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ECONOMIC ROLE AND RELATIONS TO LAND USE OF SECOND VERSUS FIRST GENERATION BIOFUELS

Második versus első generációs bioüzemanyagok gazdasági szerepe, kapcsolata a földhasználattal

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Abstract

Earlier research analyzing secondary data and reviewing EU directives pointed out that EU/national tax (excise) and policy legislation had an impact on the incidence of two biofuels considered to be renewable energy sources, biodiesel and bioethanol. Based on EU Member state reports on biofuel use prepared for the European Commission, the dynamic growth of biodiesel and bioethanol use predicted by trend calculations from 2006 data did happen.

The close correlation between the progressive and dynamic growth in biofuel use and the trends in EU regulatory measures and tax allowances can be attributed to the EU energy policy targets set.

The paper reviews this approach from the energy perspective, based on the proposal of Indirect Land Use Change "ILUC", highlighting the correlations between land use changes and greenhouse gas emissions (Directive 2009/28/EC of the European Parliament and of the Council). The question emerges, to which extent maximisation of first generation biofuels ratio in 5%$_E$ may have an impact on second generation biofuel production as opposed to earlier concepts on the overall 10%$_E$ obligation. Prevalence of the latter is subject to wide ranging innovation of economic operators in the supply chain, whilst failing competitiveness of the EU as a whole and changes in agribusiness should also be taken into consideration.

Keywords *alternative energy, legal environment, production capacity, raw materials*

JEL kód: O13; Q15; Q42

Összefoglalás

Korábbi kutatómunkánkban szekunder adatok elemzésével, illetve a direktívák áttekintésével kimutattuk, hogy az uniós és a nemzeti szakmai, illetve adójogi (jövedéki) szabályozás – a bioüzemanyag, mint megújuló energiaforrás tekintetében – a biodízel és a bioetanol elterjedésére hatással van. A biodízel és a bioetanol felhasználásának dinamikus növekedésére szekunder adatokon 2006-ban végzett trendszámításokban kapott várható növekedés bekövetkezett, az Európai Unió tagállamai által a bioüzemanyag felhasználással kapcsolatban a Bizottság részére készített jelentések alapján.

Az Európai Unió energiapolitikájában meghatározott célokra vezethető vissza, hogy a bioüzemanyag-felhasználás fokozatos és dinamikus növekedése és az Európai Unió szabályzó rendszerének változása, adókedvezmények alkalmazása között szoros kapcsolat mutatható ki.

A tanulmány a témakör energetikai szempontú megközelítését az Indirect Land Use Change „ILUC" elnevezésű javaslat alapján vizsgálja, kiemelve a földhasználat változás és üvegházhatású gázkibocsátás közötti összefüggéseket (28/2009 EK irányelv). Kérdés, hogy a korábbi elképzelésekkel szemben (10%-os kötelezettség) az első generációs bioüzemanyagok 5%-ban történő maximalizálása mennyiben befolyásolja a második generációs bioüzemanyagok termelését. Ezek elterjedése függ a termékpálya szereplői széleskörű innovációs tevékenységétől, ugyanakkor számolni kell az Európai Unió versenyképességének csökkenésével, illetve változásokkal az agrárgazdaságban is.

Kulcsszavak *alternatív energia, jogszabályi környezet, termelési kapacitás, alapanyag*

Introduction

Considering the carrying capacity of the Earth and our oversized ecological footprint, it is just a question of time when production of fossile fuel reserves reaches its climax, when car manufacturers start mass production of novel technology vehicles at affordable prices and what the new fuel will be [Bai A. 2011].

For the purposes of a new fuel, biomass is considered to be the first choice. Community regulation stipulates that the proportion of fuel from renewable sources should reach 10% of total fuels used by 2020 in transportation [Directive 2009/28/EC of the European Parliament and the Council].

Substantial deviations were demonstrated in the extent of emissions originating from indirect land use changes related to the biofuel supply chain by research concerning production of agricultural crops for industrial purposes and the manufacture and use of fuels derived from them [ILUC 2012]. The difference may adversely affect emission reductions – having a positive impact on the greenhouse effect – if emissions of fossil fuel use for this purpose is taken into account for comparison.

A solution to the emerging problem may be the promotion of second generation biofuels [Popp et al. 2010]. Therefore, the European Commission finds it important to maximise first generation biofuel use at $5\%_E$ and the remaining part must be coming from second generation biofuels [Commission Recommendation of 2012 on the amending of Directive 2009/28/EC].

In line with the proposal of the European Commission this research revised the topic from several aspects in addition to the impact of biofuel use on land use. Discernible trends are evaluated against the feasibility of the obligatory percentage ratio ($10\%_E$) specified for biofuel use and beside the land use problem other bottlenecks are also identified.

Materials and method

The findings of the trend calculation prepared during former secondary research on estimates of biofuel use in the EU Member States including in particular Hungary [Boros 2006, Boros 2011, Boros 2013] were compared to the trend calculations made using the factual figures

from the past period since. The study focused on the period between 2005 and 2009 – no more recent figures were used since Member States to not publish reports to this effect any more under the effective directive. Amendment to the directive is currently underway [Directive 2009/28/EC of the European Parliament and of the Council]. For the purposes of the study, only Member States with biofuel use exceeding 200,000 tons per annum were selected [European Commission. Member_states_reports_directive_2003_30_ec_2006-2011]. Member States investigated included: Austria, Czech Republic, United Kingdom, France, The Netherlands, Poland, Hungary, Germany, Italy, Portugal, Romania, Spain and Sweden. Biofuel use was evaluated by fitting functions used for trend calculations on the basis of actual figures.

Penetration of biofuels in the energy mix was assessed and stated also for the Member States with biofuel use in excess of 200,000 tons per year and the average rate of the European Union as a whole for the year 2009 was determined with respect to Member States individual considerations. Using the tendency revealed in the trend analysis for biofuel use the share of biofuel in Hungary was studied in the period from 2010 to 2012 in addition to year 2009 [National Tax and Customs Office 2014].

The practical state-of-affairs was presented with a view to the feasibility of the 2020 target of $10\%_E$ applicable to Hungary [Hungarian Government 2011: Action Plan for Renewable Energy Utilisation in Hungary 2010-2020; Government Decision No 1002/2011. (I. 14.)], with the help of an in-depth interview with key operators in the sector in January 2014 [Zách D. 2014], in consideration of the mandatory application of $4.9\%_E$ biofuel ratio effective pursuant to national legislation from 1 January 2014 [Government Decree No343/2010. (XII. 28.)], and reviewing the parameters having an impact on standard qualities concerning the biodiesel contents of diesel fuels 7% v/v [Hungarian Standard. MSZ EN 590 2013], and concerning E5 gasoline 5% v/v and E10 gasoline 10% v/v [Hungarian Standard. MSZ EN 228 2013] (stressing the differences between volumetric percentage ratio and energy percent).

Using the calculation results for biofuel rates the minimum necessary area under canicola (rapeseed) and maize (corn) crops was determined [Central Statistical Office 2014]. The purpose of the research using the diesel and gasoline consumption figures of 2012 as the benchmark [National Tax and Customs Office] was to determine whether or not the $10\%_E$ target applicable to Hungary by the year 2020 can be met as a function of land use for second generation biofuels or regardless of the land use pattern applied.

Results

Unlike in the findings of earlier work, biodiesel and bioethanol in the trend calculations matched linear functions better than polynomial functions. Based on this it has been established that the growth rate of biofuel became constant. Exponential functions also match quite finely for biodiesel and bioethanol mathematically, this option however was not considered due to professional reasons: rapeseed, the source of biodiesel has limited area under crop, while motor vehicles running on bioethanol are available in limited supply only. Biofuel use for 2010 was estimated using linear functions. Comparing facts with earlier estimations for 2010 it can be stated that earlier expectations were not met. The factual growth rate of the biofuels use in 2009 has been decreased by 93,323 tonne/year and in 2010 it has been increased by 73,207 tonne/year compering to our earlier estimated arithmetic average of 2,454,187 tonne/year. Using the linear correlation fitting well for the data from 2005 to 2009 3,454,864 tons and 12,675,067 tons of bioethanol and biodiesel use were estimated, respectively. Adding the two values gives an estimated total biofuel use for 2010 as 16,129,931 tons. (Figure 1)

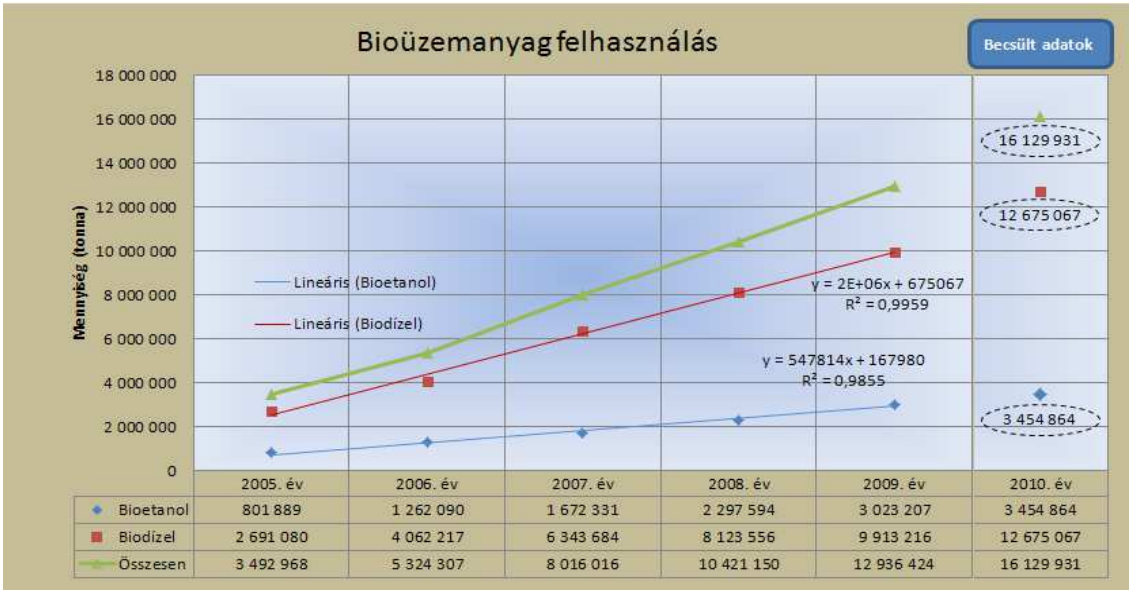

Figure 1: Aggregate biofuel use in EU Member States (quantity in tons, bioethanol, biodiesel, total, estimated figures on far right)

Sources: http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm
Editing and calculations by the authors based on EU Member States reports on biofuel use

Assessing the tendency shows that the share of biofuel use in the transport sector of the examined EU Member States in 2009 was 4.36%$_E$. Hungary ranks 9th with 3.75%$_E$ in terms of biofuel rates (Table 1)

Table 1: Biofuel percentage ratio achieved by selected EU Member States

Serial number	Member State	Ratio of biofuels in the energy contents in 2009
1	Austria	7,00%
2	France	6,25%
3	Germany	5,50%
4	Sweden	5,25%
5	Poland	4,63%
6	Portugal	4,28%
7	Romania	4,10%
8	The Netherlands	3,75%
9	Hungary	3,75%
10	Spain	3,55%
11	Italy	3,47%
12	Czech Republic	2,72%
13	United Kingdom	2,48%
Total		**4,36%**

Source: http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm
Table edited and calculated by the authors based on EU Member States reports on biofuel use

In the subsequent part of our research Hungary was put in the focus. It has been established that compared to the 2010 benchmark the biofuel ratio declined in Hungary, which can be explained by the decline of gasoline sold. The ratio of biofuels was determined by comparing the aggregate energy contents of diesel oil and gasoline to biodiesel and biopetrol (biogasoline) expressed in energy contents one by one, and using the values obtained this way the value calculated for biofuels was divided with the value for fossil fuels. Using the calculation method outlined above the applicable percentage levels for the years 2010, 2011 and 2012 were 4.41%$_E$, 4.04%$_E$ and 4.11%$_E$, respectively.

The calculation uses exact energy percentage ($\%_E$) values, because it takes into account the volumes of biofuels and fossil fuels expressed in their energy contents without including any weighing factors. The value obtained this way will be higher than the value obtained with the calculation method used in Hungary's country report for the years 2009 and 2010 (where biodiesel and diesel oil plus bioethanol and gasoline volumes expressed in energy contents were divided with each other separately and the arithmetic means of the two percentage values obtained this way was expressed in percentage) [European Commission. Member_states_reports_directive_2003_30_ec_2010-2011]. Calculation method for calculating the ratio of biofuels is presented on Table 2 below.

Table 2 Biofuel rates achieved by Hungary

Year	Fuel type	energy contents (PJ)	energy contents of its biodiesel or bioethanol ratio (PJ)	Percentage ratio of biofuels in energy content
2010	Diesel	106,01	5,21	4,91%
	Gasoline	55,17	1,90	3,44%
	Total	**161,19**	**7,11**	**4,41%**
2011	Diesel	116,99	5,13	4,39%
	Gasoline	51,89	1,69	3,26%
	Total	**168,88**	**6,83**	**4,04%**
2012	Diesel	113,42	5,21	4,60%
	Gasoline	51,37	1,57	3,05%
	Total	**164,80**	**6,78**	**4,11%**

Source: (http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm Table edited by the authors based on Hungary's 2010 country report, and the consolidated figures by the National Tax and Customs Office for 2011 and 2012

It was stated that – regarding the maximum amount allowed for biodiesel 7% v/v and bioethanol 5% v/v expressed in terms of volumetric percentage values as per the requirements laid down in the effective Hungarian diesel and gasoline standards, respectively [Hungarian standard. MSZ EN 590 2013, Hungarian standard. MSZ EN 228 2013] – the value of $4.9\%_E$ specified for both diesel and gasoline in Government Decree No 343/2010. (XII. 28.) effective with 1st of January 2014 can simply not be met for each fuel types, due to the fact that the rate derived from the difference between the two units of measurement volumetric percentage vs. energy percentage is *1.1 for biodiesel and 1.5 for bioethanol* [Zách D. 2014].

Furthermore, it was also investigated how the biofuel rates will change when the limits in fuel standards and operating parameters of vehicles allow for practical application of the 10% v/v biofuel use jointly (for instance, the E10 standard petrol will become suitable for use in transportation without damaging effects or 10% bio-version will be blended in diesel oil). According to the completed calculations with 2012 as a benchmark $8.34\%_E$ biologically derived fuel rates can be achieved in Hungary by the year 2020 (Table 3).

Table 3 Feasibility of biofuel rates for Hungary

Year	Fuel	energy contents (PJ)	biodiesel or bioethanol volume (litre)	energy contents of its biodiesel or bioethanol ratio (PJ)	Percentage ratio of biofuels in energy content	vol% associated with energy contents of the biofuel
2012	Diesel	113,42	157 968 328	5,21	4,60%	5,06%
	Gasoline	51,37	74 598 041	1,57	3,05%	4,57%
	Total	**164,80**		**6,78**	**4,11%**	
Prospects based on the effective standard	Diesel	113,42	218 574 389	7,21	6,36%	7,00%
	Gasoline	51,37	81 502 803	1,71	3,33%	5,00%
	Total	**164,80**		**8,92**	**5,42%**	
Prospects with 10%$_E$ ratio based on possible standard	Diesel	113,42	312 459 237	10,31	9,09%	10,00%
	Gasoline	51,37	163 169 470	3,43	6,67%	10,00%
	Total	**164,80**		**13,74**	**8,34%**	

Source: Table edited and calculated by the authors based on consolidated figures of the National Tax and Customs Office for 2012

In the next step changes in land use in relation to the maximum 5%$_E$ ILUC defined first generation biofuel rate were assessed. It was established that the size of land under rapeseed must be increased up to 176,304 hectares even when the joint performance of the 4.9%$_E$ rate is to be met – let alone achieving the target separately by the individual fuel types as stipulated in Government Decree No 343/2010. (XII. 28.). Considering the limit of the effective diesel oil standard for biodiesel as the benchmark and calculating with a biofuel ratio of 5.42%$_E$, the demand for land under rapeseed will grow to 243,945 hectares. In case the European Union fails to endorse the proposal on maximum allowable off-set of 5%$_E$ for first generation biofuels, the size of land under rapeseed will have to be further increased to 348,727 hectares, changing the rate of land under rapeseed by a factor of 2.11 compared to the 2012 benchmark. The set of criteria applied to maize will not cause such a growth in land use compared to the 2012 figure. Changes in land use related to biofuel ratios in Hungary is presented in Table below.

Table 4 Size of land needed to cover biofuel ratios in Hungary

Change in land use				
Production figures in Hungary	Rapeseed (kg)	Biodiesel (L)	Maize (kg)	Bioethanol (L)
Harvested in 2012 (hectares)	**164 916**		**1 191 291**	
Total yield in 2012	414 637 000		4 762 707 000	
Average yield and return rate in 2012	2 510	896	4 000	1481
Based on 2012 biofuel ratios	442 522 883	157 968 328	201 480 192	74 598 041
Land requirement (hectares)	**176 304**		**50 370**	
Prospects based on effective standard	612 301 022	218 574 389	220 129 110	81 502 803
Land requirement (hectares)	**243 945**		**55 032**	
Prospects with 10%$_E$ requirement based on prospective standard	875 304 336	312 459 237	440 700 796	163 169 470
Land requirement (hectares)	**348 727**		**110 175**	

Source: http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omf001a.html
http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn001a.html
http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn002c.html
Table edited and calculated by the authors based on Central Statistical Office figures for types of cultivation and economic sectors, arable land under key grain and land crops and their use

It was found that changing the size of land under rapeseed from 164,916 hectares in 2012 to 348,727 hectares results in an increment of 183,811 hectares under energy crops. If compensated by reducing the area of 1,191,291 hectares under maize in 2012 means a 15% reduction in corn production.

Due to the limited scope of this paper the impact of second generation biofuels on land use was not discussed here. The issue will be covered more in details in future papers.

Conclusions

Biofuel use was evaluated by fitting typical functions used for trend calculations on the basis of actual figures. A key issue for the years to come will be whether first and/or second generation biofuels will be a potent candidate for replacing current fossil fuels in transportation as a new energy resource on the long term.

In the event the proposal on maximum allowable off-set of 5%$_E$ for first generation biofuels is endorsed, the size of rapeseed tillage in Hungary would have to be increased to 245,000 hectares as a minimum compared to 165,000 hectares in 2012. In case the proposal is dismissed ie. the current Community regulation on maximum 10%$_E$ of biofuels ratio will not be changed, and taking into consideration our calculation in order to fulfil the 8,34%$_E$ use of biofuels (biofuels ratio) in Hungary – by establishing the chance of the 10% v/v blending in the effective fuel standard - the growth of the land use size of rapeseed tillage should be increased up to minimum 350,000 hectares. Changing the size of rapeseed tillage from 165,000 hectares in 2012 to 350,000 hectares results in an increment of nearly 185,000 hectares of energy crop tillage. If this is achieved by reducing the maize tillage of nearly 1,200,000 hectares in 2012 it would result in a 15% reduction in corn production.

Taking into account the current Community regulation and the proposed modification, Hungary will not be able to perform for 2020 the request of 10%$_E$ proportion of biofuel use in transportation.

The emerging problem goes far beyond the competition with food crops for arable land as a resource with limited availability, that is whether food or industrial raw material should be produced on a piece of land. In our view we have to face the fact that the prevailing concept for the use of biofuels fails to meet practical testing. The theoretical model is simply flawed. Innovation has to turn to completely new vistas if a feasible new model is ever to be created. Assertive promotion of second generation biofuels may represent a partial solution to reduce the greenhouse effect but will provide no answer to the fuel needs of the future generations.

References

BAI A. [2011] Újabb generációs bioüzemanyagok perspektívái. Magyar Tudomány. 2011. 1./10. pp.) http://www.matud.iif.hu/2011/07/12.htm (last accessed: 2 February 2014)

BOROS S. [2006] Bioüzemanyagok felhasználásával kapcsolatos adójogi szabályozás értékelése. Szakdolgozat. Gyöngyös, (7./15. pp.)

BOROS S. [2011] A bioüzemanyag, mint megújuló erőforrás Magyarországon - lehet-e elősegíteni az elterjedését szabályozással? TDK-dolgozat. Gyöngyös, (20./37. pp.)

BOROS S. [2013] A bioüzemanyag, mint megújuló erőforrás Magyarországon - lehet-e elősegíteni az elterjedését szabályozással? OTDK-dolgozat. Veszprém, (20./36. pp.)

Official Journal of the European Union [2009 L140] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Proposal of the European Commission [2012] for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources, Brussels (1/25 pp)

European Commission [2012] MEMO-12-787 Indirect Land Use Change (ILUC). Brüsszel, (1./4. pp.)

European Commission. Member_states_reports_directive_2003_30_ec_2005-2011 http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm (last accessed: 10 October 2013)
Központi Statisztikai Hivatal. A fontosabb gabonafélék termesztése és felhasználása. (1./4.pp.) http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn001a.html (last accessed: 31 January 2014)
Központi Statisztikai Hivatal. A fontosabb szántóföldi növények termesztése és felhasználása. (1./4.pp.) http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn002c.html (last accessed: 31 January 2014)
Magyar Kormány [2011] Magyarország Megújuló Energia Hasznosítási Cselekvési Terve 2010-2020. (164./166. pp.) http://www.kormany.hu/download/2/b9/30000/Meg%C3%BAjul%C3%B3%20Energia_Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20terve%202010_2020%20kiadv%C3%A1ny.pdf (last accessed: 20 January 2014)
Magyar Kormány [2011] Magyarország Megújuló Energia Hasznosítási Cselekvési Tervével összefüggő egyes feladatokról szóló 1002/2011. (I. 14.) Korm. határozat. http://njt.hu/cgi_bin/njt_doc.cgi?docid=140441.204259 (last accessed: 20 January 2014)
Magyar Közlöny. [2010. évi 199. szám] A fenntartható bioüzemanyag-termelés követelményeiről és igazolásáról szóló 343/2010. (XII. 28.) Korm. rendelet.
Magyar Szabványügyi Testület. [2013] Gépjármű-hajtóanyagok. Dízelgázolaj. Követelmények és vizsgálati módszerek. Magyar Szabvány. MSZ EN 590. (1./17. pp.)
Magyar Szabványügyi Testület. [2013] Gépjármű-hajtóanyagok. Ólmozatlan motorbenzin. Követelmények és vizsgálati módszerek. Magyar Szabvány. MSZ EN 228. (1-19. pp.)
Nemzeti Adó- és Vámhivatal [2014] Kötelező bioüzemanyag részarányt tartalmazó 2011. évre és 2012. évre vonatkozó összesített általános adatok. (1./2. pp.)
Nemzeti Adó- és Vámhivatal. http://www.nav.gov.hu/nav/szolgaltatasok/adostatisztikak/jovedeki_statisztikak/uzemanyagtolto_allomasok_forgalmi_adatai_havi_bontasban.html (last accessed: 31 January 2014)
POPP J. – SOMOGYI A. – BÍRÓ T. [2010] Újabb feszültség a láthatáron az élelmiszer- és bioüzemanyag-ipar között? Gazdálkodás. (592./603. pp.) http://ageconsearch.umn.edu/bitstream/99181/2/Popp%20et%20al_2010_6.pdf (last accessed: 2 February 2014)
ZÁCH D. [2014] Jön a benzin, amitől elromolhat az autó. Totalcar - Magazin (1./8. pp.) http://totalcar.hu/magazin/kozelet/2014/01/24/jol_nezze_meg_mit_tankol/ (last accessed: 24 January 2014)

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