NIS GAZPROM NEFT FUTURE AT WORK

Advanced biofuels production in Serbia

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ADVANCED FUELS – WHERE ARE WE NOW?

- On 14.06.2018 Europe set new regulatory framework for renewable energy which includes a binding renewable energy target for the EU for 2030 of 32% e.e. (with an upwards revision clause by 2023) and **14%e.e. target in transport sector**
- **3.5% e.e. target was set for second generation biofuels**
- The use of palm oil as fuel should disappear in Europe by 2030
- Sustainability of the use of bioenergy as well as design and stability of support schemes for renewables will be improved

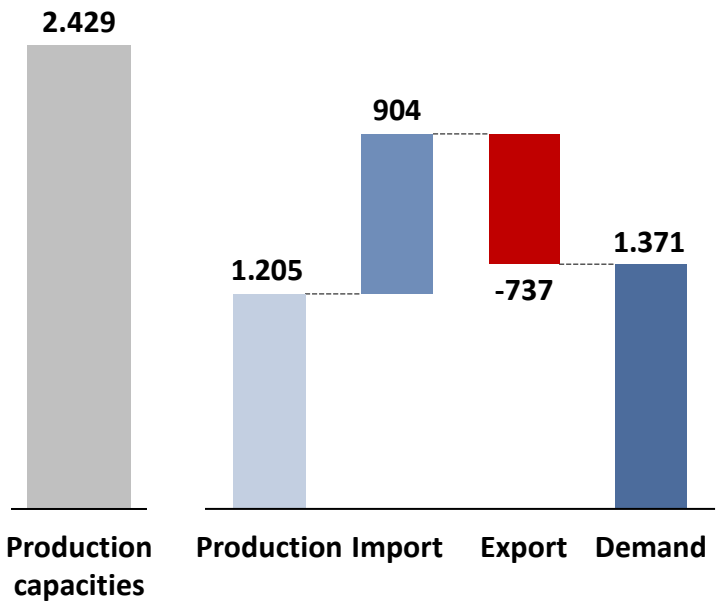
New RED should be delivered within next few months

BIOFUELS IN THE REGIONAL COUNTRIES

Renewables in transport in Region 2015-2016 (% energy)

	Actual	NREAP	% Realization	Actual	NREAP	% Realization	NREAP Target
	2015			2016			2020
Austria	7,9%	4,4%	178,8%	7,4%	4,6%	162,3%	11,4%
Romania	3,4%	6,7%	49,8%	3,2%	7,1%	44,7%	10,0%
Slovenia	1,6%	4,3%	36,2%	1,5%	5,1%	28,7%	10,5%
Greece	2,8%	6,2%	45,8%	2,8%	6,9%	41,2%	10,1%
Hungary	3,9%	5,1%	77,7%	4,0%	5,4%	73,3%	10,0%
Croatia	1,2%	3,9%	31,8%	1,3%	4,5%	28,1%	10,0%
Bulgaria	5,8%	5,5%	105,2%	5,7%	6,7%	84,9%	10,8%
Serbia	0,0%	n/a	0,0%	0,0%	n/a	0,0%	10,0%
Macedonia	1,5%	1,3%	114,0%	1,5%	1,4%	104,5%	13,0%
B&H	0,0%	4,8%	0,0%	1,0%	6,8%	14,6%	10,3%
Average	3,1%	4,3%	64,8%	3,0%	5,0%	56,9%	10,6%

Production capacities of bioethanol I generation* and FAME in 2016, [000 t]



- Most of the Regional countries haven't achieved the targets in transport sector set in their NREAP (National Renewable Energy Action Plan) → 56,9% in average in 2016, even lower than in 2015
- Utilization of the biofuels production capacities is very low due to non-compliance with bio share targets

The biofuels part of the EU deal from June 2018 also includes a freeze on so-called first generation biofuels like ethanol, which are produced domestically, at the levels of production reached by each EU member state in 2020

* Bioethanol production capacities include all types of ethanol production (for food and for fuels)

Sources: NREAP, EU Stat, Biofuels Association's website

SITUATION IN THE REGIONAL COUNTRIES

Description

- Use of the second generation biofuels will be obligatory, no suppliers* in the Region
- In the most of the Regional countries significant volume of biomass
- Agricultural wastes would be used as a production raw material → as most suitable straw from the agricultural products e.g. soy, maize, wheat, mostly available in Vojvodina province (Serbia), Semberia region (Bosnia and Herzegovina), Slavonija (Croatia) and south Hungary
- In the Region, biomass is widely used for the energy and cattle breeding
- Min. 70% of straw should remain on the fields
- **Thus a realistic picture on biomass market in the Region is a necessity**

…overcoming problems

Many environmental and economic problems that Serbia and the Regional countries are facing could be overcome by implementing the project, due to the multiple **benefits of Second generation biofuels production:**

- Lignocellulosic biofuel (LCB) would help Serbian and domicile oil companies to fulfill their obligations set by 2009/28/EC and 2015/1513/EC
- Large export opportunities exist since there are very few plants in the world and specific interest could be provided to the renewable sources which could help the countries to fulfill COP21 obligations
- Sustainability issues exist

*Crwescentino plant is not operating for several months

LCB POSSIBLE CONTRIBUTION TO RES OBLIGATIONS OF SERBIA AND THE REGIONAL COUNTRIES

- Most of the Regional countries have little or no progress in 2009/28/EC nad 2015/1513 goals achievement *
- LCB would help in the gaps reducing
- For a target of 0,5% e.e. in transport fuels in 2020, approx. LCB 230 kt/y is needed for the Regional countries
- To achieve a new target of 3,5% e.e. in 2030 for transport fuels** in the Regional countries approx. LCB 1.640 kt/y is needed

Possible volumes of LCB consumption in the Region [000 t]

Volume (000t/y)	2015		2020		2025		2030	
	Serbia	Region	Serbia	Region	Serbia	Region	Serbia	Region
Gasoline consumption	409	6.678	411	6.665	395	6.486	375	6.285
Ethanol needs	0	246	22	456	31	614	39	661
LCB for 0,5% e.e. in gasoline	0	0	3	53	3	52	3	50
LCB for 0,5% e.e. in transport fuels	0	0	16	232	17	234	18	234
LCB for 3,5% e.e. in gasoline	0	0	23	372	22	362	21	350
LCB for 3,5% e.e. in transport fuels	0	0	114	1.625	119	1.640	123	1.638

* Croatia announced a LCB plant 55 kt/y construction

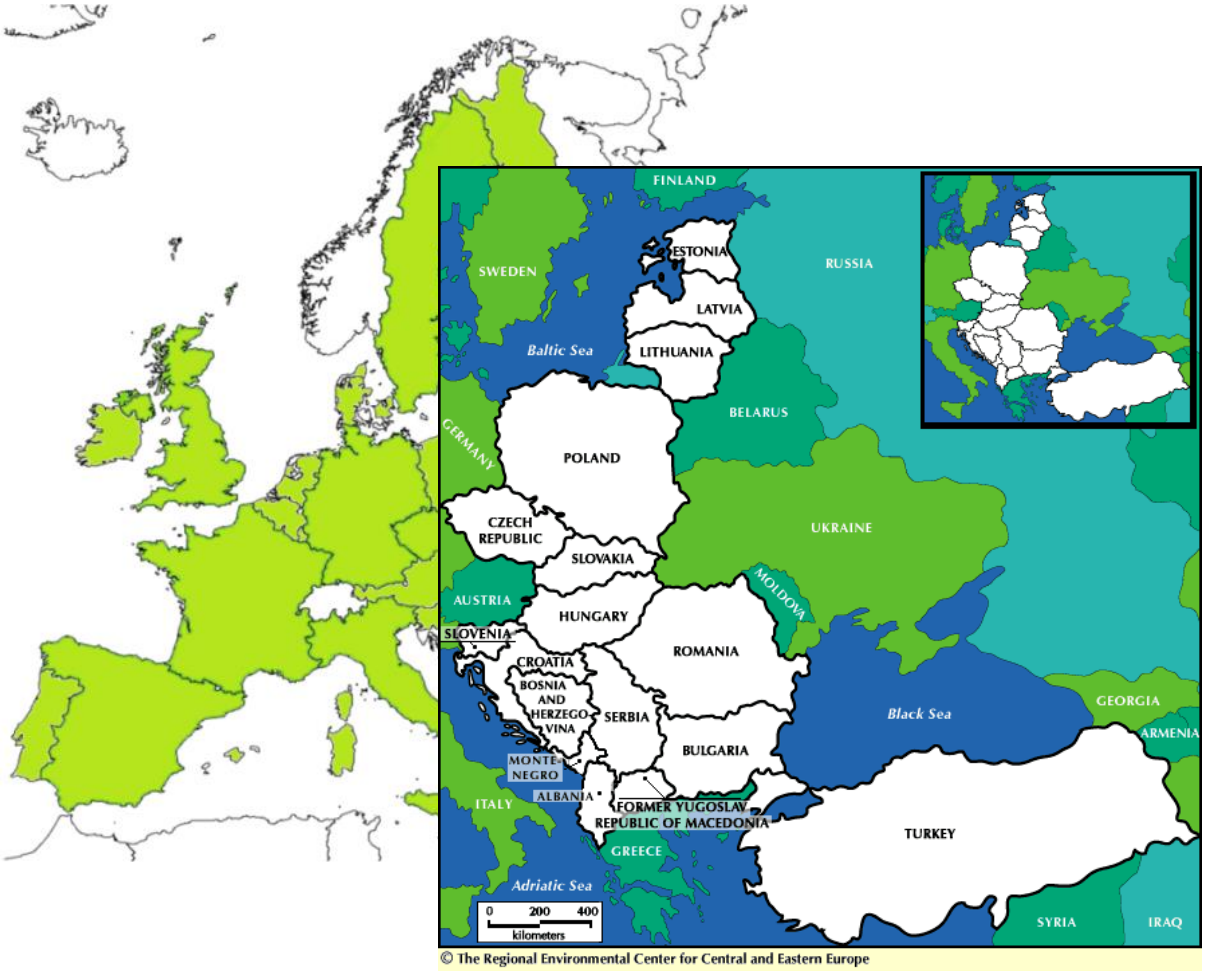
** Projections based on tne IHS and Wood Mackenzie data, EV impact still not clear

LCB PRODUCTION PLANT IN CRESCENTINO, ITALY

Crescentino is the first plant in the world with the industrial production of LCB

- Based on the PROESA™ technology for biochemical conversion, developed by Biochemtex.
- From 4.5 -5.5 t of dry biomass, 1 t of bioethanol is produced (for our planned production of 40,000 t/a the needed dry lignocellulosic biomass quantity is up to 220,000t/a (+/- 5%)
- Feedstock used for LCB production are mainly wheat and rice straw, as well as energy crop Arundo Donax, supplied from a maximum radius of 70 km
- Lignin, as a residue from bioethanol production is combusted for electricity generation in plant of installed power of 13 MW. Generated energy is sufficient to supply facility own demand
- Used water is completely recycled, so no waste water is generated
- Value of the investment for the LCB plant in Crescentino was 150 million €, including needed technology development. This plant provides approximately 100 full-time job.
- As per technology owner, GHG reduction achieved through use of the ethanol from the LCB plant in Crescentino is up to 90 %

CASE STUDY PERFORMED WITHIN S2BIOM WP9 AND SPONSORED BY CEI



Case study performed can be used as **Market study for LCB plant FS** because Study answered several question:

- Availability of biomass by type and locations
- Biomass supply options and costs
- Biomass locations‘ opportunities/ constraints
- Sustainability requirements fulfilment
- Confirmed that Novi Sad is a right location for a production plant (possible location for „brown field“ project: Refinery Novi Sad)

REPUBLIC OF SERBIA RENEWABLE POTENTIALS

As per „ National renewable energy action plan of the Republic of Serbia“ addopted in 2013, the biomass potential amounts to approximately 3.3 Mtoe per year (2.2 Mtoe per year is unused, and 1.1 Mtoe is use

Density of crop residues (with moisture content about 14 %)

Based on data on biomass available for 43 communities of Vojvodina, the highest density of crop residues are in Sombor community (less than 100 km from Novi Sad) and Zrenjanin community (about 40 km from Novi Sad)

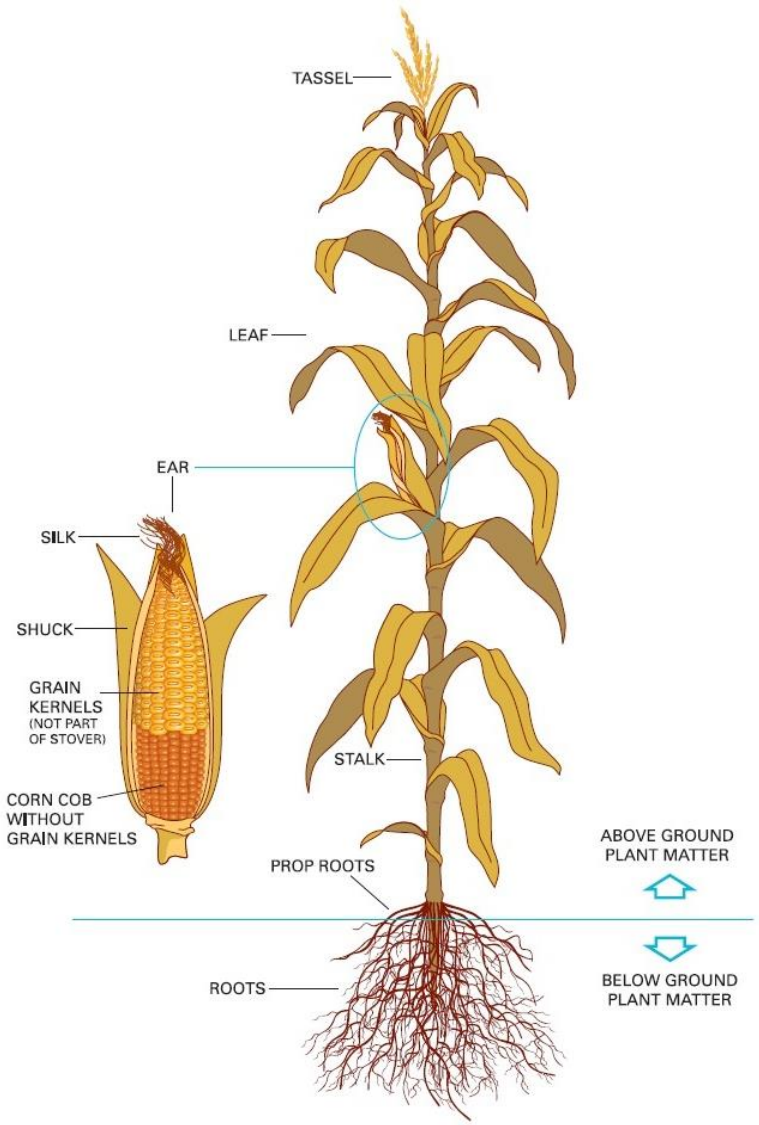
VOJVODINA - ENERGY POTENTIAL IN CROPS

- The biggest potential of crop residues presents corn stover, second place wheat straw
- Most significant ways to use corn stover are:
  - as a feedstock for LCB production
  - as a co-substrate for biogas generation and
  - as a fuel for combustion

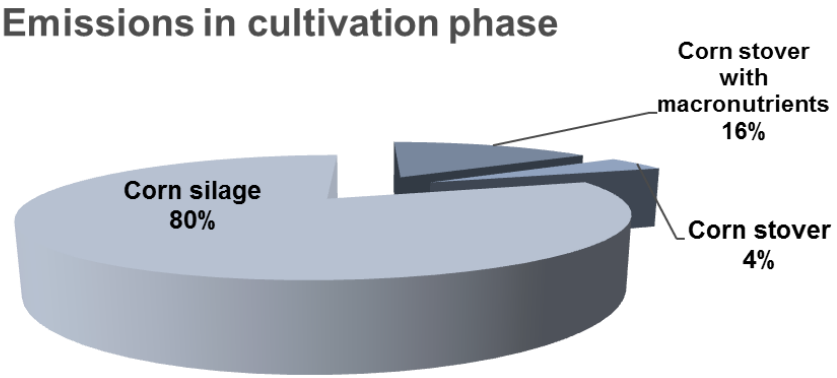
Crop	Acreage, 1,000 ha	Total mass, 1,000 t	Sustainable potential, 1,000 t		Energy potential, 1,000 t	
			Big farms	M/S farms	Big farms	M/S farms
Wheat	298	1,120	264	320	**250**	**280**
Ray	1.5	4.5	1	1	1	1
Barley	48	155	52	50	48	45
Corn *	637	3,288	s 114	s 310	**s 110**	**s 280**
			c 10	c 360	**c 10**	**c 330**
Sunflower	172	680	0	0	0	0
Soybean	128	620	150	130	150	130
Oil rape	4.2	17.6	6	5	6	5
Total		5,885.1	597	ca. 1.176	ca. 575	ca. 1.071
			1,773		**1,646**	

*s – corn stover
c – corn cobs

CORN IS MAJOR FIELD CROP IN ALL DANUBE DOWNSTREAM COUNTRIES



- Utilization of corn stover as renewable resource is very positive regarding GHG savings

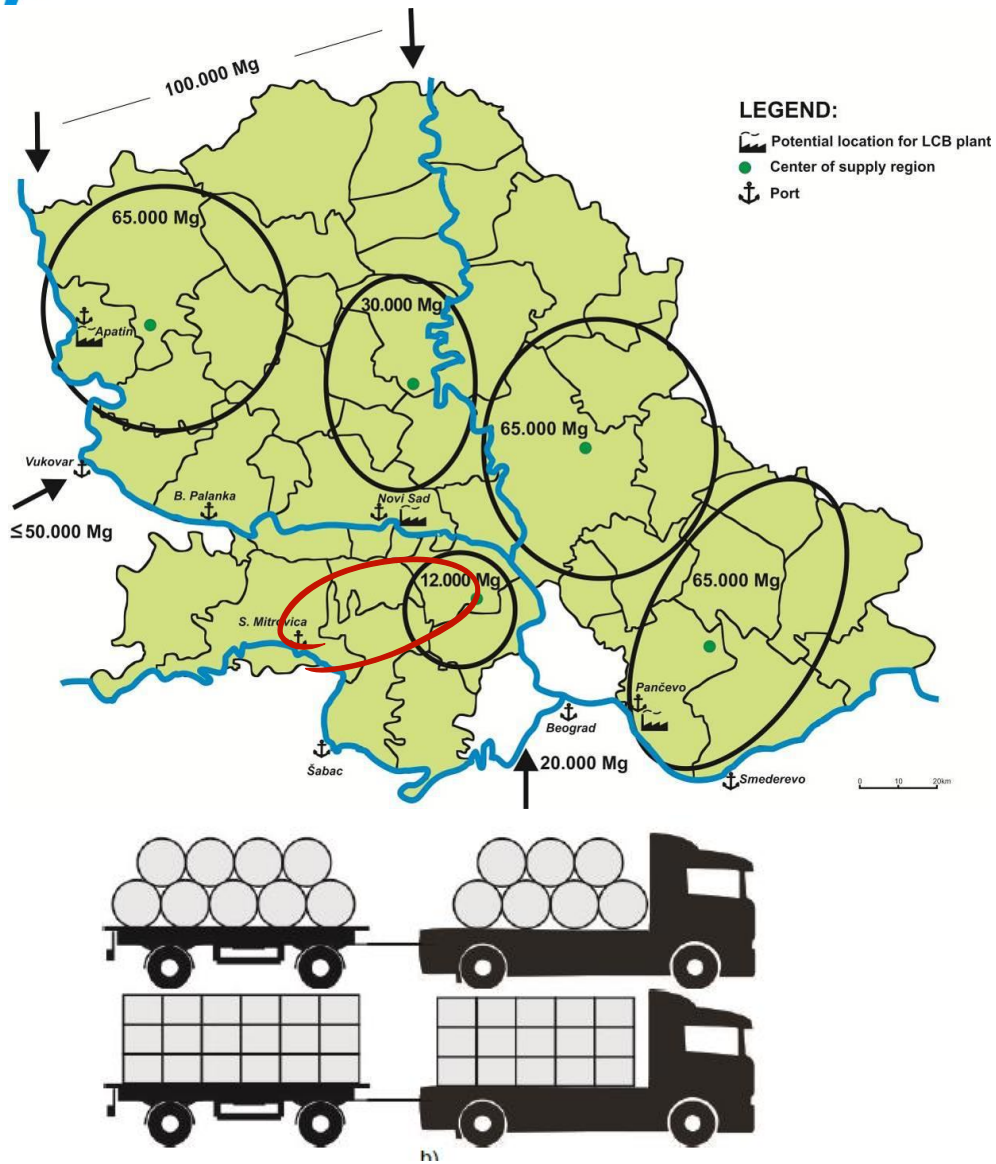


- The following problems were identified:
  - Proper collection and storage procedures for corn stover → Faculty is performing their own tests
  - LCB production requires big amounts of feedstock thus it would be better **to plan supplying from more than one country**

CORN STOVER HARVEST PROCEDURE & STORAGE

- Based on experiences in Serbia as well as in the other countries, it was found out that the best solution will be to perform two-pass procedure
- For mapping a density of the potentials only plots of ≥5 ha were considered
- Corn stover contamination is one the critical issues, soiling should be up to 5%
- The open air storage on elevated basement and by tarpaulin covered stacks can be reasonable solution.
- **Regarding storage capacity in the LCB plant, 7 days of biomass should be in the production plant warehouse (proposed by Beta renewables),**
- Total costs of harvested dry matter were estimated to be between **42 and 45€/t**, including values of removed nutrients and some revenue for farmers.

LOGISTIC



- Supply logistic was evaluated by application of location-allocation-problem, and best locations for LCB refinery identified, whereby only locations having Danube harbour were selected. These resulted with estimation of average supply costs for corn stover to a plant llocation of **57** and **60 €/t** for water and road transport, respectively.
- **According to the calc results, from the logistic point of view the best location for LCB plant is Novi Sad**

LCB FEEDSTOCK ENVIRONMENTAL IMPACT

Within supply region radius up to 60 km, CO_2 emission is in the range 13 to 15 gCO2eq/MJ, what makes about 40 % of defined limit, which is 33.5 gCO2eq/MJ

Emissions of GHG for procurement of corn stover for different distances (representative supply radius) and different yields:

Reduced yield

Harvest procedure	Specific emission, gCO_{2eq}/MJ			Share in maximal permitted emissions		
	20 km	60 km	100 km	20 km	60 km	100 km
FH	10.9	15.6	20.4	32%	47%	61%
BB	12.0	13.3	14.6	36%	40%	43%
RB	13.2	15.0	16.7	39%	45%	50%

Common yield

Harvest procedure	Specific emission, gCO_{2eq}/MJ			Share in maximal permitted emissions		
	20 km	60 km	100 km	20 km	60 km	100 km
FH	9.3	13.2	17.2	28%	39%	51%
BB	11.6	12.9	14.2	35%	38%	42%
RB	12.8	14.6	16.3	38%	43%	49%

High yield

Harvest procedure	Specific emission, gCO_{2eq}/MJ			Share in maximal permitted emissions		
	20 km	60 km	100 km	20 km	60 km	100 km
FH	8.2	11.4	14.6	25%	34%	43%
BB	11.4	12.7	13.9	34%	38%	42%
RB	12.5	14.3	16.0	37%	43%	48%

FH – forage harvester; BB – big rectangular bales; RB – round bales

ASSUMPTIONS FOR THE CALCULATION

The financial analyses were performed to define minimal price of LCB needed to obtain profitability of investment. Analyses were performed for two plant capacities, 40 and 50 kt LCB per annum. General conditions were:

- Time of project completing is twelve months
- Project lasting is twenty years
- NPV of project is positive
- Liquidity is achieved in all years
- Financing and costs of the capital based on EBRD conditions
- Payback period is less than half of project lasting
- CAPEX for LCB plant type PROESA™ was 100 M€
- OPEX includes: feedstock costs; enzymes and yeasts costs; ash disposal expenses; gross salaries for 40 employees; expenses for license; other business expenses
- No energy costs

PROJECT ECONOMICS

- 8-9 years pay-back based on different price of Ethanol (compared to market price of ethanol resulting into the project viability)
- For all presented cases, including reduction of CAPEX and enzyme expenses reduction, expected in future, th**e pre-set profitability threshold is not reached.**
- **Only with** incentives **150 €/t applied**, production can be profitable (cases E3 and E4)

Case	Investment M€	Loan M€	Subsidies €/t	Bioethanol 10^3 t/a	Biomass 10^3 t/a	Biomass €/t	Enzymes €/t	License €/t	**Bioethanol €/t**
A1	106,3	100	-	40	200	60	180	22	**1030**
A2	104,9	-	-	40	200	60	180	22	**930**
A3	104,9	-	150	40	200	60	180	22	**780**
B1	104,9	-	-	40	200	57	180	22	**915**
B3	105,0	-	-	40	200	65	180	22	**955**
C	104,9	-	-	40	200	60	180	26	**935**
D	94,6	-	-	40	200	60	180	22	**895**
E1	94,4	-	-	40	200	55	150	22	**840**
E2	94,9	-	-	50	250	55	150	22	**765**
E3	94,9	-	150	50	250	55	150	22	**612**
E4	95,0	-	150	50	250	60	150	22	**640**

A- Finance sources; **B** - feedstock costs; **C** – cost of licence; **D** – CAPEX; **E** – expected future costs minimizing

CONCLUDING COMMENTS

The problems being identified as crucial:

- Development of adequate collection of corn stover and other agriculture waste → future efforts should be oriented toward its solving but these issues should be addressed by biomass supplier;
- „Break-even“ price of bio-Ethanol 2G compared to the bio-Ethanol market price → future effort should be oriented on further improvement of the economics of the process and these issues should be addressed by investor and product distributor;
- Development of the current demand on bio components in the region → motor fuels producers and distributors should recognize the obligations from EU legislation on min. content of the advanced bio components in motor **fuels 3,5% e.e. and requirements on GHG savings of 40% by 2030** and these issues should be addressed by investor in line with National and EU legislation;
- Timing and sourcing of the proposed project → decision should be based on 3 problems solution identified above and these issues should be addressed by investor;
- **Even though study was concentrated on biomass availability in Serbia, due to the similar agricultural conditions the study results can be applicable for the Regional countries as well, thus the Regional cooperation in problems solving would bring mutual benefits**

THANK YOU FOR THE ATTENTION

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