.4	0.8	0.0	1.5	0.8	1.3	0.4	*6.3*	*4.0*	*10.3*
2014	0.6	−0.5	−1.0	−0.5	0.6	1.6	2.8	2.8	1.9	3.3	*−0.8*	*12.4*	*11.6*
2015	0.4	0.7	0.7	1.5	1.2	2.3	1.0	1.8	2.6	1.7	*4.4*	*9.4*	*13.9*
2016	0.3	0.0	0.4	1.3	1.3	0.8	0.6	1.0	1.1	1.9	*3.3*	*5.4*	*8.7*
2017	0.6	0.8	1.0	1.4	1.5	2.3	2.3	2.1	3.1	2.6	*5.3*	*12.4*	*17.7*
2018	1.2	1.5	1.6	2.1	2.8	2.9	3.0	3.0	3.4	3.4	*9.4*	*15.7*	*25.1*

Source: Own calculations.

Hungarian energy policy documents. In 2010–2012, one of the main objectives was clearly to improve social conditions of the poorest income deciles, and the measure in question was not included in the policy documents, rather its potential negative effects were highlighted. This is especially true for the National Energy Strategy 2030 with an Outlook to 2050 that was adopted in 2011, one and a half years after Fidesz's parliamentary election victory and just over one year before the utility cost reduction programme started.[19] Post-2012, utility price cuts have appeared more and more prominently in the energy policy documents. Seemingly, strategy makers have tried to catch up with the existing measures. They intend to provide an objective justification of the programme and thus the issue of energy poverty has become more pronounced. Energy poverty was not given major attention until 2013 and the 2014 parliamentary elections. In 2015, the Third National Energy Efficiency Action Plan until 2020 [54] and the National Building Energy Performance Strategy [53] were already emphasising the role of financial savings from the utility cost reduction in improving energy efficiency and decreasing energy poverty, but five years later, in January 2020, the government went as far as to regard the maintenance of the achievements of the utility cost reduction programme as one of the main objectives of the 2020 NES [77] and NECP [34]. This is repeated in Hungary's LTRS [44], submitted to the European Commission in 2021.

The 2011 NES dealt with the issue of energy poverty, claiming that 'social benefits targeting the elimination of energy poverty should be allocated on a needs basis'. Regulated prices appeared here in the differentiated (block) tariff system to be fine-tuned in the medium term. However, the separation of welfare considerations from energy objectives was emphasised only for the long term. Strategy developers were fully aware of the negative consequences of regulated prices when referring to excess energy consumption and security-of-supply drawbacks of underinvestment due to uncovered costs. The 2011 NES focused on consumer awareness to limit consumption and improve energy efficiency. As a priority, it aimed to design coherent and targeted investment incentives for renewables [81].

The EU liberalisation model aims to shift to market pricing for consumers, including households. In doing so, retail price regulation should be phased out, and protection can be provided only to vulnerable clients. According to this model, market pricing is the desirable solution in the long run and energy poverty can be mitigated by investing in energy efficiency. Although regulated prices run counter to the EU's liberalisation efforts [82], the reception of price regulation highly depends on its type and time frame [83]. The Hungarian utility cost reduction programme employs general price regulation, a less favourable option as compared to targeted price regulation focusing on well-defined social groups. Both the duration and purpose of the Hungarian programme are unclear, but the EU law of state intervention requires to demonstrate that the state intervention is not permanent but temporary [82]. The price regulation has to target market failures originating from the imperfect state of liberalisation. In view of these facts, the European Commission has several times expressed its concern.[20]

2018–2019 was the time for all EU member states to prepare their NECPs covering the period from 2021 to 2030. The NECP serves as a basis for EU-funded projects in the sector related to the multiannual financial framework for the period of 2021–2027. The draft NECP was submitted to the European Commission in January 2019 [84], followed by the Commission's assessment and recommendations in June 2019. The latter required the Hungarian government to present existing and planned actions to phase out energy subsidies and thus to withdraw the utility cost reduction programme at some point in the future and instead apply other tools, as well as to create a complex strategy to reduce energy poverty [85].[21] Although the final NECP released in January 2020 contains the requested list of subsidies, some contradiction is noticeable. The NECP declares that fossil fuels are not subsidised directly in Hungary. Rather, subsidies are indirectly granted to products and services on the market. At the same time, it is argued that the share of subsidies to fossil-fuel-use-related general services as a percentage of tax revenues is similar to the OECD average and even slightly under the European OECD average [34]. In the assessment of the final NECP, the European Commission [87] also points to this contradiction and refers to its own analyses identifying significant direct fossil-fuel subsidies in Hungary. The NECP says that conceptual transformation may be necessary in the price regulation of electricity, gas and district heating, but preserving the results of the utility cost reduction programme is paramount [34].[22] Nonetheless, one of the main recommendations of the IEA [88] to Hungary is the elimination of administratively determined end-user prices.

Evaluating the draft NECP, the Commission also asked the Hungarian government to define specific objectives related to energy poverty [85]. As feedback, the final version links energy poverty directly to the utility cost reduction programme, with which the government achieved two things in a single action: it identified a measure against energy poverty and demonstrated the targeted nature of the utility rate cuts. The final NECP determines the main vulnerable social groups: large families living in detached houses in small communities and retired people living alone in multi-family residential buildings (and sometimes in detached houses) [34]. However, the details of measures to protect these social groups are still missing [87], not to mention the fact that our calculations using the Lorenz curve and the Gini coefficient illustrate growing inequalities for energy expenditure, total expenditure and net household income during the period of 2010–2018 [37,73].

[19] There was, however, some momentary halt in the continuity of the process because the so-called Széll Kálmán Plan, a debt-cutting and economic-growth-boosting plan released in March 2011, promised regulated prices and a price freeze, which was followed by the 2011 NES in October and price increases in 2012 [80].

[20] Eventually, two interrelated issues having connections to the utility cost reduction programme got to court.

[21] The latter is in line with the requirements of the EU's 2018 Regulation on the governance of the Energy Union and Climate Action [86].

[22] One sentence, however, foresees the possibility of more serious changes. The question is whether this is just about compliance with the European Commission [34].

The EU requires member states to locally identify and measure energy poverty [89,90]. The Hungarian government tends to avoid the use of the words 'poverty' and 'energy poverty'. In the NECP, it is only said that Hungary will measure the effectiveness of policies aimed at reducing heating difficulties by monitoring the share of households that spend at least 25% of their income on energy costs (a share that amounted to 9.8% in 2016) [34]. When defining energy poverty in the 2020 law dealing with energy efficiency, the term 'households to be supported' refers to households whose annual energy costs of heating the indoor space to 20 °C and of producing hot water exceeds 25% of the household's annual income [91]. The NECP calculates an under-heating ratio that indicates how much less heating energy the population uses compared to what would be required to keep buildings' temperature at a minimum of 20 °C throughout the whole year. This ratio varies from building to building and is between 35% and 42% [34].

Regulated energy prices remain in focus in the Hungarian LTRS, but the emphasis is shifted to long-term sustainability. The strategy continues to use the term 'households to be supported' instead of 'energy poverty', but points out the problem. It intends to halve the number of households to be supported by 2030, in comparison to the 2021 level [43].

As suggested in the Introduction, the utility cost reduction programme not only appears in strategic documents, but it determines the government's approach to strategic issues debated at the European Union level. For example, Hungary, along with Poland, Czechia and Estonia, blocked the EU's 2050 carbon-neutrality target at the summit in Brussels in June 2019, on the grounds that this would cause a 30–40% rise in electricity bills of the Hungarian households, claiming that its decision would save the utility cost reduction programme [92]. In the end, the EU leaders agreed to the target in December 2019, though Poland was exempted from the commitment for the time being. A year and a half later, in summer 2021, using the utility cost reduction programme as an argument, the Hungarian government expressed its opposition to the European Commission's proposal to extend the EU's Emission Trading System (ETS) to the transport and building sector as part of the Fit for 55 package.

5.2. *The relationship between market factors and regulated residential electricity and gas prices*

The basic question is how regulated gas and electricity prices relate to market fundamentals, because while the Hungarian regulated prices are fixed, market prices are changing.[23] Regulated prices for both gas and electricity rose for the population in the period between the formation of the government in 2010 and the start of the utility cost reduction in 2013. However, on a market basis, price reductions for both gas and electricity should have taken place at the end of the 2000s.

Again, the issue of gas prices is the most important. Import prices and the existence of domestic production are decisive. As for the latter, it is taken into account at artificially low price levels when setting residential gas prices [93]. Import gas prices were high between 2011 and 2014, but gas market-based (hub-based) prices were lower than oil-linked. Between 2015 and 2020, gas prices on the European market and Russian contract prices developed favourably, but in 2021, much higher import gas prices occurred. Due to high import gas prices, 2013–2014 was the wrong time to carry out a utility costs reduction programme of such magnitude [94]. Declining regulated gas prices were supported by concessions from Russian gas giant Gazprom on gas volumes and prices in 2013 and 2014 [95]. The decline in oil prices began in mid-2014 and hub-based gas prices also lowered in 2014. However, at the time of the decisions on the utility rate cuts, it was not possible to see with certainty that gas market would develop so favourably between 2015 and 2020; the government gambled and won.[24] Market conditions called for even further price reductions, but the government refrained from doing so. In 2020, the government argued that the advantage of unchanged gas prices was predictability, and anyway, free market participants did not essentially offer better prices [96]. However, in fact, gas providers did not dare to compete with regulated prices (*anonymous personal information*, 26 November 2020). When Germany's E. ON started selling gas at a lower price than the regulated level, it faced conflict with the government. From the point of view of the government's coordinate system, it was a good decision not to reduce household gas prices further, but to create a reserve for hard times. High import gas prices experienced from 2021 onwards will definitely bring these difficulties into focus.[25]

Between 2013 and 2018, favourable cyclical circumstances made regulated electricity prices sustainable. However, starting in the second half of 2018, soaring market electricity prices pushed the universal service system into increasing losses. While in the case of gas, domestic gas production is a great help in supporting the system, cheap electricity from Hungary's Paks Nuclear Power Plant plays the helping role in electricity. Due to high carbon dioxide, natural gas and balancing prices and other costs in relation to the energy efficiency obligation scheme (see Section 5.3) and the green transition, the price pressure is high and non-residential consumers have to bear the burden [93]. However, so far there have been no consequences in the electricity sector similar to those in water supply and sanitation as well as household waste collection, where utility companies are constantly facing very serious problems because of the utility cost reduction programme.

As Boute [83] highlights, the energy sector is highly capital intensive and characterised by long pay-back periods. Although utility rate cuts have a negative effect on gross capital formation in the Hungarian electricity, gas, steam and air conditioning supply sector, it had been depressed even before the introduction of the state intervention. In 2010, gross capital formation per 1000 people in this sector reached a level of only EUR 104,000 in Hungary, representing slightly more than half of the Slovakian figure, just a third of the Czech data, but nearly the same as in Poland. Sectoral gross capital formation as a share of GDP stood at only a little bit over 1%, compared to the figures of 1.1% in Poland, 2.0% in Slovakia and 2.1% in Czechia. From this already low level, the Hungarian ratio fell further to 0.4% in 2016. However, in 2017 and 2018, when renationalisation in Hungary was gaining ground, a significant rebound was observed in Hungary. In 2018, sectoral gross capital formation per 1000 people and the ratio of sectoral gross capital formation to GDP increased to EUR 92,000 and 0.7%, respectively. Between 2013 and 2016, an investment of slightly more than EUR 202 million disappeared from the electricity, gas, steam and air conditioning supply sector, compared to the 2012 data [3,97,98]. Utility rate cuts have thus weakened security of supply, not only because declining household energy prices have increased energy use, but also due to the lack of investment. The consequences are very similar to those described by Boute [83,99].

5.3. *Energy consumption and energy efficiency targets and achievements*

The unintended increase in household energy demand is well illustrated by the fact that in 2018 the government had to significantly increase its 2015 forecast for 2020 from 247 PJ to 264 PJ in the business-as-usual scenario and from 207 PJ to 243 PJ in the 'joint effort' scenario,

[23] District heating is not discussed separately here due to its complex nature.

[24] *Borbála Takácsné Tóth* provided detailed information on this issue (17 August 2021).

[25] The entire portfolio of residential gas customers was hedged with financial instruments in the gas year 2021/2022 (i.e. until September 2022). Therefore, problems are expected to arise afterwards (*anonymous personal information*, 14 December 2021).

Table 10
Hungary''s energy consumption forecasts for 2020 and 2030 revised in 2015 and 2018 as part of the 2011 NES (PJ).

	2012	2015	2020				2030			
	1160/2015	1274/2018	1160/2015		1274/2018		1160/2015		1274/2018	
	Fact	Fact	BAU	JE	BAU	JE	BAU	JE	BAU	JE
Primary	992[a]	1055[b]	1101	1009	1187	1110	1217	1028	1411	1217
Final	677[c]	725[d]	766	693	822	761	840	692	929	775
Households	215[e]	249	247	207	264	243	284	187	278	210

BAU: business-as-usual scenario. JE: joint-effort scenario.
[a] This roughly corresponds to the term 'primary energy consumption (Europe 2020–2030)' in Table 1.
[b] This corresponds to the first three categories in Table 1.
[c] This roughly corresponds to the term 'final consumption for energy use' in Table 1.
[d] This roughly corresponds to the term 'final energy consumption (Europe 2020–2030)' in Table 1.
[e] For some reason, this strongly differs from the figure available in Table 1.
Source: [100,101].

Table 11
Forecasts of the NECP for Hungary's energy consumption based on scenarios with existing measures (WEM) and with additional measures (WAM), 2005–2040 (ktoe).

	2010*	2015*	2017*	2020	2025	2030	2035	2040
WEM								
Primary[a]	24,618	23,298	24,481	27,349	27,904	31,774	30,638	30,583
Final[b]	17,450	17,400	18,506	19,068	20,043	20,661	21,221	21,463
Households	6649	5970	6299	6202	6069	5923	5731	5351
WAM								
Primary[a]	24,618	23,298	24,481	26,855	27,153	30,664	28,630	28,395
Final[b]	17,450	17,400	18,506	18,749	18,749	18,722	18,751	18,750
Households	6649	5970	6299	5962	4950	4076	3783	3680

*Actual (factual) data.
[a] This corresponds to the term 'primary energy consumption (Europe 2020–2030)' in Table 1.
[b] This corresponds to the term 'final energy consumption (Europe 2020–2030)' in Table 1.
Source: ITM [102].

the latter involving new policy measures. Therefore, the energy savings target calculated as a difference of the two scenarios decreased from 40 PJ to 21 PJ (Table 10) [100,101]. The final NECP expects final household energy consumption to decrease by either 0.8% or 31.7% between 2015 and 2030 depending on existing or additional policy measures (WEM or WAM scenarios) (Table 11) [34].

The LTRS goes further and determines new but controversial energy efficiency and emission objectives. It aims to achieve energy savings of 20% in residential buildings by 2030, but without determining the reference year.[26] This target is linked to the indicative milestone of reducing carbon emissions of residential buildings by 20% compared to the average of 2018–2020, which suggests that a 20% reduction in energy consumption results in a 20% reduction in emissions [43].

In the NECP, the share of natural gas in the residential energy mix is set to decrease from 45% in 2016 to 32% by 2030, while that of electricity will increase from 15% to over 28%. The role of renewables will be virtually unchanged at around 28%, though some restructuring is foreseen. The government wants to replace traditional firewood use with heat pump installations and more efficient biomass-heating solutions [34].

Despite energy savings potential, very little has been done so far. Higher prices can give an incentive to invest in energy efficiency, but they alone will not do the job or trigger everyone to do so, and some cannot afford it. Therefore, state intervention has an important role to play in the area of energy efficiency. Among the government measures, since 2014, 130,000 households have been supported with non-repayable grants, with a total of HUF 29 billion,[27] to invest in energy efficiency within the framework of the so-called 'Warm Home Programme' [84]. Originally, much more money was expected to be spent on energy efficiency improvement of residential buildings, due to available EU funds for the period of 2014–2020. However, at the end of 2015, the government decided to reallocate these EU funds for modernisation of public buildings, despite the fact that more than twice as much energy can be saved by residential buildings as by spending the same money on public buildings. The government claimed that it would have been too complicated for the Hungarian institutional system to implement the programme [103]. Instead, an interest-free energy-efficiency loan has been offered to households since 2017, a quite different tool, which has not so far proved popular.

Particularly problematic is the unpredictable support system in Hungary. Many investments have been delayed because people have waited for the opportunity to apply for state-supported energy-efficiency investments. Meanwhile, investment costs have risen notably due to increasing construction material prices and sectoral wages, the latter being linked to labour shortages, and contractors deliver low-quality results in many cases. These factors and the utility cost reduction increase the payback period, which works against investments [104].

Such system uncertainty also exists for new buildings. Their energy performance standards have been significantly strengthened. The 2010/31/EU Directive on the energy performance of buildings determined nearly zero energy requirements for new residential buildings from 2021 [105], but at the last minute, in late 2020, the government postponed its introduction for half a year, and then in March 2021 until mid-2022.

A recent survey confirms the importance of direct non-repayable grants in residential energy-efficiency investments in Hungary [106]. However, the government does not intend to provide such support in the

[26] Our calculations show that this refers to the difference between figures under the WEM and WAM scenarios for 2030 [102].
[27] In contrast, the final NECP mentions only HUF 26 billion [34].

future,[28] while the new home renovation support programme that started in 2021 does not require energy-efficiency improvement, though it is considered as an alternative policy measure by the 2021 LTRS. In accordance with the 2018 EU Energy Efficiency Directive [89], Hungary must achieve an annual average new savings of 7 PJ between 2021 and 2030, out of which, as suggested by the LTRS, 5 PJ is intended to be yielded by alternative policy measures and 2 PJ within the energy efficiency obligation scheme through the obligated parties, including gas and electricity traders and universal service providers as well as distributors of transport fuel to end users [34,43]. However, since the obligation scheme allows these energy companies a degree of freedom to choose between the clientele of the investment, they are expected to first focus on large companies, because that is where these savings can be realised most cost-effectively. The appropriateness of this system for deep energy renovations of single-family detached homes, such as thermal insulation and window replacement, is questionable because of the slow return on investment with the low utility rates and because of the fragmentation of projects. There is also the question of how the operating cost of the system will be financed, because it cannot be included in the price in the residential sector due to the utility cost reduction [107,108]. But alternative policy measures, such as the interest-free energy-efficiency loan, will still apply, and energy-poor households will be financed by the obligation scheme as an alternative policy measure [43].

6. Conclusions and policy implications

Although high domestic gas and electricity prices in purchasing power standard, high energy expenditure shares as a percentage of total household consumer expenditure and a market situation allowing energy price cuts during most of the period reaffirmed the rationale for the state intervention, this article argues against the programme itself because of its negative effects. Controversial changes are shown regarding the three key intervention points available for decreasing the energy expenditure share: reduced regulated prices but increased non-regulated solid fuel prices, increasing disposable incomes but growing inequalities, as well as increasing energy consumption and unsatisfactory energy-efficiency performance.

The key finding of the decomposition analysis is that decreasing household energy prices had a positive impact on energy use. The intervention price effect reveals an extra energy use of 13.2 PJ between 2013 and 2018. This is a serious amount of energy, especially compared to the energy saving targets of 40 PJ (old) and 21 PJ (updated) planned to be achieved by 2020, but also when compared to the 2018 residential energy consumption of 244 PJ. The price elasticity of energy sources justifies an increase in demand amid falling prices but it cannot be argued that if prices had followed the market trend and thus had fallen on a market basis, a similar excess energy consumption would have resulted. We believe that a sudden, government-driven price reduction promising long-term protection and backed by a large campaign has a different effect on energy consumption than a market-based price cut, which carries with it the possibility of future price increases.

Households have been affected to very different degrees. The intervention price effect was stronger in the upper income deciles than in the lower ones. Despite reduced regulated prices and increased non-regulated solid fuel prices, firewood and coal have only slightly lost popularity, confirmed by the price effect and the structure effect. Apart from a minor shift, there was no mass switch from these fuels to higher-quality energy sources, except for a slight rebound in gas, which means that reduced regulated prices without other incentives are not enough for such restructuring. The poorest households, using firewood or coal as a main source for heating and cooking, cannot afford to replace their old and inefficient heating equipment or to improve their heating systems to move away from lower-quality fuels. These households would have been most in need of support all along, but they have only been given heating cost support by the 2018 winter utility cost reduction programme, and at most, they have the opportunity to apply for 'social fuel'. The programme did not decrease social inequalities, which can be seen not only in the use of various energy sources, but also in the expenditure effect. As a result of rising living standards, households of the highest income deciles increased their energy use to a much greater extent than the poorest. Growing disparities in energy expenditure can also be observed. In this case, again, the effect is lower in the poorest income deciles.

A market situation allowing energy price cuts does not mean the utility cost reduction programme itself was appropriate. The main problem is the government's approach to the concept of pricing and the role of the energy regulator in this. It should not be up to the government to set prices, and especially not to leave them fixed in the long run and for everyone. It is an acceptable approach not to let residential prices move with constantly changing market prices, but to smooth price fluctuations and to keep price increases under certain control. Nevertheless, the wealthy do not need to be protected, but the vulnerable do. This has its own international best practices, but price signals are needed to influence energy conservation, energy efficiency investments and fuel mix diversification, the latter including the transition to renewables, other than simple firewood, thus to renewables considered appropriate by the government in its energy strategy documents. However, the utility cost reduction also erodes the competitiveness of renewables. Current high wholesale electricity and gas prices challenge the previously consensual EU liberalisation model. In this price environment, it is hardly politically viable to pass these prices on to residential consumers. Meanwhile, service providers should not operate at a loss either, nor should investments in the sector disappear, which is a security-of-supply issue. In electricity, reduced regulated residential prices have been a problem since 2018, when utility companies became unable to cover their costs, and a similar negative turnaround is expected for gas. Such burden can only be partially passed on to non-household consumers, and will ultimately be fed into various retail prices. The lucky years have come to an end, and if wholesale gas and electricity prices remain high, system problems will arise, but price increases are very difficult to justify when the issue is politicised to such an extent. Fidesz governments have moved from emphasising the negative consequences of regulated prices to including the maintenance of the results of the residential utility cost reduction programme into the main objectives of the energy strategy documents. By now, the utility cost reduction programme has become directly and tightly linked to energy poverty but problems of solid-fuel-heating consumers have not been properly addressed.

During the years of the utility cost reduction, only little progress has been made in utilising the large energy savings potential in the renovation of existing residential homes. Households are not motivated to spend their savings from the utility cost reduction programme on this, reflected in the shifting market basket of consumer goods and services. Lower energy prices allow energy-related expenditure to make up a lower share of total household expenditure and consumers spend more on food and non-alcoholic beverages, enabling it to become the biggest item again. Emphasis should be placed on raising the awareness of individuals about both energy efficiency and simply energy conservation. It should be made clear to households that they should spend their savings on energy-efficiency investments, because this is the only way to reduce energy expenditure in the long term. As the 2015 Energy and Climate Awareness Raising Action Plan states, 'for the Hungarian population the cost-oriented motivation is the most appropriate' [109], so the awareness-raising campaigns should focus on that. However, the Hungarian government also needs to recognise that investment in energy efficiency has a wide variety of benefits, many of which are quantifiable [110].

Therefore, two key policy recommendations follow from this research: on the one hand, to eliminate the utility cost reduction

[28] Nevertheless, signs of change were apparent in this approach at the end of 2021.

programme and instead provide support to those in need through pricing and social programmes, and on the other, to give priority to energy efficiency. A predictable and sustainable system must be in place in the long term for energy-efficiency investments to materialise. Programmes without energy-efficiency requirements, such as the new home renovation support programme, should not be initiated. This is a missed opportunity for energy-efficiency improvement that swallows up funds from energy-efficiency projects and may lock in the existing low energy-efficiency level of the buildings. Meanwhile, there are serious questions as to whether the government's new energy efficiency measures, delving into uncharted territory, will be enough to meet the government's ambitious target for reducing residential energy consumption.

This study provides a comprehensive impact assessment of the utility cost reduction programme but there are at least two limitations and also another issue worth exploring further in future research. First, regional differences in the impact of regulated energy prices are not considered, though the role of geographic space is determinant. Residential energy consumption is concentrated in specific places, i.e. regions and cities, and there are significant differences between rural areas and cities. The inclusion of this dimension into the analysis would allow further conclusions to be drawn. However, regional energy consumption data by energy sources and income deciles are not available, and the current methodology is not appropriate for measuring neighbouring effects. Second, population data are not adjusted by mobility and migration in spite of the fact that more than half a million Hungarians live permanently or temporarily in other EU member states and tens of thousands of people commute across borders regularly. Only rough estimations are available and the reported data are controversial in many cases. This issue should be further examined on the basis of new research results. Finally, a further new research direction could be to analyse long-term impacts of climate change on residential energy consumption in the context of the utility cost reduction programme. This could also bring us closer to determining specific mitigation policies and measures.

Credit author statement

Csaba Weiner: Investigation, Formal analysis, Writing – original draft, Supervision, Writing – review & editing. **Tekla Szép:** Conceptualisation, Methodology, Data curation, Investigation, Formal analysis, Writing – original draft, Visualisation, Writing – review & editing.

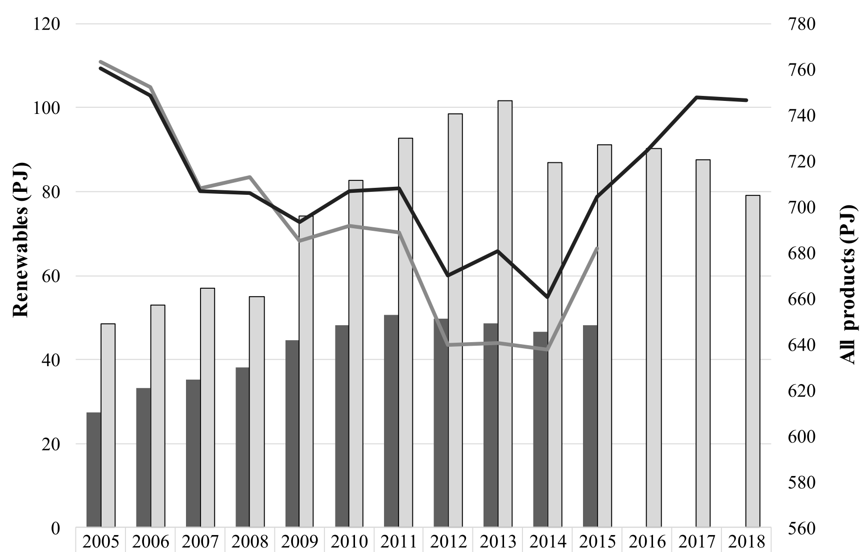
Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to thank the six anonymous Reviewers for their useful comments and suggestions on the earlier drafts of this article. Special thanks go to András György Deák, Balázs Felsmann, Olivér Hortay, Péter Kotek, Tamás Pálvölgyi, László Szabó, Balázs Sziklai, Borbála Takácsné Tóth and anonymous experts who helped the authors at various stages of the research.

Appendix



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Final consumption for energy use - renewables (old methodology, PJ)	28	33	35	38	45	48	51	50	49	47	48			
Final consumption for energy use - renewables (new methodology, PJ)	48	53	57	55	74	83	93	99	102	87	91	90	88	79
Final consumption for energy use - all products (old methodology, PJ)	763	752	708	713	685	692	689	640	641	638	682			
Final consumption for energy use - all products (new methodology, PJ)	761	749	707	706	693	707	708	670	681	660	705	725	748	747

Fig. A1. Final energy consumption in Hungary using the old and the new methodology, 2005–2018 (PJ)
Source: Own compilation based on Eurostat [22,23].

Table A1
Decomposition results of residential energy consumption in Hungary using different methodologies, 2010–2018 (PJ)

	2011	2012	2013	2014	2015	2016	2017	2018
1. Old methodology with old renewable energy consumption statistics								
Total	*−5.2*	*−13.2*	*−7.5*	*0.1*	*3.7*			
Price effect	−21.2	−10.1	17.0	14.5	5.2			
Intensive structure effect	1.2	−6.4	−8.8	−4.3	−2.2			
Extensive structure effect	4.6	−3.1	−24.6	−17.7	−15.1			
Expenditure effect	10.8	7.1	9.5	8.3	16.4			
Population effect	−0.7	−0.6	−0.6	−0.7	−0.6			
2. Old methodology with (1) adjusted renewable energy consumption statistics, (2) an extended assessment period and thus (3) the inclusion of the 2018 winter utility cost reduction programme								
Total	*−5.0*	*−13.2*	*−7.4*	*0.2*	*3.9*	*3.4*	*5.8*	*−0.6*
Price effect	−22.0	−17.0	9.8	9.7	3.3	−5.0	−4.5	−7.4
Intensive structure effect	1.8	0.6	−1.4	1.0	0.0	2.7	2.3	−1.5
Extensive structure effect	4.7	−3.2	−25.0	−18.1	−15.4	−3.3	−9.0	−14.3
Expenditure effect	11.1	7.0	9.8	8.3	16.6	9.8	17.6	22.9
Population effect	−0.7	−0.6	−0.6	−0.7	−0.6	−0.8	−0.6	−0.3
3. New methodology with (1) adjusted renewable energy consumption statistics, (2) an extended assessment period and thus (3) the inclusion of the 2018 winter utility cost reduction programme								
Total	*−4.7*	*−13.1*	*−7.3*	*1.7*	*2.7*	*3.1*	*5.7*	*0.0*
Price effect	−28.1	−19.2	5.7	−10.7	19.1	0.4	−2.9	−21.5
Intensive structure effect	1.6	0.6	−1.6	1.0	0.4	3.0	2.4	−2.0
Extensive structure effect	10.2	−1.3	−21.2	0.6	−30.1	−8.3	−10.7	−1.0
Expenditure effect	12.3	7.4	10.3	11.6	13.9	8.7	17.7	25.1
Population effect	−0.7	−0.6	−0.6	−0.7	−0.6	−0.7	−0.7	−0.4

Source: Own calculations.

References

[1] RAMON, Eurostat, Metadata, Classification of individual consumption by purpose, 2018 version, n.d. (accessed 18 November 2020) in: https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=COICOP_2018&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC.

[2] Eurostat, Population unable to keep home adequately warm by poverty status, 24 March 2021 (accessed 26 March 2021), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sdg_07_60&lang=en.

[3] Eurostat, Population on 1 January, 5 July 2021. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tps00001. (Accessed 7 November 2021).

[4] Eurostat, Total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor – EU-SILC survey, 2 December 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_mdho01&lang=en. (Accessed 6 December 2021).

[5] Eurostat, Arrears on utility bills – EU-SILC survey, 27 October 2021 (accessed 8 November 2021), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_mdes07&lang=en.

[6] Right to Energy Coalition, About energy poverty. https://righttoenergy.org/about-energy-poverty/. (Accessed 3 December 2021).

[7] Eurostat, Share of population living in a dwelling not comfortably cool during summer time by income quintile and degree of urbanisation, 8 February 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_hcmp03&lang=en. (Accessed 7 November 2021).

[8] Eurostat, Final consumption expenditure of households by consumption purpose (COICOP 3 digit), 24 March 2021 (accessed 26 March 2021), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_co3_p3&lang=en.

[9] J. Clifton, D. Díaz-Fuentes, M. Fernández-Gutiérrez, Vulnerable consumers and satisfaction with public services: does country matter? Int. Rev. Adm. Sci. 85 (2019) 264–285, https://doi.org/10.1177/0020852317691341.

[10] ACER (European Union Agency for the Cooperation of Energy Regulators) and CEER (Council of European Energy Regulators), ACER market monitoring report 2019: energy retail and consumer protection volume, 26 October 2020. https://www.ceer.eu/documents/104400/7065288/2019+Retail+and+Consumer+Protection+-+Volume+3/53f57f31-62b7-8d87-62f4-1d9df49d4acb. (Accessed 9 December 2021).

[11] Eurostat, GDP per capita in PPS, 15 February 2021 (accessed 17 February 2021), https://ec.europa.eu/eurostat/databrowser/view/tec00114/default/table?lang=en.

[12] Eurostat, Real GDP growth rate – Volume, 15 February 2021. https://ec.europa.eu/eurostat/databrowser/view/tec00115/default/table?lang=en. (Accessed 17 February 2021).

[13] Eurostat, Electricity prices for household consumers. Bi-annual data, 11 March 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_204&lang=en. (Accessed 13 March 2021).

[14] Eurostat, Gas prices for household consumers – Bi-annual data, 8 February 2021 (accessed 13 March 2021), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_202&lang=en.

[15] Eurostat, Final energy consumption by sector, 8 February 2021 (accessed 9 February 2021), https://ec.europa.eu/eurostat/databrowser/view/ten00124/default/table?lang=en.

[16] Odyssee-Mure, Energy efficiency trends for households in the EU. https://www.odyssee-mure.eu/publications/efficiency-by-sector/households/trends-europe.html, 2021. (Accessed 11 December 2021).

[17] MEKH (Hungarian Energy and Public Utility Regulatory Authority), National detailed energy balance – Eurostat format – annual, 29 January 2021. http://www.mekh.hu/download/3/c7/e0000/7_4_orszagos_eves_%20Eurostat_%20tipusu_%20reszletes_%20energiamerleg_2014_2019.xlsx. (Accessed 3 February 2021).

[18] Eurostat, Energy import dependency by products, 8 February 2021 (accessed 9 February 2021), https://ec.europa.eu/eurostat/databrowser/view/sdg_07_50/default/table?lang=en.

[19] T. Sebestyén Szép, The effects of utility cost reduction on residential energy consumption in Hungary: a decomposition analysis, Int. J. Sustain. Energy Plan. Manag. 13 (2017) 61–78, https://doi.org/10.5278/ijsepm.2017.13.5.

[20] REKK (Regional Centre for Energy Policy Research), Vihar a rezsiben. A REKK elemzése a 2013. januári rezsicsökkentésről [Storm in utility costs: analysis of the utility cost reduction of January 2013], Műhelytanulmány No. 2013/1, REKK, Budapest, 2013. . in: https://rekk.hu/downloads/projects/rekk-rezsi-muhelytanulmany.pdf. (Accessed 15 November 2021).

[21] L. Szabó, P. Kotek, The second utility bill cut, REKK Hungarian Energy Market Report Q1 2014, Regional Centre for Energy Policy Research (REKK), Budapest, 2014, pp. 10–14. https://rekk.hu/downloads/publications/rekk_report_2014_1.pdf. (Accessed 19 December 2021).

[22] Eurostat, Energy from renewable sources: statistics explained (accessed 10 August 2018; this link does not work anymore), https://ec.europa.eu/eurostat/statistics-explained/pdfscache/26960.pdf, 2017.

[23] Eurostat, Complete energy balances, 8 February 2021 (accessed 9 February 2021), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_bal_c&lang=en.

[24] REKK (Regional Centre for Energy Policy Research), Erdészeti és ültetvény eredetű fás szárú energetikai biomassza Magyarországon [Firewood energy biomass of plantation and forestry origins in Hungary], Műhelytanulmány No. 2009/5, REKK, Budapest. https://rekk.hu/downloads/projects/wp2009_5.pdf, 2009. (Accessed 15 July 2018).

[25] REKK (Regional Centre for Energy Policy Research), Meg-megújuló statisztikák [Revised renewable statistics], REKK Policy Brief No. 01/2017, REKK, Budapest. http://rekk.hu/downloads/academic_publications/rekk_policybrief_hu_2017_01.pdf, 2017. (Accessed 15 July 2018).

[26] M. Bartek-Lesi, B. Dézsi, B. Felsmann, E. Kácsor, P. Kotek, A. Mezősi, V. Rácz, A. Selei, G. Szajkó, L. Szabó, B. Takácsné Tóth, A 2030-as megújulóenergia-arány elérésének költségbecslése [Cost Estimates for Reaching the 2030 Renewable Energy Ratio], Regional Centre for Energy Policy Research (REKK), Budapest, 2019. https://rekk.hu/downloads/projects/2019_REKK_NEKT_megujulo_final.pdf. (Accessed 23 May 2020).

[27] C. Yuan, S. Liu, J. Wu, The relationship among energy prices and energy consumption in China, Energy Pol. 38 (2010) 197–207, https://doi.org/10.1016/j.enpol.2009.09.006.

[28] W. Chung, M.S. Kam, C.Y. Ip, A study of residential energy use in Hong-Kong by decomposition analysis, Appl. Energy 88 (2011) 5180–5187, https://doi.org/10.1016/j.apenergy.2011.07.030.

[29] X. Zhao, N. Li, C. Ma, Residential energy consumption in urban China: a decomposition analysis, Energy Pol. 41 (2012) 644–653, https://doi.org/10.1016/j.enpol.2009.11.019.

[30] F. Gassmann, R. Tsukada, Switching off or switching source: energy consumption and household response to higher energy prices in the Kyrgyz Republic, Centr. Asian Surv. 33 (2014) 531–549, https://doi.org/10.1080/02634937.2014.982979.
[31] Z. Liu, T. Zhao, Contribution of price/expenditure factors of residential energy consumption in China from 1993 to 2011: a decomposition analysis, Energy Convers. Manag. 98 (2015) 401–410, https://doi.org/10.1016/j.enconman.2015.04.008.
[32] S. Moshiri, The effects of the energy price reform on households' consumption in Iran, Energy Pol. 79 (2015) 177–188, https://doi.org/10.1016/j.enpol.2015.01.012.
[33] Eurostat, Disaggregated final energy consumption in households – Quantities, 19 March 2021 (accessed 26 March 2021), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_d_hhq&lang=en.
[34] ITM (Hungary's Ministry of National Development), Magyarország Nemzeti Energia- És Klímaterve [Hungary's National Energy and Climate Plan], 2020.
[35] MEKH (Hungarian Energy and Public Utility Regulatory Authority), Annual natural gas balance, 2014–2019, 29 January 2021 (accessed 3 February 2021), http://www.mekh.hu/download/7/c7/e0000/3_2_annual_natural_gas_balance_2014_2019.xlsx.
[36] KSH (Hungarian Central Statistical Office), Gázellátás (1990–) [Gas supply (1990–)]. https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_zrk003.html, 2020. (Accessed 30 April 2021).
[37] KSH (Hungarian Central Statistical Office), Annual per capita expenditure by COICOP, income deciles, regions and type of settlements (2010–). https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_zhc021a.html, 2020. (Accessed 17 January 2021).
[38] KSH (Hungarian Central Statistical Office), A háztartások energiafelhasználása, 2008 [Household energy use, 2008]. http://www.ksh.hu/docs/hun/xftp/idoszaki/pdf/haztartenergia08.pdf, 2010.
[39] Piac&Profit, A rezsicsökkentés a mélybe lökte az inflációt [The utility cost reduction pushes inflation down], 11 November 2014 (accessed 7 October 2019), https://piacesprofit.hu/gazdasag/a-rezsicsokkentes-a-melybe-lokte-az-inflaciot/.
[40] KSH (Hungarian Central Statistical Office), Annual averages prices of selected goods and services (1996–). https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_qsf003b.html, 2021. (Accessed 30 April 2021).
[41] A.Z. Bajomi, A szociális tüzelőanyag-támogatás Magyarországon [Social heating fuel support in Hungary], Habitat for Humanity Hungary, Budapest, 2018. https://habitat.hu/wp-content/uploads/2018/09/hfhh_tuzifa_tanulmany.pdf. (Accessed 7 October 2019).
[42] B Belicza, A fával és szénnel tüzelők rezsije is csökkenhet [Utility costs of people burning wood and coal may also decrease], 24.hu, 15 September 2013. https://24.hu/belfold/2013/09/15/a-faval-es-szennel-tuzelok-rezsije-is-csokkenhet/. (Accessed 14 August 2021).
[43] ITM (Hungary's Ministry for Innovation and Technology), Hosszú Távú Felújítási Stratégia az (EU) 2018/844 számú irányelve alapján a 2021–2027 közötti kohéziós célú támogatások kifizetését lehetővé tevő feljogosító feltételek teljesítése céljából [Long-Term Renovation Strategy under Directive (EU) 2018/844 to Fulfil Eligibility Conditions for Payments from Cohesion Funds for 2021–2027], 2021. https://ec.europa.eu/energy/sites/default/files/documents/hu_2020_ltrs.pdf. (Accessed 1 August 2021).
[44] Z. Szilágyi, Változások a földgázpiacon [Changes in the natural gas market], Magyar Épületgépészet 63 (2014) 25–27.
[45] KSH (Hungarian Central Statistical Office), A települések infrastrukturális ellátottsága, 2019 [Infrastructural supply of settlements, 2019], Infrastructural supply of settlements, 2020, 2019, https://www.ksh.hu/docs/hun/xftp/stattukor/telepinfra/2019/index.html. (Accessed 30 April 2021).
[46] G. Rácz, Alig maradt a kormány szerint rezsitartozás [Hardly Any Utility Arrears Left According to the Government] Napi.hu, 30 November 2019. https://www.napi.hu/magyar_gazdasag/rezsicsokkentes-tartozas.696048.html. (Accessed 23 December 2020).
[47] Eurostat, Adjusted Gross Disposable Income of Households Per Capita, 11 February 2021. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sdg_10_20&lang=en. (Accessed 17 February 2021).
[48] Eurostat, Eurostat, Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates, 15 February 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=prc_ppp_ind&lang=en. (Accessed 17 February 2021).
[49] Eurostat, Annual Key Indicators by Member States – Households, 28 January 2021. http://ec.europa.eu/eurostat/documents/499359/499434/HH+Annual+Ratios+2017/d6e259dd-76b9-4a82-b5d9-f83d7c80d7c3. (Accessed 17 February 2021).
[50] Eurostat, People at Risk of Poverty or Social Exclusion by Age and Sex, 10 March 2021. http://ec.europa.eu/eurostat/product?code=ilc_peps01&language=en&mode=view. (Accessed 26 March 2021).
[51] Portfolio, Hiába tűntek el teljesen, megtaláltuk a mélyszegénységben élő magyarokat [Even Though They Had Disappeared Completely, We Found Hungarians Living in Extreme Poverty], 23 October 2018. https://www.portfolio.hu/gazdasag/20181023/hiaba-tuntek-el-teljesen-megtalaltuk-a-melyszegenysegben-elo-magyarokat-301922. (Accessed 7 October 2019).
[52] Eurostat, Persons by Risk of Poverty, Material Deprivation, Work Intensity of the Household, Age and Sex of the Person – Intersections of Europe 2020 Poverty Target Indicators, 10 March 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_pees01&lang=en. (Accessed 26 March 2021).
[53] NFM (Hungary's Ministry of National Development), ÉMI Nonprofit Kft., National Building Energy Performance Strategy, 2015. https://ec.europa.eu/energy/sites/ener/files/documents/2014_article4_hungary_en%20translation.pdf. (Accessed 17 November 2019).
[54] NFM (Hungary's Ministry of National Development), Hungary's National Energy Efficiency Action Plan until 2020, 2015. https://ec.europa.eu/energy/sites/ener/files/documents/hungaryActionPlan2014_en.pdf. (Accessed 17 November 2019).
[55] OpenExp, European Energy Poverty Index (EEPI): Assessing Member States' Progress in Alleviating the Domestic and Transport Energy Poverty Nexus, 2019. https://www.openexp.eu/sites/default/files/publication/files/european_energy_poverty_index-eepi_en.pdf. (Accessed 26 March 2021).
[56] M. Bartek-Lesi, Rezsicsökkentés vagy háztartási energiahatékonyság? [Utility cost reduction or household energy efficiency?] Metazsúl blog, 28 October 2019. https://blog.rekk.hu/bejegyzes/18/rezsicsokkentes-vagy-haztartasi-energiahatekonysag. (Accessed 4 November 2019).
[57] J.M. Cansino, A. Sánchez-Braza, M.L. Rodríguez-Arévalo, Driving forces of Spain's CO2 emissions: a LMDI decomposition approach, Renew. Sustain. Energy Rev. 48 (2015) 749–759, https://doi.org/10.1016/j.rser.2015.04.011.
[58] W. Fan, L. Li, F. Wang, D. Li, Driving factors of CO2 emission inequality in China: the role of government expenditure, China Econ. Rev. 64 (2020) 101545, https://doi.org/10.1016/j.chieco.2020.101545.
[59] O. Kaltenegger, What drives total real unit energy costs globally? A novel LMDI decomposition approach, Appl. Energy 261 (2020) 114340, https://doi.org/10.1016/j.apenergy.2019.114340.
[60] R. Hoekstra, J.C.J.M. van der Bergh, Comparing structural and index decomposition analysis, Energy Econ. 25 (2003) 39–64, https://doi.org/10.1016/s0140-9883(02)00059-2.
[61] X. Zhao, C. Ma, D. Hong, Why did China's energy intensity increase during 1998–2006? Decomposition and policy analysis, Energy Pol. 38 (2010) 1379–1388, https://doi.org/10.1016/j.enpol.2009.11.019.
[62] B.W. Ang, K.-H. Choi, Decomposition of aggregate energy and gas emission intensities for industry: a refined divisia index method, Energy J. 18 (1997) 59–73.
[63] F.L. Liu, B.W. Ang, Eight methods for decomposing the aggregate energy-intensity of industry, Appl. Energy 76 (2003) 15–23, https://doi.org/10.1016/s0306-2619(03)00043-6.
[64] B.W. Ang, The LMDI approach to decomposition analysis: a practical guide, Energy Pol. 33 (2005) 867–871, https://doi.org/10.1016/j.enpol.2003.10.010.
[65] B.W. Ang, LMDI decomposition approach: a guide for implementation, Energy Pol. 86 (2015) 233–238, https://doi.org/10.1016/j.enpol.2015.07.007.
[66] R. Haas, Energy efficiency indicators in the residential sector, Energy Pol. 25 (1997) 789–802, https://doi.org/10.1016/s0301-4215(97)00069-4.
[67] C. Achao, R. Schaeffer, Decomposition analysis of the variations in residential electricity consumption in Brazil for the 1980–2007 period: measuring the activity, intensity and structure effect, Energy Pol. 37 (2009) 5208–5220, https://doi.org/10.1016/j.enpol.2009.07.043.
[68] B. Hojjati, S.H. Wade, U.S. household energy consumption and intensity trends: a decomposition approach, Energy Pol. 48 (2012) 304–314, https://doi.org/10.1016/j.enpol.2012.05.024.
[69] G. Du, W. Lin, C. Sun, D. Zhang, Residential electricity consumption after the reform of tiered pricing for household electricity in China, Appl. Energy 157 (2015) 276–283, https://doi.org/10.1016/j.apenergy.2015.08.003.
[70] M.M. Hasan, W. Chongbo, Estimating energy-related CO2 emission growth in Bangladesh: the LMDI decomposition method approach, Energy Strateg. Rev. 32 (2020) 100565, https://doi.org/10.1016/j.esr.2020.100565.
[71] Enerdata, Odyssee Database, 2017. http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html. (Accessed 17 January 2021).
[72] Eurostat, Cooling and Heating Degree Days by Country – Annual Data, 8 February 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_chdd_a&lang=en. (Accessed 9 February 2021).
[73] KSH (Hungarian Central Statistical Office), Data of Total Households by Deciles, Regions and Type of Settlements 2010, 2020. http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_zhc014a.html. (Accessed 17 January 2021).
[74] OECD/IEA, Energy Statistics Manual, OECD/IEA, Paris, 2004. https://ec.europa.eu/eurostat/documents/3859598/5885369/NRG-2004-EN.PDF/b3c4b86f-8e88-4ca6-9188-b95320900b3f. (Accessed 11 February 2020).
[75] Odyssee-Mure, Q&A – Definition, 2021. https://www.odyssee-mure.eu/faq/efficiency-indicators-policies-definitions/. (Accessed 6 August 2021).
[76] European Environment Agency, Influence of Climate on Household Energy Consumption Per Dwelling: Metadata, 14 March 2012. https://www.eea.europa.eu/data-and-maps/figures/influence-of-climate-on-households-2. (Accessed 6 August 2021).
[77] ITM (Hungary's Ministry of National Development), Nemzeti Energiastratégia 2030, Kitekintéssel 2040-ig [National Energy Strategy 2030 with an Outlook to 2040], 2020.
[78] S. Bouzarovski, S. Tirado Herrero, S. Petrova, D. Ürge-Vorsatz, Unpacking the spaces and politics of energy poverty: path-dependencies, deprivation and fuel switching in post-communist Hungary, Local Environ. 21 (2016) 1151–1170, https://doi.org/10.1080/13549839.2015.1075480.
[79] P. Bucsky, Közel 300 ezren hagyták el az országot 2010 óta, sokan meglepő helyekre mentek [Nearly 300,000 People Have Left the Country since 2010, Many Have Gone to Surprising Places], G7.hu, 25 February 2019. https://g7.hu/adat/20190225/kozel-300-ezren-hagytak-el-az-orszagot-2010-ota-sokan-meglepo-helyekre-mentek/. (Accessed 25 February 2019).
[80] Government of Hungary, Széll Kálmán Terv: Összefogás az adósság ellen [Széll Kálmán Plan: Joining Forces against Debt], 2011. https://2010-2014.kormany.hu/download/4/d1/20000/Sz%25C3%25A9ll%2520K%25C3%25A1lm%25C3%25A1n%2520Terv.pdf. (Accessed 5 April 2021).

[81] NFM (Hungary's Ministry of National Development), National Energy Strategy 2030, 2012. https://2010-2014.kormany.hu/download/7/d7/70000/Hungarian%20Energy%20Strategy%202030.pdf. (Accessed 17 November 2019).

[82] S. Fischerauer, A. Johnston, State regulation of retail energy prices: an anachronism in the liberalized EU energy market, J. World Energy Law Bus. 9 (2016) 458–474, https://doi.org/10.1093/jwelb/jww032.

[83] A. Boute, Challenging the re-regulation of liberalized electricity prices under investment arbitration, Energy Law J. 32 (2011) 497–539. https://www.eba-net.org/assets/1/6/14-497-boute.pdf.

[84] ITM (Hungary's Ministry for Innovation and Technology), National Energy and Climate Plan of Hungary, Draft, 2018. https://ec.europa.eu/energy/sites/default/files/documents/hungary_draftnecp.pdf. (Accessed 15 September 2019).

[85] European Commission, Assessment of the Draft National Energy and Climate Plan of Hungary. Commission Staff Working Document, SWD(2019) 267 final, 2019. https://ec.europa.eu/energy/sites/ener/files/documents/hu_swd_en.pdf. (Accessed 27 February 2020).

[86] European Parliament and Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, 2018. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG&toc=OJ:L:2018:328:FULL. (Accessed 3 December 2019).

[87] European Commission, Assessment of the Final National Energy and Climate Plan of Hungary SWD(2020) 916 final, 2020. https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_hungary.pdf. (Accessed 3 March 2021).

[88] IEA (International Energy Agency), Hungary, n.d. (accessed 7 January 2021) in: https://www.iea.org/countries/hungary.

[89] European Parliament and Council, Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 Amending Directive 2012/27/EU on Energy Efficiency, 2018. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2002&from=EN. (Accessed 3 December 2019).

[90] L. Kőszeghy, N. Feldmár, Energiaszegénység magyarországi kontextusban [Energy poverty in the Hungarian context]. International conference and workshop Háztartások nehézségeitől a klímaválságig [From household difficulties to the climate crisis], Centre for Social Sciences, Budapest, 25–26 November 2019. https://www.elosztoprojekt.hu/wp-content/uploads/2019/12/LeaN%C3%B3ra.pdf. (Accessed 3 December 2019).

[91] Act CLX of 2020 on the Amendment of Certain Energy Efficiency Acts (XII. 21.). https://net.jogtar.hu/jogszabaly?docid=A2000160.TV&timeshift=fffffff4&txtreferer=00000001.TXT. (Accessed 26 February 2021).

[92] D. Bolcsó, A magyar kormány a rezsicsökkentés miatt blokkolta az uniós klímatervet [The Hungarian Government Blocks the Climate Plan of the EU Because of Utility Cost Reduction], Index.hu, 21 June 2019. https://index.hu/techtud/2019/06/21/klimavaltozas_karbonsemlegesseg_europai_unio_2050_blokkolas_rezsi_rezsicsokkentes/. (Accessed 21 June 2019).

[93] B. Felsmann, Fel kell készülnünk a magas energiaárak időszakára [We Need to Prepare for High Energy Price Periods], G7.hu, 21 July 2021. https://g7.hu/adat/20210721/fel-kell-keszulnunk-a-magas-energiaarak-idoszakara/. (Accessed 16 August 2021).

[94] B. Takácsné Tóth, P. Kotek, A. Selei, A magyar gázpiaci liberalizáció 15 éve [Fifteen years of gas market liberalisation in Hungary], Vezetéstudomány 50 (2019) 32–45, https://doi.org/10.14267%2FVEZTUD.2019.KSZ.04.

[95] A. Deák, C. Weiner, Hungary: leveraging political influence, in: O. Shentov, R. Stefanov, M. Vladimirov (Eds.), The Russian Economic Grip on Central and Eastern Europe, Routledge, Abingdon, UK, New York, US, 2019, pp. 136–150.

[96] I. Marnitz, Leeresztett a gázkassza [Gas Budget Dropped], Népszava, 18 June 2020. https://nepszava.hu/3081988_leeresztett-a-gazkassza. (Accessed 18 June 2020).

[97] Eurostat, GDP and Main Components (Output, Expenditure and Income), 26 March 2021. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_gdp&lang=en. (Accessed 26 March 2021).

[98] Eurostat, Gross capital formation by industry (up to NACE A*64), 16 March 2021. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64_p5&lang=en. (Accessed 26 March 2021).

[99] A. Boute, Energy justice along the 'new silk road': balancing investors' and consumers' rights in Central Asia, in: I. del Guayo, L. Godden, D.D. Zillman, M. F. Montoya, J.J. González (Eds.), Energy Justice and Energy Law, 2020, https://doi.org/10.1093/oso/9780198860754.003.0008. Oxford Scholarship Online.

[100] Government Decree 1160/2015 (III. 20.). http://www.kozlonyok.hu/nkonline/MKPDF/hiteles/MK15036.pdf. (Accessed 14 October 2019).

[101] Government Decree 1274/2018 (VI. 15.). http://njt.hu/cgi_bin/njt_doc.cgi?docid=208881.355578. (Accessed 14 October 2019).

[102] ITM (Hungary's Ministry for Innovation and Technology), Magyarország Nemzeti Energia- és Klímaterve – 2–3. melléklet [Hungary's National Energy and Climate Plan – Annexes 2–3], 2020.

[103] Napi hu, Így vett ki a kormány 90 milliárdot az ön zsebéből is [That Is How the Government Took 90 Billion Out of Your Pocket], 28 April 2016. https://www.napi.hu/ingatlan/igy_vett_ki_a_kormany_90_milliardot_az_on_zsebebol_is.613896.html. (Accessed 7 October 2019).

[104] F. Sáfián, Energiafogyasztás és energiahatékonyság a hazai háztartásokban [Energy consumption and energy efficiency of domestic households]. International conference and workshop 'Háztartások nehézségeitől a klímaválságig' [From household difficulties to the climate crisis], Centre for Social Sciences, Budapest, 25-26 November 2019. https://www.elosztoprojekt.hu/wp-content/uploads/2019/12/Safian_MEHI_Habitat_enszeg_2019.nov_.25.pptx.pdf.

[105] European Commission, Nearly zero-energy buildings. https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-performance-of-buildings/nearly-zero-energy-buildings, n.d. (Accessed 13 March 2021).

[106] Z. Koritár, F. Sáfián, I. Illésné Szécsi, A. Pálffy, Hazai felújítási hullám [Domestic Renovation Wave], MEHI (Hungarian Energy Efficiency Institute), Budapest, 2021. http://mehi.hu/sites/default/files/mehi_hazai_felujitasi_hullam_tanulmany_2021.pdf. (Accessed 24 April 2021).

[107] MEHI (Hungarian Energy Efficiency Institute), A Magyar Energiahatékonysági Intézet állásfoglalása az elkészült energetikai stratégiai dokumentumokról [Statement of Hungarian Energy Efficiency Institute on completed energy strategy documents], 13 February 2020. https://mehi.hu/sites/default/files/nekt_vegleges_mehi_velemeny.pdf. (Accessed 15 August 2021).

[108] B. Felsmann, Olyan rendszer jon januartol, amely par ev mulva energiaar-emelest feltetelez [System to come from January assuming increases in energy prices in few years], G7.hu, 30 December 2020. https://g7.hu/kozelet/20201230/olyan-rendszer-jon-januartol-amely-par-ev-mulva-energiaar-emelest-feltetelez/. (Accessed 30 December 2020).

[109] NFM (Hungary's Ministry of National Development), Energia- és Klímatudatossági Szemléletformálási Cselekvési Terv [Energy and Climate Awareness Raising Action Plan], 2015. https://2010-2014.kormany.hu/download/0/0c/41000/Energia-%20%C3%A9s%20Kl%C3%ADmatudatoss%C3%A1gi%20Szeml%C3%A9letform%C3%A1l%C3%A1si%20Cselekv%C3%A9si%20Terv.pdf. (Accessed 17 November 2019).

[110] J. Thema, F. Suerkemper, J. Couder, N. Mzavanadze, S. Chatterjee, J. Teubler, S. Thomas, D. Ürge-Vorsatz, M.B. Hansen, S. Bouzarovski, J. Rasch, S. Wilke, The multiple benefits of the 2030 EU energy efficiency potential, Energies 12 (2019) 2798, https://doi.org/10.3390/en12142798.