



## **Current State and Prospects of Bioenergy Development in Ukraine**

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***We are greening the energy!***

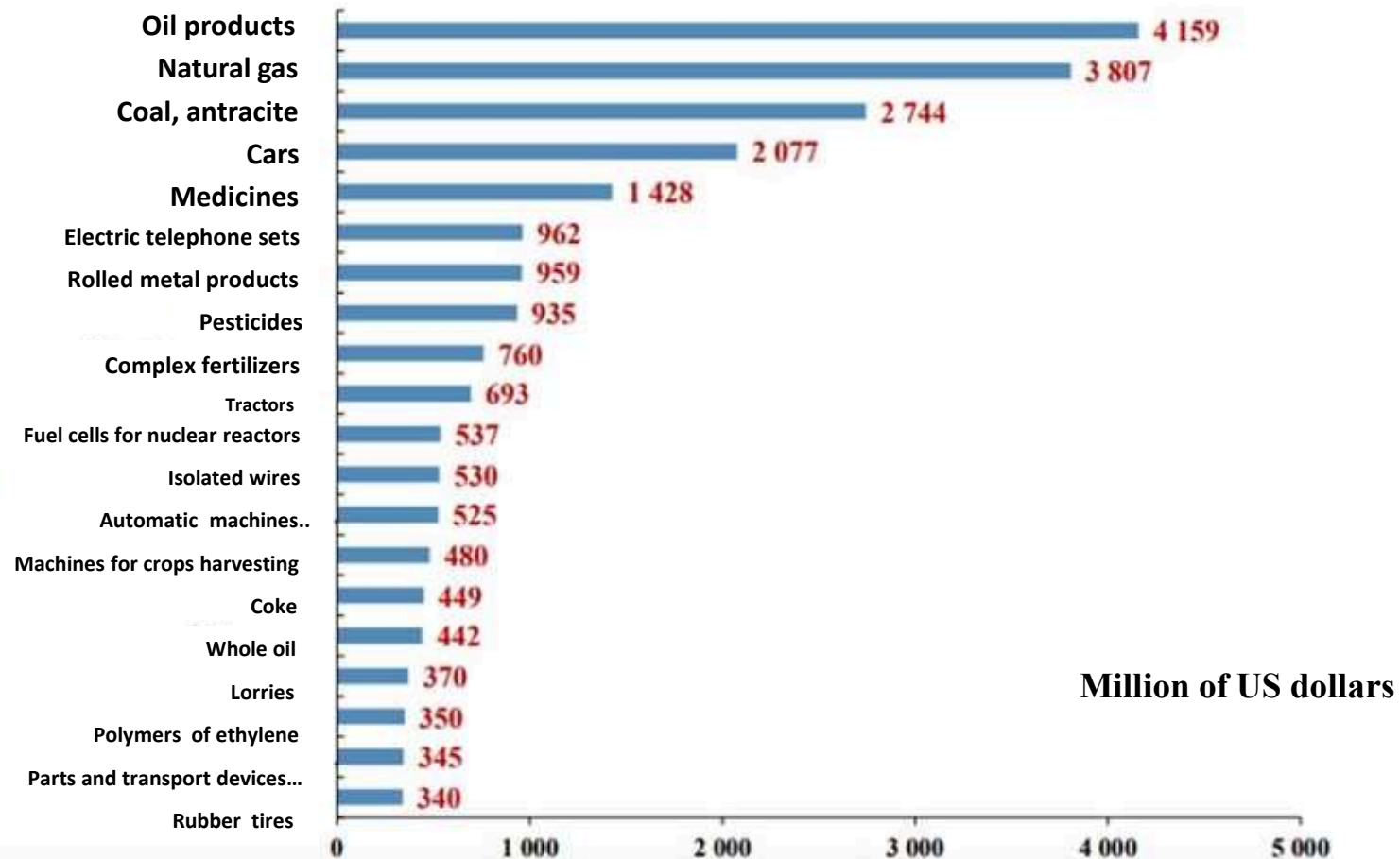
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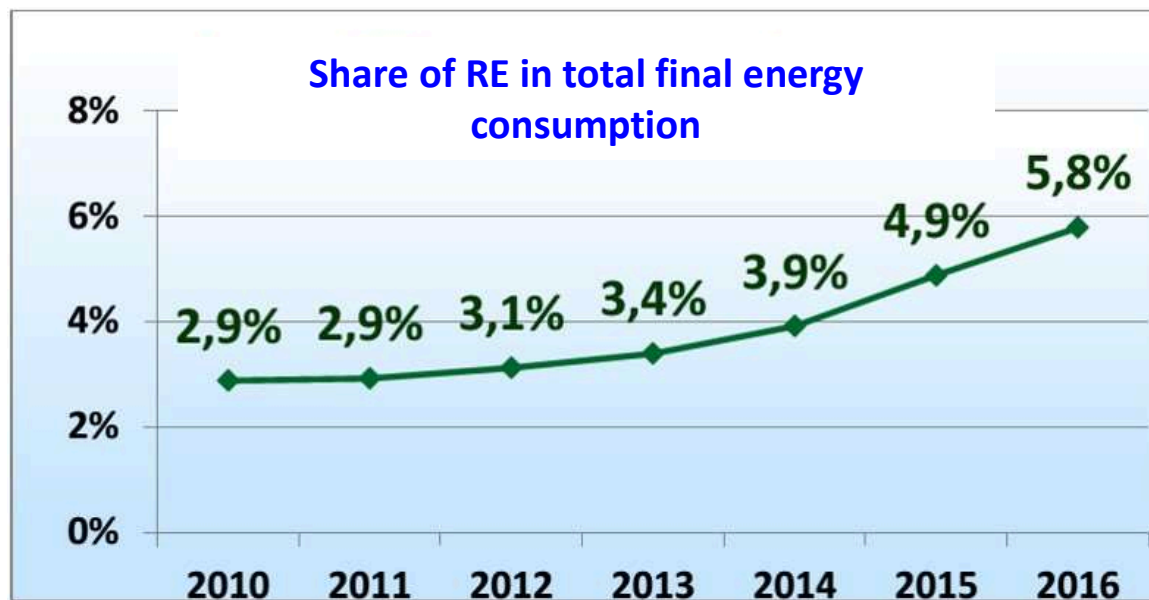
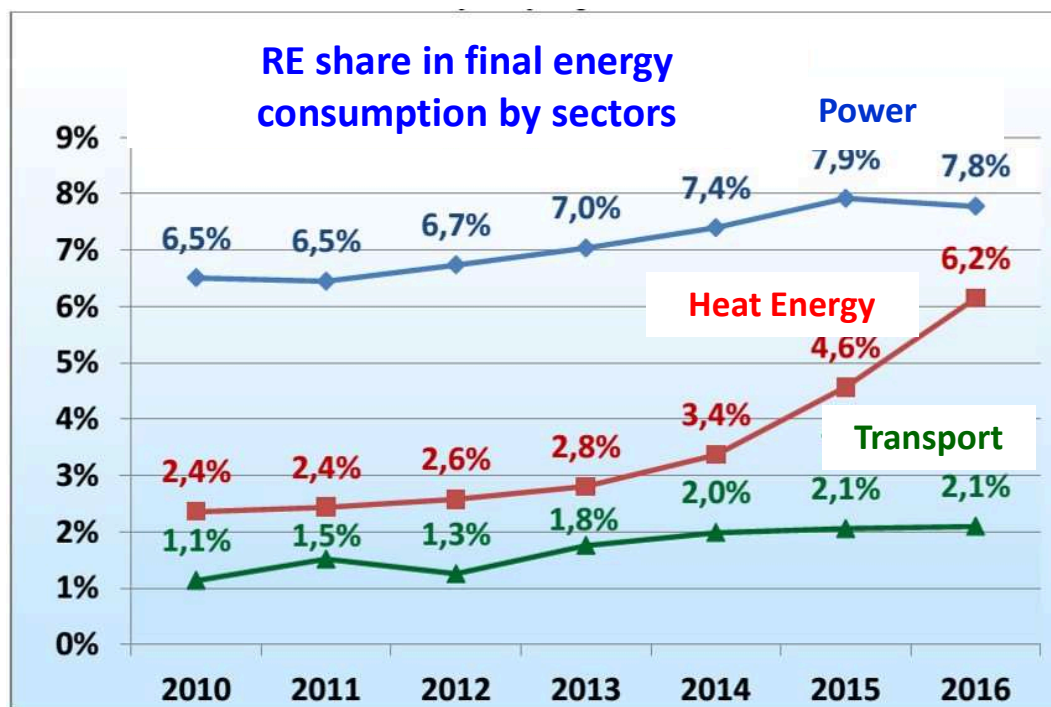
**Physical persons:** Maraykin R., Petrov Ya., Ilchuk M., Bereznytska M., Epshtein Yu., Galchynska Yu., Teush S., Gres O., Stupak S., Romanyuk O., Kotsar O., Moroz O.

# Ukraine's imports in 2017, million of US dollars

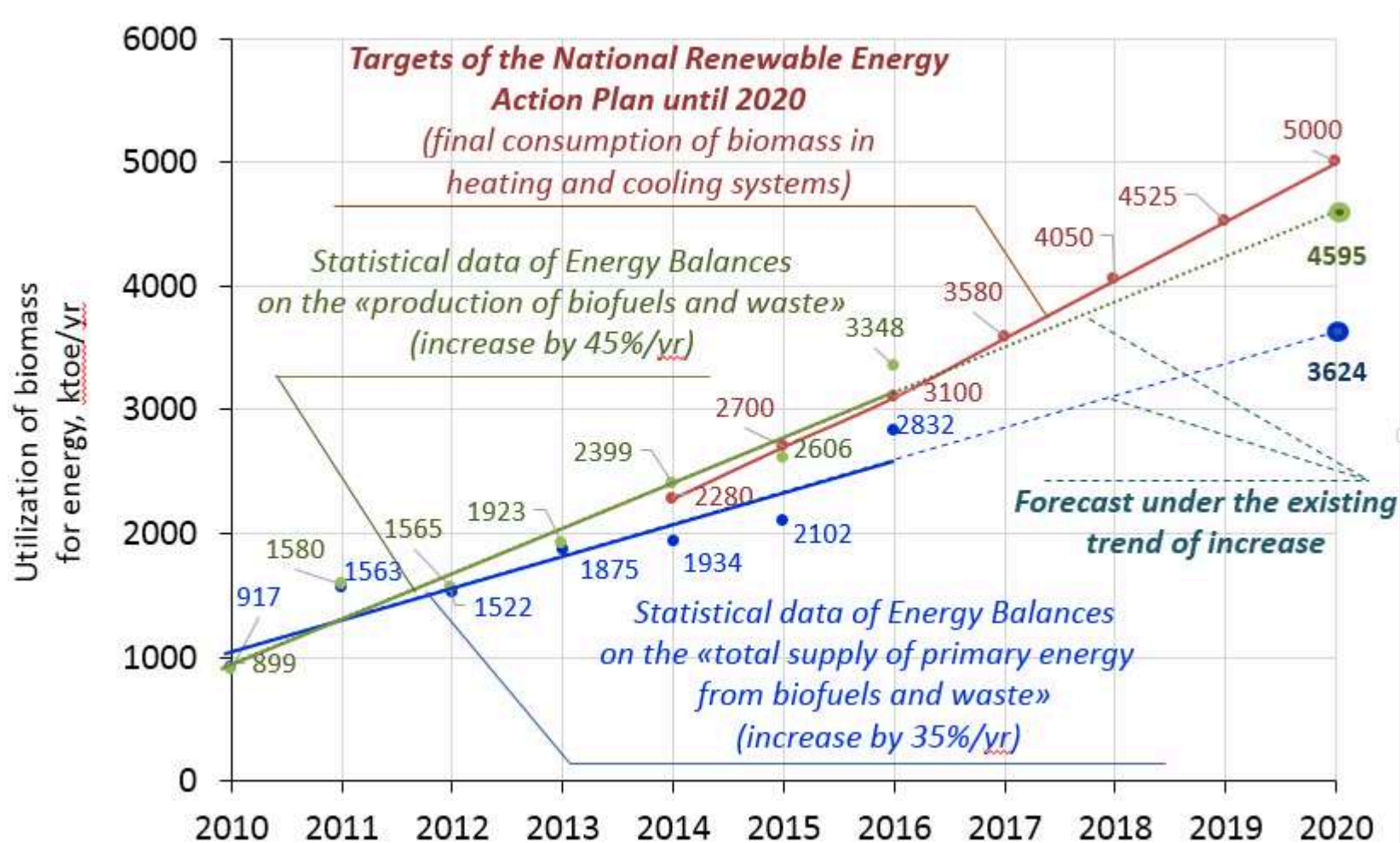
## The structure of Ukraine import in 2017. Principal items



## Production of Renewable Energy in Ukraine according official Energy Balances (2010-2016)



## Trends of bioenergy development in Ukraine (2010-2016)



**Energy Balance of Ukraine for 2016:**

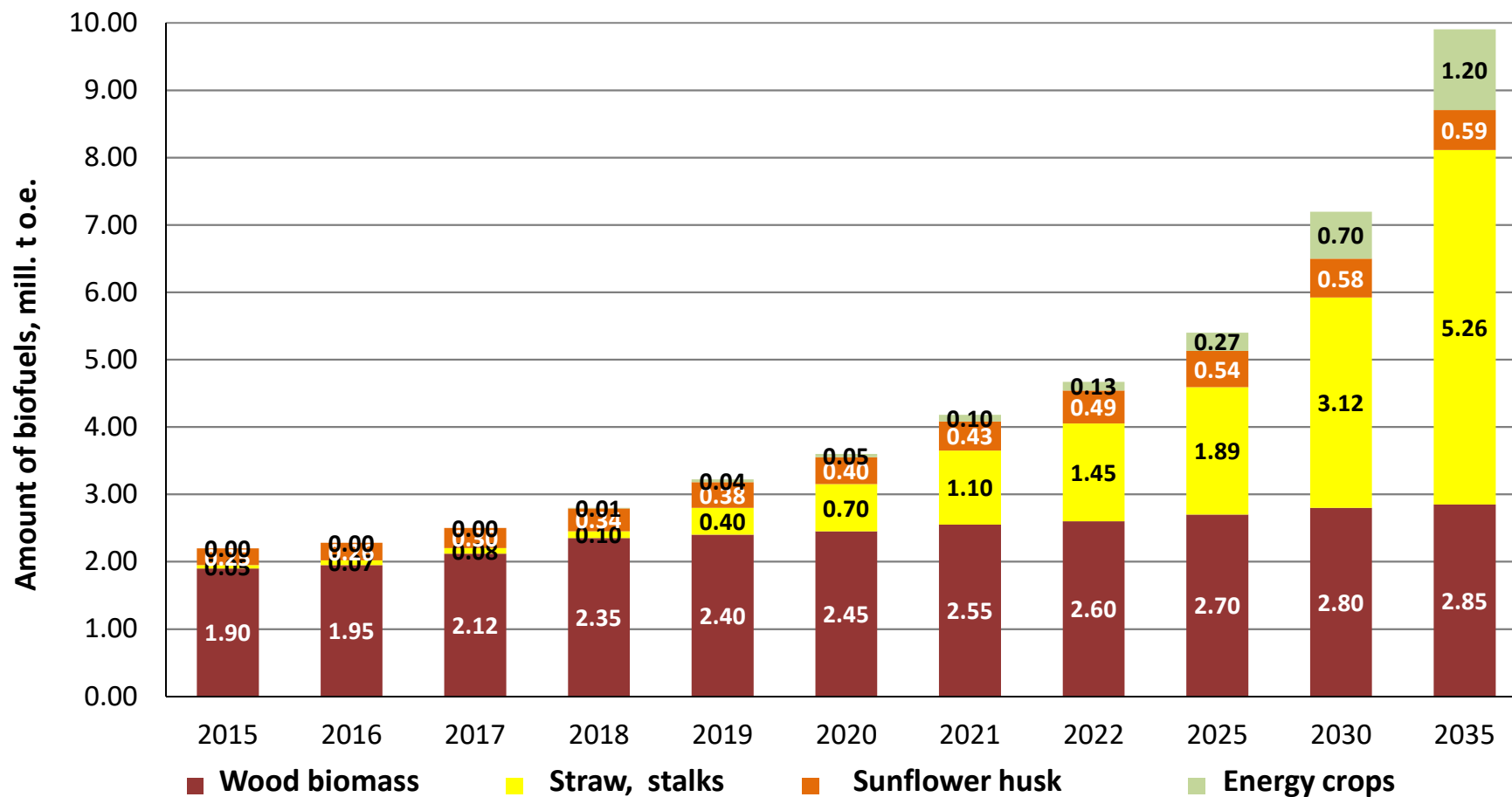
**Share of biofuels in the structure of RES production – 81%**

## Structure of Total primary energy supply according New Energy Strategy of Ukraine till 2035

Type of energy source	2015 (fact)	2020 (forecast)	2025 (forecast)	2030 (forecast)	2035 (forecast)
Coal	27,3	18	14	13	12
Natural Gas	26,1	24,3	27	28	29
Oil Products	10,5	9,5	8	7,5	7
Nuclear Energy	23	24	28	27	24
<b>Biomass, Biofuels and Wastes</b>	<b>2,1</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>11</b>
Solar and Wind Energy	0,1	1	2	5	10
Hydro Energy	0,5	1	1	1	1
Thermal energy	0,5	0,5	1	1,5	2
<b>TOTAL, <u>mill t o.e.</u></b>	<b>90,1</b>	<b>82,3</b>	<b>87</b>	<b>91</b>	<b>96</b>

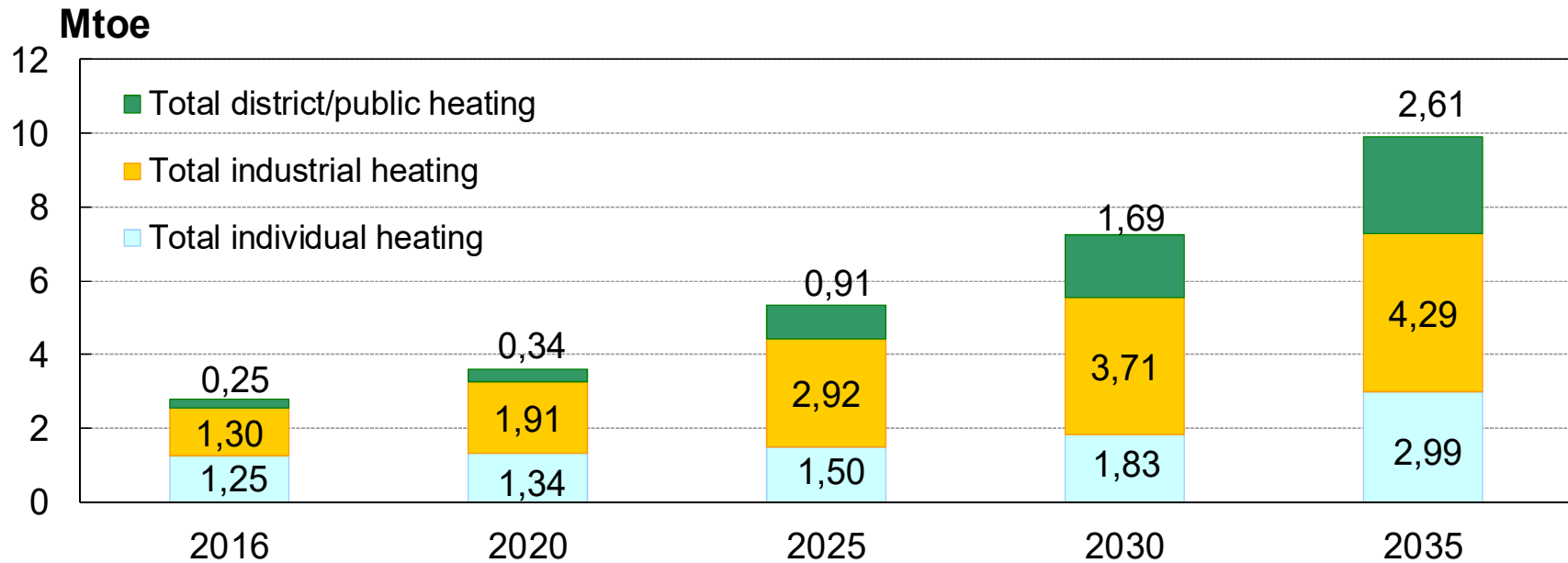
[http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art\\_id=245234085&cat\\_id=35109](http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245234085&cat_id=35109)

## Forecast of total amount of consumption and structure of solid biofuels in Ukraine (2015 – 2035)

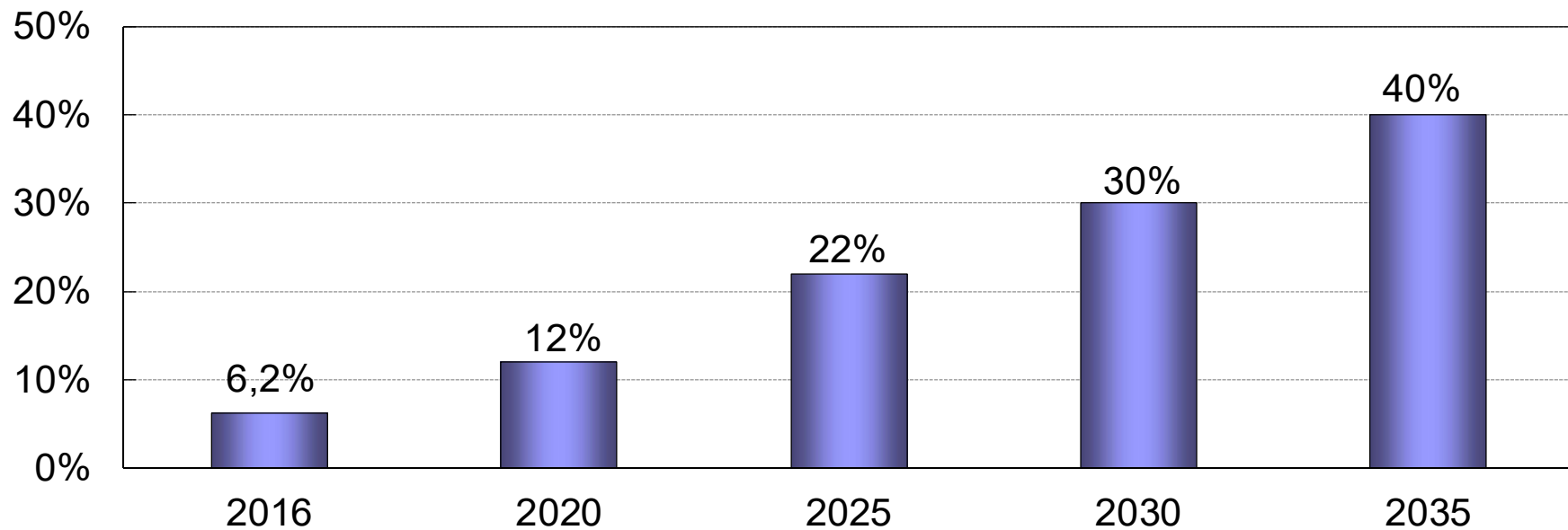


Type of biomass	2015	2016	2017	2018	2019	2020	2021	2022	2025	2030	2035
Wood fuels	1,90	1,95	2,12	2,35	2,40	2,45	2,55	2,60	2,70	2,80	2,85
Straw, stalks	0,05	0,07	0,08	0,10	0,40	0,70	1,10	1,45	1,89	3,12	5,26
Sunflower husk	0,25	0,26	0,30	0,34	0,38	0,40	0,43	0,49	0,54	0,58	0,59
Energy crops	0,00	0,00	0,00	0,01	0,04	0,05	0,10	0,13	0,27	0,70	1,20
<b>TOTAL, mill. t o.e.</b>	<b>2,20</b>	<b>2,28</b>	<b>2,50</b>	<b>2,80</b>	<b>3,22</b>	<b>3,60</b>	<b>4,18</b>	<b>4,67</b>	<b>5,40</b>	<b>7,20</b>	<b>9,90</b>

## Forecast of Renewable Heat Production in Ukraine (2016-2035)



## Forecast of RES share in heat production (2016-2035), %





## Forecast of Renewable Heat Production in Ukraine (2016 – 2035)

Year	MW, heat	MWe	Mtoe	NG replacement, billion m3	Share of RES	CO2 reduction, MtCO2/y	Total investments, million Euro	Total new jobs
<b>2016</b>	5000	45	2,8	3,5	6,2%	6,2	1 000	13 000
<b>2020*</b>	7 000	250	3,6	4,4	12%	8,6	1 800	22 000
<b>2025</b>	11 250	800	5,3	6,6	22%	12,9	3 800	42 000
<b>2030</b>	16 200	1260	7,2	8,9	30%	17,5	5 700	64 000
<b>2035**</b>	24 000	1780	9,9	12,2	40%	24,0	8 000	97 000

\* according Renewable Energy Action Plan till 2020.

\*\* according Energy Strategy of Ukraine till 2035.

## Potential of biomass available for energy in Ukraine (2016)

Type of biomass	Theoretical potential, Mt	Potential available for energy	
		Share of theoretical potential, %	Mtoe
Straw of grain crops	36.1	30	3.70
Straw of rape	2.1	40	0.28
By-products of grain corn production (stalks, cobs)	36.5	40	2.79
By-products of sunflower production (stalks, heads)	25.9	40	1.48
Secondary agricultural residues (sunflower husk)	2.0	86	0.84
Wood biomass (firewood, felling residues, wood processing waste)	6.6	94	1.55
Wood biomass (dead wood, wood from shelterbelt forests, pruning)	8.8	44	1.03
Biodiesel (rapeseed)	-	-	0.16
Bioethanol (corn and sugar beet)	-	-	0.66
Biogas from waste and by-products of agricultural sector	1.6 bln m <sup>3</sup> CH <sub>4</sub>	50	0.68
Landfill gas	0.6 bln m <sup>3</sup> CH <sub>4</sub>	34	0.18
Sewage gas (industrial and municipal wastewater)	1.0 bln m <sup>3</sup> CH <sub>4</sub>	23	0.19
<b>Energy crops:</b>			
- willow, poplar, miscanthus (1 mln ha*)	11.5	100	4.88
- corn for biogas (1 mln ha*)	3.0 bln m <sup>3</sup> CH <sub>4</sub>	100	2.57
<b>TOTAL</b>	-	-	<b>21.01</b>

43%

35%

\* In case of growing on 1 mln ha of unused agricultural land.

# Main drivers and barriers for bioenergy development

## Drivers:

1. **Market prices** on natural gas for industry and public organizations. Considerable increase of natural gas prices for population and for DH companies heating population from May 2015 (but they are ~100% less than current market prices yet).
2. **Improvement of tariff system** for heat energy from Alternative Energy Sources (AES incl. RE): transition from “self cost + 6%” model to new model from April 2017. Now tariff on heat energy from AES = tariff on heat energy from natural gas - 10%.
3. First steps in **monetization of subsidies for population** (from January 2018).

## Barriers:

1. **Natural gas prices for population and for DH companies heating population are not market** (~100% less than current market prices yet).

*The price has been increased on 23.5% from 1 November 2018 (under IMF's request to Ukraine for next credit). There is a schedule of equalizing of these prices with prices for industry till January 2020.*

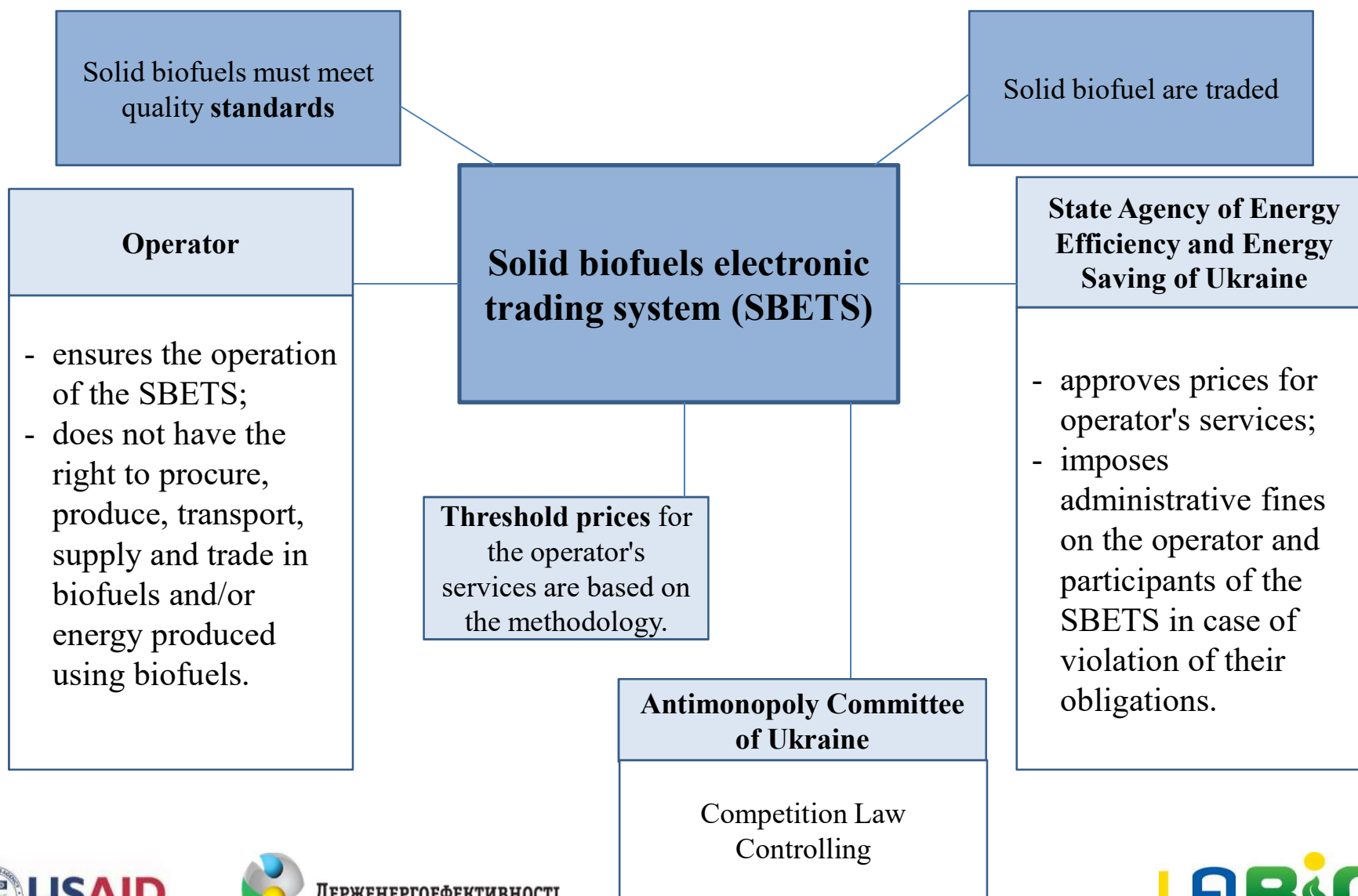
2. **Lack of solid biofuels market development.**

*Establishment of solid biofuel electronic trading system is in progress – needed legislation is developed (similar to Lithuanian Biofuel Exchange Baltpool).*

3. Stimulation of **electricity production from biomass and biogas** is insufficient. These sectors fall behind the electricity production from the sun and wind and trends of their development do not match the similar trends in EU countries.

4. **Imperfect model of DH supply** (monopoly position of DH companies, problems with third party access to heating networks). *Improvements are developed and under discussion.* The competition introduction in the DH systems is scheduled for 2020.

## Solid biofuels electronic trading system establishment in Ukraine



## Feasibility study for crop residues baling (1).

**Basic list of equipment for harvesting by-products of wheat and grain maize production in square bales with 20-35 t/h productivity.**

Process	Equipment	Cost per unit, th. EUR	Quantity, units	Costs, th. EUR
Picking up and densifying	1. Baling*:	308	1	308
	Tractor Deutz-Fahr X 720	135	1	135
	Baler MF 2270	173	1	173
Collecting and transporting	2. Collection and storing bales at a field's edge:	131	1	131
	Tractor New Holland TD5.110	35	1	35
	Automatic bale loader Arcusin AutoStack XP 54 T	96	1	96
	3. Loading:	71	2	142
	Telehandler MF9407			
TOTAL	4. Transportation**:	80	4	320
	Truck MAZ with a semitrailer			
				<b>901</b>
				<b>581***</b>

\* Corn header Geringhoff Mais Star Collect is used to form corn stover swaths (its price is 54 th. EUR/unit)

\*\* Distance for transportation from the fields to the central storing place is up to 30 km

\*\*\* Capital costs of equipment for harvesting by-products of wheat and grain maize in bales in case of availability of trucks for biomass transportation.

## Feasibility study for crop residues baling (2)

Indicators	Value	
	wheat straw	corn stover
Capacity by the final product (biomass bales)	6000 t/yr	6000 t/yr
Feedstock price	6.5 EUR/t*	8.8 EUR/t*
Capital costs	581 th. EUR	
Operating costs	173 th. EUR/yr	
Loan (the share of capital costs)	60%	
Loan rate	7%	
Net cost of biomass bales**	18 EUR/t	
Sale price of biomass bales	25 EUR/t without VAT	
Simple payback period	<b>4.1 yr</b>	
Discounted payback period (under discount rate of 7%)	<b>4.4 yr</b>	
IRR	<b>24.1%</b>	

\* Crop residues price is determined by the cost of equivalent amount of mineral fertilizers required to replace the nutrients in biomass

\*\* Net cost includes direct costs for harvesting biomass, deductions for equipment amortization and interest payments on the loan

## Feasibility study for biomass boiler and CHP plant running on straw bales in district heating.

Indicator	Boiler plant on straw bales, 10 MW	CHP on straw bales: condensing turbine with steam extraction, 6 MW <sub>e</sub> + 18 MW <sub>th</sub>	TPP on straw bales: condensing turbine, 6 MW <sub>e</sub>
Price of straw bales with delivery, EUR/t without VAT	25	25	25
Fuel consumption, kt/year	13.5	77.1	59.6
<b>Economic indicators:</b>			
Gas saving in heat production, million m <sup>3</sup> /year	5.2	9.60	-
Total investment, million EUR	2.5	23.1	19.8
<b>Implementation by own funds:</b>			
IRR, %	25	15	9
<b>Simple payback period, years</b> (tariff for heat production: 950 UAH/Gcal without VAT *)	<b>3.9</b>	<b>5.6</b>	<b>7.3</b>
<b>Implementation by own and credit funds: (credit is 60% of capital costs by 8% per annum for 8 years with deferred capital repayments for 1 year)</b>			
IRR, %	22	12	6
<b>Simple payback period, years</b>	4.4	6.7	8.7

\* Tariff rate is 0.9 of the natural gas heat tariff; it is assessed according to the Law of Ukraine N 1959-VIII of 21.03.2017 <http://zakon3.rada.gov.ua/laws/show/1959-19>

## Feasibility study for biomass boiler and CHP plant running on baled maize stalks in district heating.

Indicator	Boiler plant on baled maize stalks, 10 MW	CHP on baled maize stalks: condensing turbine with steam extraction, 6 MW <sub>e</sub> + 18 MW <sub>th</sub>	TPP on baled maize stalks: condensing turbine, 6 MW <sub>e</sub>
Price of baled maize stalks with delivery, EUR/t without VAT	25	25	25
Fuel consumption, kt/year	14.1	80.9	61.8
<b>Economic indicators:</b>			
Gas saving in heat production, million m <sup>3</sup> /year	5.2	9.6	-
Total investment, million EUR	2.2	16.2	15.9
<b>Implementation by own funds:</b>			
IRR, %	28	23	13
<b>Simple payback period, years</b> (tariff for heat production: 950 UAH/Gcal without VAT *)	3.4	4.1	6.0
<b>Implementation by own and credit funds:</b> <i>(credit is 60% of capital costs by 8% per annum for 8 years with deferred capital repayments for 1 year)</i>			
IRR, %	25	20	10
<b>Simple payback period, years</b>	3.9	4.8	7.2

\* Tariff rate is 0.9 of the natural gas heat tariff, it is assessed according to the Law of Ukraine N 1959-VIII of 21.03.2017 <http://zakon3.rada.gov.ua/laws/show/1959-19>



## Feasibility study for biomass boiler and CHP plant running on sunflower husk pellets in district heating.

Indicator	Boiler plant on sunflower husk pellets , 10 MW	CHP on sunflower husk pellets : condensing turbine with steam extraction, 6 MW <sub>e</sub> + 18 MW <sub>th</sub>	TPP on sunflower husk pellets : condensing turbine, 6 MW <sub>e</sub>
Price of sunflower husk pellets with delivery, EUR/t without VAT	<b>48</b>	<b>48</b>	<b>48</b>
Fuel consumption, kt/year	10.2	61.5	47.0
<b>Economic indicators:</b>			
Gas saving in heat production, million m <sup>3</sup> /year	5.2	9.6	-
Total investment, million EUR	1.4	16.2	15.9
<b>Implementation by own funds:</b>			
IRR, %	<b>40</b>	<b>17</b>	<b>7</b>
<b>Simple payback period</b> , years (tariff for heat production: 950 UAH/Gcal without VAT *)	<b>2.5</b>	<b>5.1</b>	<b>7.8</b>
<b>Implementation by own and credit funds: (credit is 60% of capital costs by 8% per annum for 8 years with deferred capital repayments for 1 year)</b>			
IRR, %	37	14	4
<b>Simple payback period</b> , years	2.7	6.0	9.3

\* Tariff rate is 0.9 of the natural gas heat tariff, it is assessed according to the Law of Ukraine N 1959-VIII of 21.03.2017 <http://zakon3.rada.gov.ua/laws/show/1959-19>

## Feasibility study for biogas projects

Item	3.2 MW <sub>e</sub> biogas plant on sugar beet pulp (100%)	9.6 MW <sub>e</sub> biogas plant on maize silage (80%) + manure (20%)
Raw material prices, UAH/t (without VAT)	<b>45 (pulp)</b>	<b>400 (silage), 0 (manure)</b>
Raw material consumption, kt/year	90	200 + 44
<i>Economic parameters:</i>		
Electricity production (net), mill kWh/year	23.3	73.5
Total investment cost, mill EUR	11.2	25.9
<b><i>Implementation by own funds:</i></b>		
IRR, %	<b>18.8</b>	<b>21.8</b>
<b>Simple payback period, years</b>	<b>5.2</b>	<b>4.5</b>
<b><i>Implementation by own and credit funds (credit is 60% of capital costs with the annual interest of 8% for 8 years with deferred capital repayments of 1 year):</i></b>		
IRR, %	16.5	19.7
<b>Simple payback period, years (electricity tariff is 0.1239 EUR/kWh without VAT*)</b>	6.1	5.2

- *The Law of Ukraine «On amending some laws of Ukraine as for providing competitive conditions for power production from alternative energy sources» (N 514-VIII of 04.06.2015)*

## Feasibility study for the production of 2nd generation bioethanol from own cereal straw and maize stalks

Indicator	Value	
Capacity by the final product (bioethanol)	55 000 t/yr	
Consumption of feedstock (cereal straw / maize stalks)*	315 000 t/yr (wet biomass )	
Feedstock price	18 EUR/t	
Capital costs*	101 million EUR	
Operating costs*	32 million EUR/yr	
Loan (share of capital costs)	60%	
Loan rate	8%	
	<b>Case I**</b>	<b>Case II***</b>
Income from the sale of bioethanol	40 million EUR/yr	62 million EUR/yr
Simple payback period	> 10 years	<b>4.5 years</b>
Discounted payback period (under discount rate of 7%)	> 10 years	<b>5.5 years</b>
NPV	---	149 million EUR
IRR	---	<b>23%</b>

\* Based on data of Biochemtex and Beta Renewables.

\*\* **Case I:** sale of bioethanol at Ukrainian market at the price of **0.57 EUR/l**, which corresponds to the average price of petrol in Ukraine as of August 2017 – 0.83 EUR/l.

\*\*\* **Case II:** sale of bioethanol at European market at the price of **0.89 EUR/l**, which corresponds to the average price of petrol in Europe as of August 2017 – 1.3 EUR/l.

In both cases difference in the heating value of petrol and bioethanol is taken into account.

## Options for business

<b>Collection, treatment, sale of agro-biomass</b>	<b>1) Collection, baling, sale of wheat straw / maize stalks</b>		<b>2) Production and sale of pellets on Ukrainian market</b>		
<b>Investments</b>	581 th. EUR (productivity: 20-35 t/h)		2.6 million EUR (productivity: 5 t/h)		
<b>IRR</b>	<b>24.1%</b>		maize stalks: <b>6%</b> ; sunflower husk: <b>36%</b>		
<b>Simple payback period</b>	<b>4.1 years</b>		maize stalks: <b>9.6 years</b> sunflower husk: <b>2.8 years</b>		
<b>Production of energy from agro-biomass</b>	<b>3) Boiler plant on straw bales</b>	<b>4) CHP plant on straw bales</b>	<b>5) Boiler plant on maize stalks</b>	<b>6) CHP plant on maize stalks</b>	<b>7) Thermal power plant on maize stalks</b>
<b>Investments*</b>	2.5 mill EUR	23.1 mill EUR	2.2 mill EUR	16.2 mill EUR	15.9 mill EUR
<b>IRR</b>	<b>28%</b>	<b>17%</b>	<b>32%</b>	<b>26%</b>	<b>16%</b>
<b>Simple payback period</b>	<b>3.4 years</b>	<b>5.1 years</b>	<b>3.1 years</b>	<b>3.7 years</b>	<b>5.3 years</b>
<b>Investments*</b>	1.4 mill EUR	16.2 mill EUR	11.2 mill EUR	25.9 mill EUR	101 mill EUR
<b>IRR</b>	<b>53%</b>	<b>26%</b>	<b>18.8%</b>	<b>21.8%</b>	<b>23%</b> (sale on European market)
<b>Simple payback period</b>	<b>1.9 years</b>	<b>3.6 years</b>	<b>5.2 years</b>	<b>4.5 years</b>	<b>4.5 years</b> (sale on European market)

- Boiler plant: 10 MW, CHP plant: 6 MW<sub>e</sub>+18 MW<sub>th</sub>, TPP: 6 MW<sub>e</sub>, biogas plant: 3 MW<sub>e</sub> (pulp), 10 MW<sub>e</sub> (silage + manure), bioethanol production: 55 kt/yr

**Thank you for attention!**

**Welcome to Ukraine and to UABio!**

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