Pure biofuels and high-percentage blends of biofuels with fossil fuels in transport in the period 2015 – 2020

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Čistá biopaliva a vysokoprocentní směsi biopaliv s fosilními palivy v dopravě v letech 2015 – 2020

Abstrakt:
Prezentuje se Program dalšího uplatnění udržitelných biopaliv v dopravě na období 2015 – 2020 schválený vládou ČR 6. 8. 2014. Program navazuje na „Víceletý program podpory dalšího uplatnění biopaliv v dopravě" schválený vládou ČR dne 25. 2. 2008 a 23. 12. 2008 Directorate – General for Competition s platností od 1. 7. 2009 do 30. 6. 2015. Jeho hlavními cíli je postupně snížit emise GHG z pohonných hmot o 6 % ve srovnání se základní normou pro fosilní pohonné hmoty do 31. 12. 2020 a zajistit v roce 2020 podíl alespoň 10 % konečné spotřeby energie v dopravě energií z obnovitelných zdrojů, tj. biopalivy a elektrickou energií. Soulad mezi těmito cíli, obdobně jako v současnosti naplňovaném víceletém programu, by měly zajistit dodávky nejen nízkoprocentních směsí v motorové naftě a motorových benzinech v souladu s příslušnými technickými normami, ale nadále také dodávky standardizovaných vysokoprocentních směsí biopaliv a čistých biopaliv, která splňují kritéria udržitelnosti potvrzená certifikátem. Potřebná podpora čistých biopaliv a vysokoprocentních směsí biopaliv s fosilními palivy je navržena na jejich přiměřeném zvýhodnění, protože kotované burzovní ceny biopaliv jsou stále vyšší než fosilních paliv. Algoritmus výpočtu výše daňové podpory, vyjadřující takové finanční prostředky, které je nutné vynaložit, aby bylo dané biopalivo nebo směsné palivo konkurenceschopné v porovnání s fosilním ekvivalentem, vychází z požadavky na zamezení překompenzace průměrné roční hodnoty této podpory. V současnosti je Program notifikován Evropskou komisí. Konečná výše daňové podpory čistých biopaliv a vysokoprocentních směsí biopaliv s fosilními palivy bude známa po jeho schválení. Biopaliva, která jsou uváděna povinně na trh v podobě standardizovaných nízkoprocentních směsí biopaliv s fosilními palivy podle zákona o ochraně ovzduší v platném znění a související legislativ, nejsou nijak finančně zvýhodněna.
Klíčová slova: *udržitelná biopaliva pro dopravu, konvenční biopaliva, moderní biopaliva, podpora biopaliv, daňové zvýhodnění udržitelných biopaliv*

1. Introduction

Fuel combustion in road transport in the EU causes about 20 % of total greenhouse gas (GHG) emissions. The share of the transport sector of the Czech Republic in GHG emissions in the recent period was similar to the EU and amounted to about 21 %.

That is why development of motor vehicles and their drives will continue to be governed more and more by environmental aspects, also due to the ever stricter standards for exhaust fumes. Also measures focusing on reduction of fuel consumption and GHG emissions affect to an increased extent optimization of vehicle and drive concepts. Exhaust and GHG emissions are also significantly affected by the origin and quality of fuels, systematically monitored in the Czech Republic in the sense of the effective legislation by the Czech Trade Inspection Authority and by the actual quality care systems, such as the "Plus Quality Seal" organized by SGS Czech Republic, Ltd., and inter-.laboratory circular tests of motor fuel quality organized by ABP and RIAE, p.r.i.. Prague. A similar effect on reduction of GHG emissions resulting from fuel combustion is exercised by systematic precision of properties in the binding technical standards for motor fuels and liquid oil products with direct impact on the environment. These include national and above all European standards issued by the European Committee for Standardization (CEN). The guaranteed unified quality in the EU Member States is important for both the environment and business.

On the basis of documents of the European Commission (EC) the European Parliament and the Council (EP and Council) have paid adequate attention to air protection for more than a decade. In the course of this period they issued a number of legislative regulations for reduction of impact of fuel combustion on air quality. The most important of them include:

- Directive of the European Parliament and of the Council 2003/30/EC of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport,
- Directive of the European Parliament and of the Council 2009/28/EC 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 (RED directive),
- Directive of the European Parliament and of the Council 2009/30/EC of 23 April 2009, amending directive 98/70/EC, as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions, and amending Council Directive 1999/32/EC, as regards the specification of fuel used by inland waterway vessels, and repealing Directive 93/12/EEC (FQD directive).

Transposition of RED and FQD directives was performed by Act No 201/2012 Coll., on air protection, and executive Government regulation No 351/2012 Coll., on biofuel sustainability criteria.

2. The revision of RED and FQD directives and current state of discussion

Scientific research shows that emissions following from indirect change of land use can differ substantially depending on the input raw materials and can negate some or all GHG reductions by the individual biofuels in comparison to the fossil fuels they replace.

With regard to this the European Commission prepared a proposal for revision of RED and FQD directives, published on 17 October 2012. The submitted proposal defines stricter biofuel sustainability criteria in relation to GHG emissions reduction introduced by these directives, addresses the issue of indirect land use change (ILUC) caused by biomass growing for biofuel production, reduces the contribution of biofuels made form "food" biomass to 5 % in the compulsory 10% share of renewable sources in transport in 2020 and introduces promotion for advanced biofuels: encourage greater market penetration for biofuels produced from municipal solid waste, aquatic material, agricultural, fisheries and forestry residues and renewable liquid and gaseous fuel of non-biological origin. They will be considered four times their energy content.

Regarding the unfavourable effects of growing of certain crops used for production of traditional 1st generation biofuels on water sources and soil erosion it will be necessary to apply more strongly other instruments and control mechanisms in the context of the Common Agricultural Policy to assure higher protection of water sources and soil quality.

The proposed revision of RED and FQD directives classifies biofuels to conventional and advanced. Conventional biofuels are fuels made from biomass with the risk of emissions following from ILUC, mainly from food crops. Advanced biofuels show zero or negligible ILUC factor, i.e. are mainly made form residual biomass and biogenic waste. The revision of the Directives RED and FQD was adopted on 28 April 2015 and namely to prepare for the transition towards advanced biofuels and minimise the overall ILUC impact limits the amount of biofuels produced from cereal and other star-rich crops, sugars and oil crops and from crops grown as main crops primarily for energy purposes on agricultural land, without restricting the overall use of such biofuels.

"Starch-rich crops" means crops comprising mainly cereals (regardless of whether only the grains are used or the whole plant, such as in the case of green maize, is used), tubers and root crops (such as potatoes, Jerusalem artichokes, sweet potatoes, cassava and yams), and corm crops (such as taro and cocoyam). "ILUC risk biofuels" means biofuels, the feed stocks of which were produced within schemes which reduce the displacement of production for purposes other than for making biofuels and which were produced in accordance with the sustainability criteria for biofuels. "Processing residue" means a substance that is not the end products that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it. "Agricultural, aquaculture, fisheries and forestry residues" means residues that are directly generated by agriculture, aquaculture, fisheries and forestry; they do not include residues from related industries or processing. "Co-products" means substance or object resulting from a production process not being a product, residue or waste (waste – substance or objects which the holder discards or intends or is required to discard). In Figure 1 shows decision tree to differentiate between waste/residue and co-product.

The revision of the Directives RED and FQD was adapted also a national target for the share of advanced biofuels. A reference value for this target is 0.5 % percentage point in energy content (e.c.) of the share of energy from renewable sources in all forms of transport in 2020. To be met with biofuels produced from feedstocks and fuels, and the contribution of which towards the target (10 % e.c.) shall be considered to be twice thein energy content: algae if cultivated on land in ponds or photobioreactors; biomass fraction of mixed municipal waste, but not separated household waste subject to recycling targets under point (a) of Article 11(2) of Directive 2008/98/EC; bio-waste as defined in Article 3(4) of Directive 2008/98/EC from private households subject to separate collection as defined in Article 3(11) of that Directive; biomass fraction of industrial waste not fit four use in the food or feed chain, including material from retail and wholesale and the agro-food and fish and aquaculture industry, and excluding used cooking oil, animal fats; straw; animal manure and sewage sludge; palm oil mill effluent and empty palm fruit bunches; tall oil pitch; crude glycerine; bagasse; grape marcs and wine lees; nut shells; husks; cobs cleaned of kernels of corn; biomass fraction of wastes and residues from forestry and forest-based industries, i.e. bark, branches, precommercial thinnings, leaves, needles, tree tops, saw dust, cutter shavings, black liquor, brown liquor, fibre sludge, lignin and tall oil; other non-food cellulosic material as defined in point (s) of the second paragraph of Article 2; other lingo-cellulosic material as defined in point (r) of the second paragraph of Article 2 except saw logs and veneer logs; renewable liquid and gaseous transport fuels of non-biological origin; carbon capture and utilisation for transport purposes, if the energy source is renewable in accordance with point (a) of the second paragraph of Article 2; bacteria, if the energy source is renewable in accordance with point (a) of the second paragraph of Article 2. Feedstocks, the contribution of which towards the target shall be considered to be twice their energy content: used cooking oil; animal fats classified as categories 1 and 2 in accordance with Regulation (EC) No 1069/2009 of the European Parliament and of the Council. "Renewable liquid and gaseous transport fuels of non-biological origin"

means liquid or gaseous fuels other than biofuels whose energy content comes from renewable energy sources other than biomass, and which are used in transport.

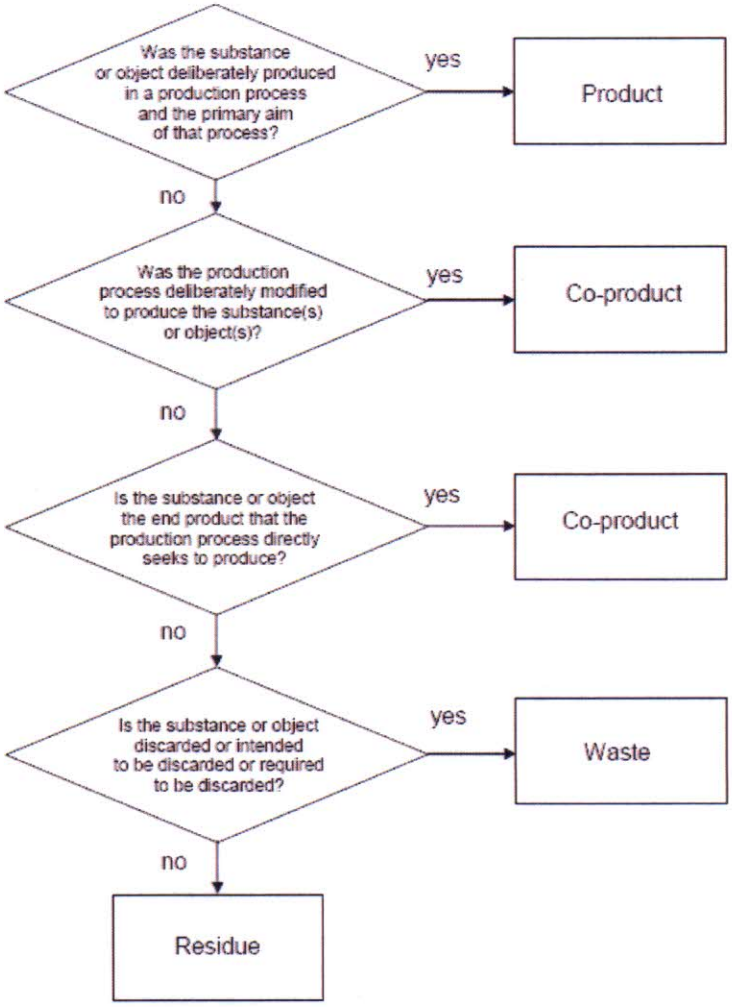

Figure 1: Decision tree to differentiate between waste/residue and co-product *(Source: EN 16214-1:2012)*

3. Programme of support for further application of sustainable biofuels in transport for the period 2015 - 2020

Like the multi-annual program approved till 30 June 2015 this new multi-annual program is conceived on the basis of Article 16 (5) of Council Directive 2003/96/EC, amending the structure of the Community framework regulations for taxation of energy products and electricity. The directive allows for exemption from or reduction of the tax rate for selected products on the basis of multiannual programs.

As concerns potential impact of the revised directives RED and FQD on further use of biofuels in the Czech Republic the liabilities listed in Table 1, i.e. continuous decrease of GHG emissions from fuel combustion by 6 % and compliance with the 10 % energy content of biofuels and renewable electricity in total energy consumption in transport by 2020 will not change.

The change will involve limited options of achievement of the specified goals with conventional biofuels and pressure on use of biofuels with GHG emissions reduction higher than 65 % already since 2017. Production of modern biofuels with GHG emissions reduction exceeding 70 - 90 % still to a small extent focuses on waste vegetable or animal oils.

For the reason of the required increase of GHG emissions reduction in the period 2017 – 2020 pressure can be expected towards achievement of higher effectiveness exerted by fuel suppliers onto all other parts of the biofuel manufacturing chain. For that reason scientific research institutions will be more closely involved in addressing this issue. The broadest space for oriented research and development in the area of biomass growing and processing in relation to traditional biofuels can be expected. In the area of advanced biofuels higher effectiveness and competitiveness across the sector will be needed.

Table 1: Quotas of biofuels and renewable electric energy for transport with regard to biofuel sustainability criteria[1)] and fuel GHG emissions reduction liability[2)] in the period 2014 – 2020

	Liability to reduce GHG emissions by (%)	Minimum GHG emissions saving by biofuels (%)	Share of biofuels and renewable electric energy in total energy consumption for transport (% energy content)
2014	2	35 (50)	5,71 (4)
2015 - 2016	2	35 (60)	5.71 (3,33)
2017 - 2019	4	50 (65)	8.00 (6.15)
2020	6	60 (70 – 80)	10.00[3)] (8.57 – 7.5)

[1)] *In compliance with RED and FQD directives and Government Regulation no 351/2012 Coll., of 3 October 2012 on biofuel sustainability criteria*

[2)] *In compliance with FQD directive and Act no 201/2012 Coll., of 2 May 2012 on Air Protection*

[3)] *Pursuant to the national renewable energy action plan in the mean values for the whole EU the share of biofuels in 2020 should amount to 8.8 % of energy content, of which 1.3 % of energy content of advanced biofuels and further 1.2 % of energy content of renewable electricity. The final shares will be known after completion of the legislative process of revisions of RED and FQD directives.*

All technical standards for pure biofuels and high-percentage blends of bio and fossil fuels have considerably increased requirements for quality and especially oxidisation stability. This requires from biofuel users a considerably more careful method of storage and handling to prevent degradation and microbial contamination of bio and mixed fuels as specified by ČSN 65 6500 (2012) standard "Fuels - Storage Conditions and Recommended usable life". Compliance with quality requirements is also a necessary precondition for promotion. In Table 2 shows specification of the maximum share of biofuels pursuant to current requirements of quality standards and pre-standards and pursuant to measurement uncertainty of the individual testing methods in compliance with ČSN EN ISO 4259 standard as the ceiling for biofuel admixtures (the blending wall).

Production of standardized rapeseed methyl-esters (FARME) and their utilization in standardized blended diesel fuel with share of 31 % V/V FARME is introduced in the Czech Republic similarly like production of vegetable oils methyl esters in some EU countries since 1992 (Fig. 2). Use of pure fatty acids methyl esters of (FAME) or rape seed oil methyl ester (RME) in existing diesel engines (especially tractor engines) was not successful for the reason of lower quality according to the RME technical standard, imperfect from the present point of view, which is why use of mixed diesel fuel B31, and since 2010 B30, was introduced (Fig. 3).

Table 2: Specification of maximum share of biofuels pursuant to current requirements of quality standards and pre-standards and measurement uncertainty of the individual testing methods in compliance with ČSN EN ISO 4259 standard as the ceiling for biofuel blend (the blending wall)

Fuel type	Quality standard	Biofuel content	Reproducibility	Measurement uncertainty interval in the limit value area
Automotive petrol	ČSN EN 228 (2013)	E5 max. 5 % vol.	0.3 % vol. ČSN EN 13132 or ČSN EN 1601	5-(0.3x0.6) = 4.8 % vol. Range 4.8 - 5.2 % vol.
		E10 max. 10 % vol.	0.8 % vol. ČSN EN 13132 or ČSN EN 1601	10-(0.8x0.6) = 9.5 % vol. Range 9.5 - 10.5 % vol.
Fuel E85	ČSN P CEN/TS 15293 (2011)	70 - 85 % vol.	1.0 % vol. for max. content 15 % vol. ČSN EN 13132 or ČSN EN 1601	70-(1.0x0.6) = 69.4 % vol. 85-(1.0x0.6) = 85.6 % vol.
Fuel E95	ČSN 65 6513 (2009)	min. 95.8 % vol. = 93.7 % w	1.9 % w ČSN EN 15721	93.7-(1.9x0.6) = 92.5 % w Range 92.5 - 95.0 % w
Diesel fuel B7	ČSN EN 590 (2014)	max. 7 % vol.	0.5 % vol. ČSN EN 14078	7-(0.5x0.6) = 6.7 % vol. Range 6.7 - 7.3 % vol.
Diesel fuel B10	Draft prEN 590 (10/2011)	max.10 % vol.	0.75 % vol. ČSN EN 14078	10-(0.75x0.6) = 9.5 % vol. Range 9.5 - 10.5 % vol.
Fuel B30	ČSN 65 6508 (2013)	min. 30 % vol.	2.3 % vol.	30-(2.3x0.6) = 28.6 % vol. min. 28.6 % vol.
Fuel B20	Draft prEN 16709 (2014)	min. 15 % vol. max. 20 % vol.	1.55 % vol.	20-(1.55x0.6) = 19.0 % vol. Range 19 - 21 % vol.
Fuel B30		min. 25 % vol. max. 30 % vol.	1.95 % vol. 2.30 % vol.	25-(1.95x0.6) = 23.8 % vol. 30+(2.3x0.6) = 31.4 % vol. Range 23.8 - 31.4 % vol.

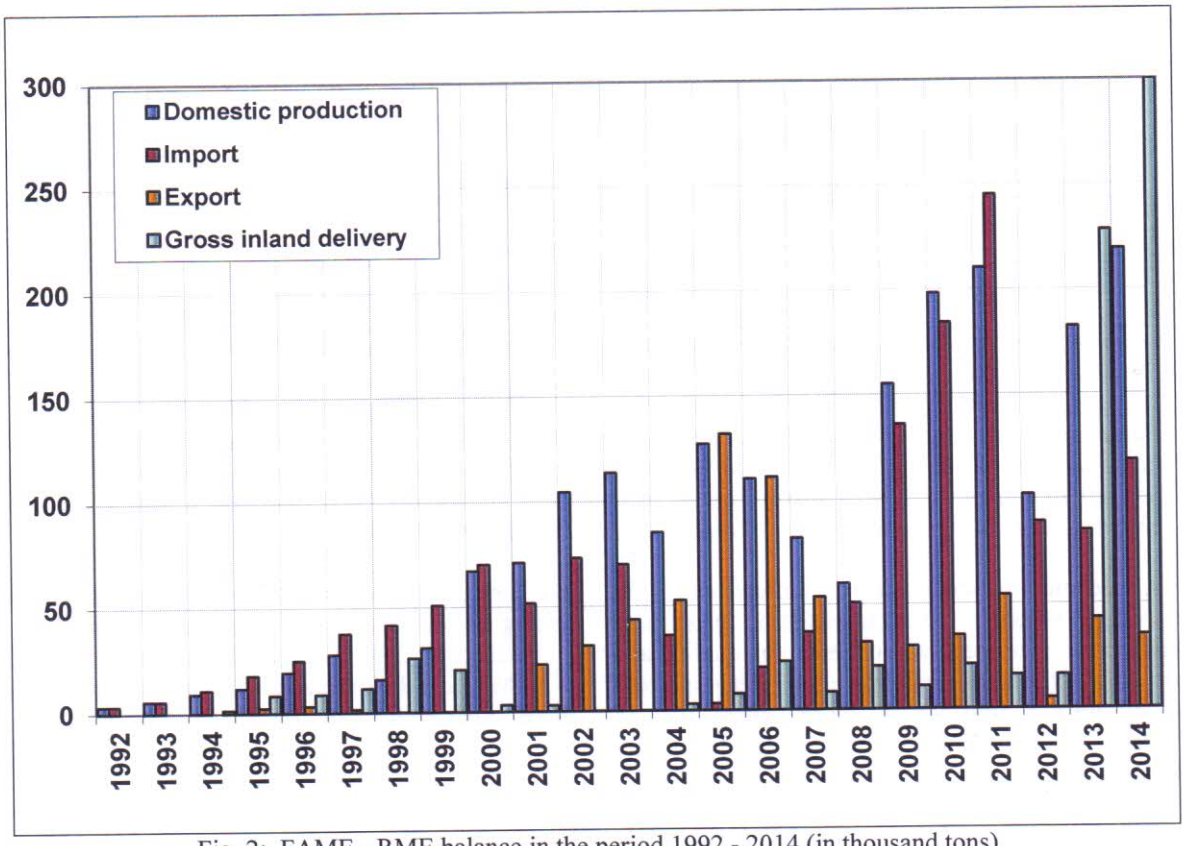

Fig. 2: FAME - RME balance in the period 1992 - 2014 (in thousand tons)
(Source: Ministry of Industry and Trade, ABP&RIAE, p.r.i.)

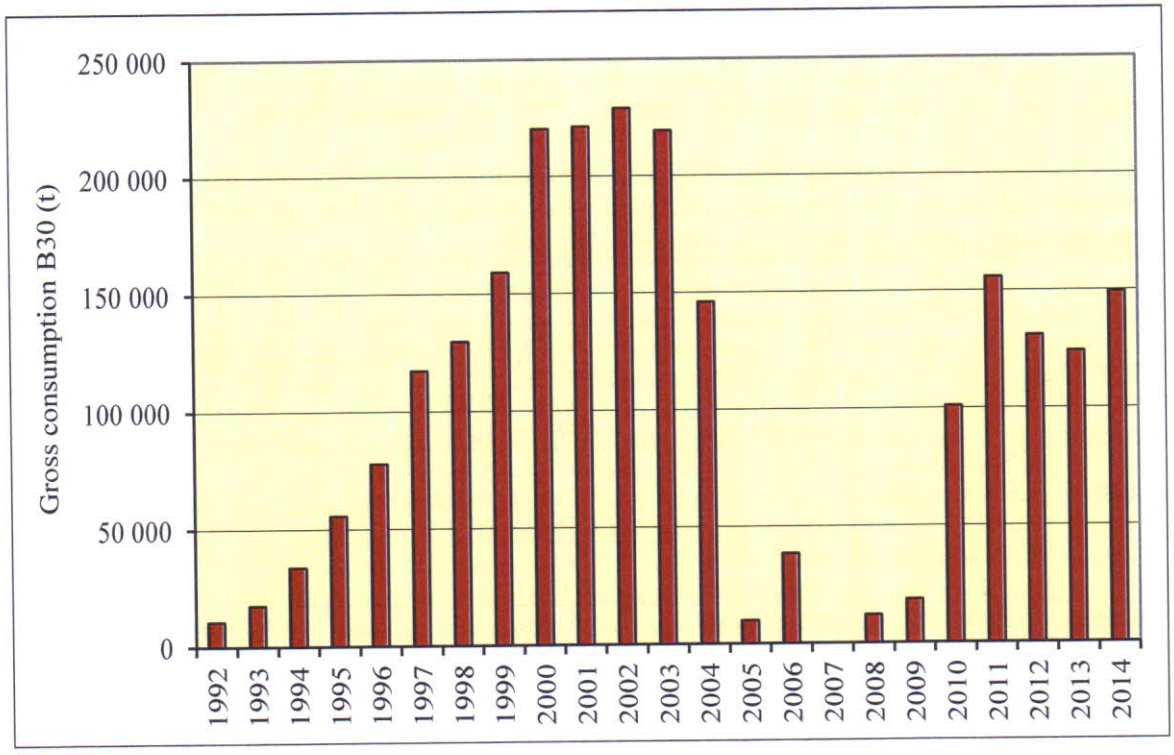

Fig. 3: Production (gross consumption) of B31, or B30 in the Czech Republic in the years 1992 – 2014 (share of RME in the years 1992 - 2009 min. 31 % weight eq., since 2010 min. 30 % vol.)
(Source: Ministry of Industry and Trade, ABP&RIAE, p.r.i.)

In relation to Fig. 2, 3 Fig. 4 shows gross consumption of B100 in the Czech Republic in the years 2010 – 2014. The year 2007 is the beginning of production of fuel bioethanol from sugar beet and cereals in the Czech Republic in market relevant quantities. Balance of production, import, export and gross consumption is shown by Fig. 5.

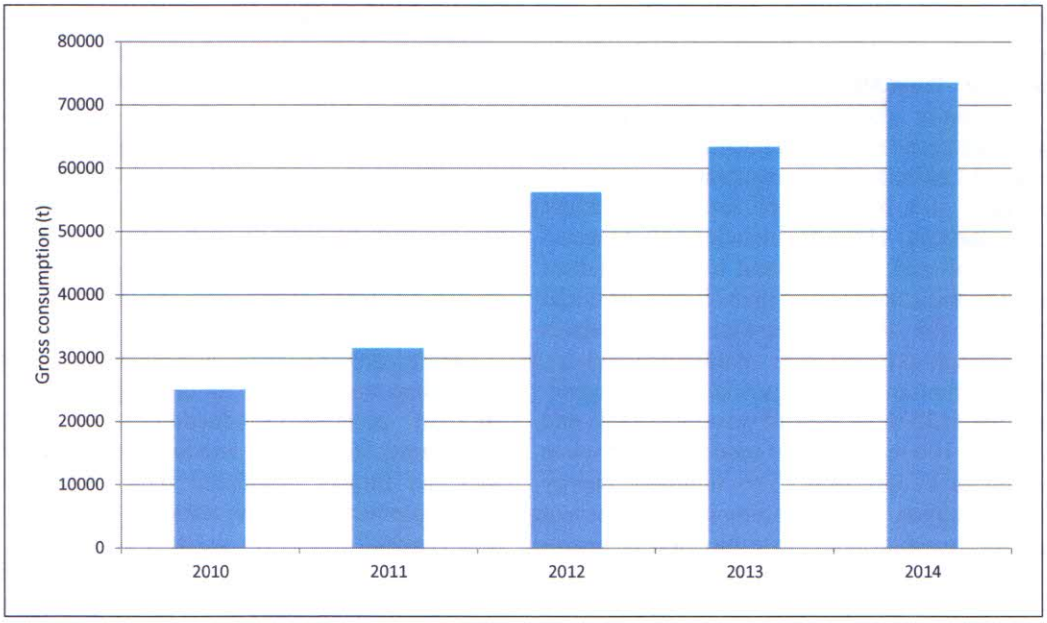

Fig. 4: Gross consumption of B100 in the Czech Republic in the years 2010 – 2014
(Source: Ministry of Industry and Trade, ABP&RIAE, p.r.i.)

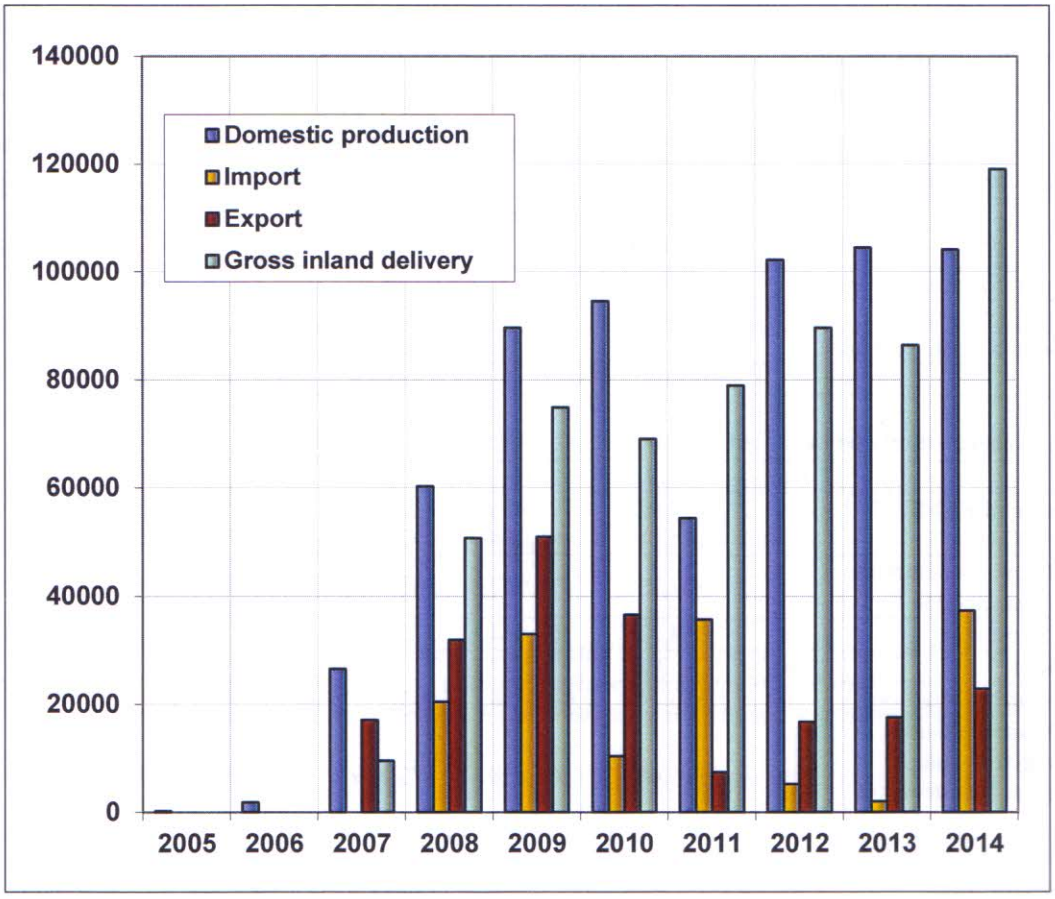

Fig. 5: Balance of production, import, export and gross consumption of bioethanol in the Czech Republic in the period 2005 – 2014 *(Source: Ministry of Industry and Trade, ABP&RIAE, p.r.i.)*

4. Available sources of biomass for manufacture of biofuels for the period 2015 - 2020

Pursuant to the Biomass Action Plan in the Czech Republic for the period 2012 - 2020 (BAP) up to 1500 thousand ha out of the total agricultural land area in the Czech Republic of around 3480 thousand ha in the case of assurance of 100% food supply sufficiency is theoretically available for biomass growth for energy generation and other purposes. With regard to agro-technical, climatic, seasonal and environmental effects BAP stipulates maximum possible usable area for non-food use in the amount of 1120 thousand ha. This area includes 680 thousand ha of arable soil and 440 thousand ha of permanent grassland. The basic scenario of manufacture of initial raw materials for biofuel manufacture calculates with total agricultural land area of 380 thousand ha, of which 20 thousand ha of permanent grassland. In addition about 32 thousand t of waste vegetable and animal oils and 100 thousand t of biodegradable waste are expected to be available. The summary energy potential of biomass from arable soil, permanent grassland, and residual and waste biomass is shown in Table 3.

As follows from BAP, the Czech Republic is able to achieve full food sufficiency and at the same time comply with the objectives of renewable source use in transport. In Table 4 shows the quantities of oilseed rape needed for production of FAME/RME in the years 2009 - 2012 and similarly Table 5 shows the quantities of cereals and sugar beet for production of fuel bioethanol.

Table 6 shows the current status of manufacture and possible introduction of biofuels from residual biomass and biogenic waste classified pursuant to the RED directive as advanced. Capacities with market relevance with regard to conversion of residual, waste biomass and biomass grown for energy generation purposes and algae to synthetic biofuels BtL may be expected rather a couple of years after 2020. And that despite the long years of research and development, and recent investment into several trial, pilot and demonstration equipments in the USA, EU and elsewhere. Even with the help of high state subsidies the commercial risks are still considerable, especially with regard to the high fluctuations of oil prices, global financial crisis and the related investment uncertainty.

With regard to energy and economic effectiveness the variant most feasible for the Czech Republic in the area of potential production of biomethane is preferential use of the existing production facilities for (raw) biogas, especially those where sufficient biogas production can be achieved without additional raw material inputs by gastight roofing of the end storage of the product of digestion. Additional investments would thus only include the gas holder, the necessary biomethane production technology with related dispensation infrastructure for vehicle fuelling and potential additional equipment allowing for processing of the abovementioned desirable types of substrates - an advanced sanitation reactor.

Table 3: The summary energy potential of biomass from arable soil, permanent grassland, and residual and waste biomass pursuant to BAP

	Area (thousand ha)	Energy potential range (PJ/year)	Median value	
			(PJ/year)	(%)
Arable soil for non-food use	680	53.1 - 76.2	64.6	40
Permanent grassland	440	22.8 - 29.8	26.3	16
Residual and waste biomass	-	57.5 - 80.8	69.1	44
Total	1120	133.4 - 186.8	160	100

Table 4: Balance of oilseed rape used for production of RME in the years 2009 – 2014

	Unit	2009	2010	2011	2012	2013	2014
Production of FAME: [1]	t	154,923	197,988	210,092	172,729	181,694	219,316
of which RME		144,013	186,268	197,492	159,979	181,694	217,315
Oilseed rape consumption for RME production [2]	t	367,233	474,983	503,605	407,946	463,320	554,153
Rape harvest area [3]	ha	354,826	368,824	373,386	401,319	418,808	289,298
Rape yield [3]	t/ha	3.18	2.83	2.80	2.76	3.45	3.95
Oilseed rape production [3]	t	1,128,119	1,042,418	1,046,071	1,109,137	1,443,210	1,537,320
Oilseed rape field area, with the given yield, allocated to production of RME	ha	115,482	167,838	179,859	147,807	134,296	140,292
Share of oilseed rape field area used for RME production out of the total rape field area	%	32.5	45.5	48.2	36.8	32.1	36.0

[1] *Source: Ministry of Industry and Trade - Eng (MIT) 6-12*
[2] *Source: RIAE, p.r.i. & ABP with regard to effectiveness of obtaining of rapeseed oil and its re-esterification, Oilseed rape 2.55 kg for production of 1 kg of RME*
[3] *Source: Czech Statistical Office*

Table 5: Balance of sugar beet and winter wheat used for production of fuel ethanol in the years 2009 – 2014

	Unit	2009	2010	2011	2012	2013	2014
Production of bioethanol: of which [1]	t	89,625	94,523	54,412	102,195	104,488	104,112
- from technical sugar beet		53,775 [2]	57,814 [2]	54,412	69,920	80,852	66,000
- from wheat		35,850 [2]	36,709 [2]	-	-	-	2,875
- from maize grain		-	-	-	32,275	23,636	35,234
Input raw material consumption: of which	t	644,762	693,190	652,400	838,341	969,415	791,340
- technical sugar beet		118,305	121,140	-	-	-	9,497
- wheat		-	-	-	88,433	64,763	96,541
- maize grain							
Harvest areas: [3]	ha						
- technical sugar beet		52,500	56,400	58,300	61,161	62,401	62,959
- wheat		831,300	833,600	863,100	815,381	829,393	835,941
- maize for grain		105,300	103,300	109,700	119,333	96,902	98,749
Yield: [3]	t/ha						
- of technical sugar beet		57.92	54.36	66.84	63.26	60,00	70,28
- of wheat		5.24	4.99	5.79	4.32	5,67	6,51
- of maize corn		8.45	6.71	8.12	7.78	6,97	8,43
Production: [3]	t						
- of technical sugar beet		3,038,000	3,065,000	3,899,000	3,868,829	3,743,772	4,424,619
- of wheat		4,358,100	4,161,600	4,993,400	3,518,896	4,700,696	5,442,349
- of maize grain		889,600	692,600	890,500	928,147	675,380	832,235
Area:	ha						
- of technical sugar beet		11,132	12,752	9,761	13,252	16,157	11,260
- of wheat		22,577	24,277	-	-	-	1,459
- of maize for grain		-	-	-	11,367	9,292	11,452
with the given yield used for production of bioethanol							
Share of areas of	%						
- technical sugar beet		21.2	22.6	16.7	21.6	25.9	17.9
- wheat		2.72	2.91	-	-	-	0.2
- maize for grain		-	-	-	9.52	9.6	11.6
processed for bioethanol out of the total areas of fields with these crops							

[1] *Source: Ministry of Industry and Trade - Eng (MIT) 6-12*
[2] *Source: Union of Distilleries of the Czech Republic*
[3] *Source: Czech Statistical Office*
Recovery balance: sugar beet: 11.99 kg per 1 kg of bioethanol, i.e. 9.3 kg per 1 l of bioethanol
wheat (soft): 3.3 kg per 1 kg of bioethanol, i.e. 2.6 kg per 1 l of bioethanol
maize grain: 2.74 kg per 1 kg of bioethanol, i.e. 2.13 kg per 1 l of bioethanol

Table 6: Current status and potential production of biofuels from residual biomass and biogenic waste classified pursuant to the RED directive as advanced

	Conversion technology	Input raw material	Installed capacities in market relevant size		
			Already existing	Potentially deployable by 2020	Expected deployment after 2020
FAME	Trans-esterification	Waste vegetable and animal oils, or fats of categories I and II	YES	YES	YES
HWVO, HEFA	Hydrogenation refining, hydro processing, isomerisation, metathesis	Waste vegetable and animal oils, or fats of categories I and II, esters, fatty acids and similar products	YES (in EU)	YES	YES
Bioethanol	Aerobic fermentation, distillation	Straw, lignocellulose residues, cellulose shares of communal and industrial waste	YES (in EU)	YES	YES
Biomethane	Anaerobic fermentation, adaptation of biogas to methane quality (CNG)	Slurry, manure, WWTP sludge, bio degradable part of communal and industrial waste, technical raw glycerine, distillery firing products	YES (in EU)	YES	YES
Synthetic biofuels, BtL	Gasification, carbonisation, torrefaction, quick pyrolysis, hydro thermal carbonisation and their combinations	Straw, lignocellulose residues and fibre, corn cobs, chaff, bio degradable part of communal and industrial waste, technical raw glycerine, resin of tall oil	NO	NO	YES

5. Proposed promotion for sustainable biofuels for the period 2015 - 2020

Pursuant to Act no 201/2012 Coll., on air protection, petrol and diesel released to free taxable circulation in the tax territory of the Czech Republic for transport purposes per calendar year must also contain the minimum quantity of certified biofuels in the amount of 4.1 % vol. of the total quantity of petrol and 6.0 % vol. of the total quantity of diesel. Act no. 201/2012 Coll., on air protection, together with the abovementioned liability, newly introduces the liability to reduce GHG emissions per unit of energy contained in the fuel across its lifecycle by 2 % by 31 December 2014, by 4 % by 31 December 2017 and by 6 % by 31 December 2020 (see also table 1) in comparison to the basic value of GHG emissions for fossil fuels specified by Government Regulation no 351/2012 Coll., on biofuel sustainability criteria. This liability of reduction of GHG emissions from fuels is related to the sum of all fuels, i.e. petrol and diesel together.

To meet the required reduction of GHG emissions manufacturers and suppliers of fuels are likely, as follows from table to force manufacturers and suppliers of biofuels to supply biofuels with GHG emissions reduction higher than 65 % already since early 2017. This table shows that biofuel shares in petrol higher than 10 % vol. and in diesel higher than 7 % vol., shown by Table 2, are not allowed by the current technical standards ČSN EN 228 "Unleaded automotive petrol" and ČSN EN 590 "Diesel fuels". Therefore these liabilities must continue to be met by use of the standardised low-percentage mixtures of bio and fossil fuels, pure biofuels and high-percentage mixtures of bio and fossil fuels.

Support for taxed standardised high-percentage mixtures of bio and fossil fuels and pure biofuels is represented by reduced tax rates, tax exemptions for pure biofuels and biofuel admixture (bio component) in mixed fuel or tax refund for mineral oils corresponding to the biofuel proportion. Compulsory marketing of biofuels in the form of standardised low-percentage mixtures of bio and fossil fuels pursuant to the air protection act, as amended, and related legislation, is not subject to any tax reduction.

Equipments for biofuel blending were improved or built and tested by fuel producers and suppliers by mid 2007. That is why manufacture and subsequent distribution of standardised automotive petrol and diesel fuels with biofuel content has so far brought virtually no technical, logistic or quality issues. Non-fulfilment of the liability of minimum biofuel content is penalised by CZK 40/l of biofuel not marketed pursuant to the air protection act. Biofuel blending

increases wholesale price of petrol and diesel fuels. Maximum increase, exclusive of VAT, amounts to CZK 0.38/l.

As show by Table 7, in the course of the period 2010 - 2014, when adequate tax support for pure biofuels and high-percentage blends of bio and fossil fuels existed, competitive conditions were balanced and infrastructure was built for development of certified fuel market with FAME B100, Ethanol E85 and maintenance of interest in B30 fuel. But without any extension of the portfolio of standardised biofuels - Ethanol E95, vegetable oil and pressurised biogas with natural gas quality.

The costs of acquisition of buses from serial production using Ethanol E95 as the engine fuel and tractors using pure vegetable oil are still not compensated by price benefit of these biofuels in comparison to diesel. Also high costs of acquisition of the operation set for adaptation of raw biogas to natural gas quality (bio CNG) still discourage investors from implementation of the necessary technology and dispensation infrastructure for vehicles using bio CNG as fuel.

From the macro-economic point of view, when monitoring the effect of employment related to the biofuel program, there is a clear benefit for agricultural, i.e. rural employment support. On the other hand this benefit is connected with impact on certain decrease of employment in the sector of crude oil processing and production of fossil fuels. This, however, may be positively affected in near future by involvement of petro-chemical refineries and the process of hydro- cracking in processing of oil and fat residues, fatty acids and esters and production of HWVO and HEFA, classified as advanced biofuels. Overall contribution to the state budget with regard to employment across the biofuel chain is slightly higher than the financial support by tax reduction.

Table 7 shows quantities of biofuels and their high-percentage blends with fossil fuels released to free tax circulation in the period 2010 - 2014 and their estimated quantities in the period 2015 – 2020. Moderate growing trend of consumption of the currently used pure and high-percentage biofuels - B100, B30 and E85 and since 2016 also Ethanol E95, pure vegetable oil and biogas.

Table 8 shows statistical data on financial support for biofuels and their high-percentage mixtures in the period 2010 – 2014 and estimated financial support in the period 2015 – 2020 and related impact on employment in agriculture and the state budget.

6. Conclusion

The main objectives of the draft multi-annual program of further application of sustainable biofuels in transport for the period 2015 - 2020 include fulfilment of the binding target of replacement of at least 10 % of the final energy consumption in transport with sustainable energy, i.e. biofuels and electricity and the liability of GHG emissions reduction per energy unit included in the fuel across its lifecycle as specified by revision RED and FQD directives. GHG emissions reduction 6 % do by the end of 2020 in comparison to the basic value of GHG emissions for fossil fuels.

Liquid renewable fuels are likely to be required by the transport sector in order to reduce its greenhouse gas emissions. Advanced biofuels, such as those made from residues, wastes and algae, provide high greenhouse gas emission savings with a low risk of causing indirect land-use change, and do not compete directly for agricultural land for the food and feed markets. It is appropriate, therefore, to encourage greater research in, and development and production of, such advanced biofuels as they are currently not commercially available in large quantities.

Transposition of the directives RED and FQD in the Czech legislation is represented by Act No 201/2012 Coll., on Air Protection, and its executive regulation of the Government no 351/2012 Coll., on Biofuel Sustainability Criteria. Options for achievement of the defined targets for conventional biofuels is limited, which results in pressure on use of biofuels with GHG emissions reduction much higher that 65 % already since 2017. In addition options of application of sustainable biofuels in the current portfolio of fuels with regard to the maximum quantity for their admixtures given by the applicable technical standards must be considered.

The needed support for pure biofuels and high/percentage blends of bio and fossil fuels is proposed for the purpose of their appropriate advantage building, as the quoted stock exchange prices of biofuels are still higher than the prices of fossil fuels. The algorithm of calculation of the amount of tax support, expressing financial means to be incurred for competitiveness of the given bio or blended fuel in comparison to their fossil equivalent, is based on the requirement for prevention of over-compensation of the mean annual value of this support.

The proposed amounts of tax support for the individual types of biofuels are shown in Table 9. These proposed, or approved and notified supports will be reviewed annually for over/compensation.

Table 7: Quantity of pure biofuels and their high-percentage blends with fossil fuels released to free tax circulation in the period 2010 - 2014 and their estimated quantity in the period 2015 – 2020 (*Source: Research Institute for Agricultural Technology (RIAE, p.r.i.)*

	Quantity released for free tax circulation										
	2010 [1)]	2011 [1)]	2012 [1)]	2013 [1)]	2014 [1)]	2015	2016	2017	2018	2019	2020
B30 (ČSN 65 6508) (thousand litres)	123,097.3	182,535.2	153,495.2	145,413.7	184,400.1	147,640.8	149,162.9	152,207.0	162,861.5	169,254.2	177,777.8
FAME B100 (ČSN EN 14214) (thousand litres)	28,198.6	35,507.2	63,137.7	71,159.5	120,094.4	81,308.4	84,014.1	84,784.7	85,550.2	86,411.5	87,272.7
Spirit for production of Ethanol E85 (ČSN P CEN/TS 15293) (thousand litres)	800.3	7,831.9	15,143.4	21,622.9	22,658.1	26,373.6	28,956.7	31,250.0	33,386.1	35,363.9	37,104.4
Ethanol E95 (ČSN 65 6513) (thousand litres)	0	0	0	0	0	0	1,285.7	2,571.4	3,857.0	5,142.7	6,428.4
Vegetable oil (ČSN 65 6516) (thousand litres)	0	0	0	0	0	0	2,176.5	3,264.8	4,353.0	5,441.3	6,529.5
Compressed biogas with natural gas quality (ČSN 65 6514) (MWh)	0	0	0	0	0	0	10,550.0	31,650.0	63,300.0	94,950.0	126,600.0

[1)] *General Customs Directorate*

Table 8: Financial support for pure biofuels and their high-percentage blends with fossil fuels in the period 2010 - 2014, estimated quantity for 2015 - 2020
(Source: Research Institute of Agricultural Engineering (RIAE, p.r.i..)

	Financial support (CZK . mio)										
	2010 [1]	2011 [1]	2012 [1]	2013 [1]	2014 [1]	2015	2016	2017	2018	2019	2020
B30 (ČSN 65 6508)	404.37	599.63	504.23	477.68	605.75	485	490	500	535	556	584
FAME B100 (ČSN EN 14214)	308.77	388.80	691.36	779.20	1,315.03	870	878	886	894	903	912
Spirit for production of Ethanol E85 (ČSN P CEN/TS 15293)	10.28	100.56	194.44	277.64	290.93	336	366	395	422	447	469
Ethanol E95 (ČSN 65 6513)	0	0	0	0	0	0	14.1	28.2	42.2	56.3	70.4
Vegetable oil (ČSN 65 6516)	0	0	0	0	0	0	23.8	35.7	47.7	59.6	71.5
Compressed biogas with natural gas quality (ČSN 65 6514)	0	0	0	0	0	0	0.72	2.16	8.66	12.99	33.52
Actual financial support	723.42	1,088.99	1,390.03	1,534.52	-	-	-	-	-	-	-
Assumed financial support according to modification N305/2008 [2]	1,178.80	1,590.00	1,342.74	1,721.75	2,211.71	2,940.05	-	-	-	-	-
Assumed financial support for the period 2014 - 2015	-	-	-	-	1,643	1,691	-	-	-	-	-
Assumed financial support for the period 2016 - 2020	-	-	-	-	-	-	**1,773**	**1,847**	**1,950**	**2,035**	**2,140**

[1] *General Customs Directorate*

[2] *Approved by the Government of the Czech Republic on 25 February 2008 by Resolution no 164/2008 and by the European Commission on 23 December 2008 by decision (notification) N305/2008 - CR Multi-annual program of further application of bio/fuels in transport.*

[3] *Annual contribution of one employee to the state budget / CZK 225 - 250 thousand Source: Agrarian Chamber of the Czech Republic.*

Table 9: Excise tax rates for fuels, applied amount of support before 30 June 2015 and proposed amount of support for pure biofuels and high/percentage blend of biofuels with fossil fuels since 1 July 2015

	Excise tax rate		Current level of tax preferences By 30 June 2015		**Proposed level of tax preferences Since 1 July 2015**	
	For mineral oils [1]	For natural gas [2]				
	(CZK/l)	(CZK/MWh)	(CZK/l)	(CZK/MWh)	**(CZK/l)**	**(CZK/MWh)**
Petrol fuel (§48 Para. 1)	12.840	-	-	-	-	-
Diesel fuel (§48 Para. 1)	10.950	-	-	-	-	-
FAME B 100 (§49 and §53)	10.950	-	10.950	-	**8.760**	-
B 30 (§48 Para. 5)	7.665	-	3.285	-	**2.435**	-
Ethanol E85 [3] (§48 Para. 17)	12.840	-	10.914	-	**9.326**	-
Ethanol E95 (§48 Para. 18)	10.950	-	10.950	-	**10.950**	-
Vegetable (rapeseed) oil (§48 Para. 19)	10.950	-	10.950	-	**9.340**	-
Biogas with natural gas quality:						
By 31 December 2014		34.20		34.20		**34.20**
1 January 2015 - 31	-	68.40	-	68.40	-	**68.40**
December 2017	-	136.80	-	136.80	-	**136.80**
1 January 2018 - 31	-	264.80	-	264.80	-	**264.80**
December 2019	-		-		-	
Since 1 January 2020						

[1] *Act no 353/2003 Coll.*

[2] *Act no 261/2007 Coll.*

[3] *Calculated for Ethanol E85 containing 85 vol. of bioethanol. In reality bio methanol level in this fuel varies across the year, ranging within 70 - 85 % V/V. The proposed amount of subsidy recalculated to pure bioethanol for production of Ethanol E85 amounts to CZK 12.6047/l.*

Thus designed support for pure biofuels and blended fuels create space for sustainable use of conventional biofuels as well as for continuous growth of production and use of modern biofuels. Technological progress across the chain will allow the modern fuels to utilise infrastructure and markets for conventional biofuels. In this context specifics of both biofuels, their production and procurement of the initial raw materials and other related strategic objectives are take into consideration. In principle promotion for advanced biofuels should take the form of full exemption from excise tax.

The Programme is currently notified by the European Commission. The final amount of tax support and high-percentage blends of biofuels with fossil fuels will be known after its approval. By notification and approval of this programme in the Czech Republic it will no longer be possible to use the tax preferences of sustainable fuels and their blends for fulfilment of bio-obligations. Pure biofuels and high-percentage blends of biofuels with fossil fuels will therefore be important in terms of meeting the obligation to reduce greenhouse gas emissions from fossil fuels. Compulsory marketing of biofuels in the form of standardised low-percentage mixtures of bio and fossil fuels pursuant to the air protection act, as amended, and related legislation, is not subject to any tax reduction.

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List of abbreviations

BAP	Biomass Action plan (responsibility of Ministry of Agriculture)
BA	Automotive petrol
B5	Diesel fuel with up to 5 % vol. of FAME/RME
B7	Diesel fuel with up to 7 % vol. of FAME/RME
BtL	Biomass to liquid, synthetic liquid fuel from biomass
CEN	European committee for standardization
CNG	Compressed natural gas used as engine fuel
DME	dimethyl-ether
EC	European Commission
EP	European Parliament
ETBE	Ethyl-Tertio-Butyl-Ether as admixture to automotive petrol
E5	Automotive petrol with bioethanol content up to 5 % vol. pursuant to ČSN EN 228
E10	Automotive petrol with bioethanol content up to 10 % vol. pursuant to ČSN EN 228
E85	Ethanol fuel for ignition engines as a mixture of 85 % vol. of bioethanol and petrol including the option of mixing petrol and ethanol in various ratios with bioethanol level higher than 50 % vol.
E95	Fuel for diesel engines with min. 95.8 % vol. of bioethanol and other additives
FAEE	Fatty Acids Ethyl Esters made by catalytic trans-esterification of triglycerides by ethanol
FAME B100	Fatty Acids Methyl Esters used as pure biofuel
FQD	Directive of the European Parliament and of the Council 2009/30/EC of 23 April 2009, amending directive 98/70/EC, as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduced of greenhouse gas emissions, and amending Council Directive 1999/32/EC, as regards the specification of fuel used by inland waterway vessels, repealing Directive 93/12/EEC
GHG	Greenhous gas including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O)
GtL	Gas to liquid, synthetic liquid fuel made from natural gas
HEFA	Hydroprocessed Esters and Fatty Acids
HVO	Hydrotreated Vegetable Oils and fats
HWVO	Hydroprocessed Waste Vegetable or animal Oils or fats
ILUC	Indirect Land Use Change
RME B100	Fatty acids methyl esters of rapeseed oil used as pure biofuel
MO	Mineral oils
MIT	Ministry of Industry and Trade of the Czech Republic

MTBE	Methyl-tertio-butyl-ether as admixture to automotive petrol
MA	Ministry of Agriculture of the Czech Republic
NREAP	National Renewable Energy Action Plan (responsibility of Ministry of Industry and Trade)
PHM	engine fuels *(not used in English version)*
RED	Directive of the European Parliament and of the Council 2009/28/EC 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
B30	Diesel fuel blends containing minimum of 30 % vol. of FAME/RME
ABP	Association for Biodiesel Production
TME	animal fat methyl ester, methyl esters of fatty acids of animal fats
PG	Permanent grassland
UCOME	Used Cooking Oil Methyl Esters, methyl esters of fatty acids of kitchen oils
RIAE, p.r.i.	Research Institute of Agricultural Engineering, public research institution

Pure Biofuels and High-percentage Blends of Biofuels with Fossil Fuels in Transport in the Period 2015 – 2020

Abstract:

There are presented program further use of sustainable biofuels in transport for the period 2015 – 2020 approved by the Government of the Czech Republic on 6 August 2014. Program follows the "Multi-year programme of supporting further utilization of biofuels in transportation" approved by the Government of the Czech Republic on 25 February 2008 and 23 December 2008 by the Directorate - General for Competition with effect as of 1 July 2009 and expiration date on 30 June 2015. Its main aim is reduction of GHG emissions generated by fuel combustion by 6 % in comparison to the basic standard for fossil fuels by 31 December 2020 and assurance of at least 10 % share of renewable energy, i.e. biofuels and electricity, in final energy consumption in transport in 2020. Harmony between these objectives, like in the currently implemented multi-annual program, should assure supplies of not only low-percentage mixtures in diesel oil and petrol in compliance with the relevant technical standards but also continued supply of standardized high-percentage mixtures of biofuels and pure biofuels meeting the sustainability criteria confirmed by the certificate. The need support for pure biofuels and high-percentage mixtures of bio and fossil fuels is proposed for the purpose of their appropriate advantage building, as the quoted stock exchange prices of biofuels are still higher than the prices of fossil fuels. The algorithm of calculation of the amount of tax support, expressing financial means to be incurred for competitiveness of the given bio or mixed fuel in comparison to their fossil equivalent, is based on the requirement for prevention of over-compensation of the mean annual value of this support. The Programme is currently notified by the European Commission. The final amount of tax support and high-percentage blends of biofuels with fossil fuels will be known after its approval. Compulsory marketing of biofuels in the form of standardised low-percentage mixtures of bio and fossil fuels pursuant to the air protection act, as amended, and related legislation, is not subject to any tax reduction.

Keywords: *sustainable biofuels for transport, conventional biofuels, advanced biofuels, promotion of biofuels, tax preferences of sustainable biofuels*

Dedication

This paper was realized in the framework of institutional support of long-term conceptual development of the Research Institute of Agricultural Engineering, p.r.i. on the basis of the Decision No. RO0614 issued by the Ministry of Agriculture of the Czech Republic. This decision include solution of two partial projects: „Balance of Production and Consumption of Fuels in Agriculture with Determination of Possibilities to their Widespread Substitution by Biofuels" and „New Technologies for Biomass Processing Focused on Raw Materials and Advanced Fuels".

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