

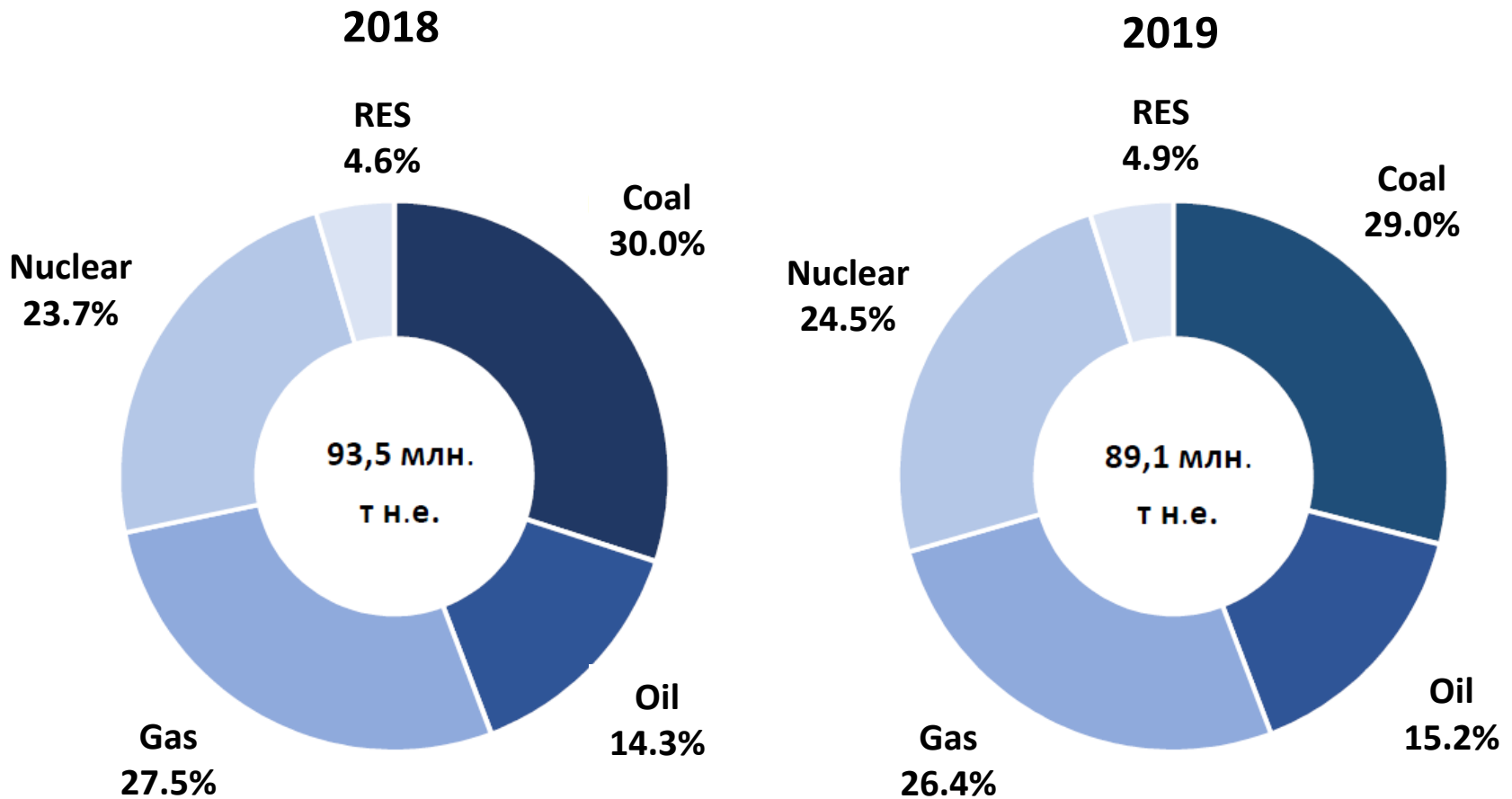
# Analysis of Ukraine's energy sector – potential for bioenergy retrofits

**Georgii Geletukha**

Head of Board, Bioenergy Association of Ukraine

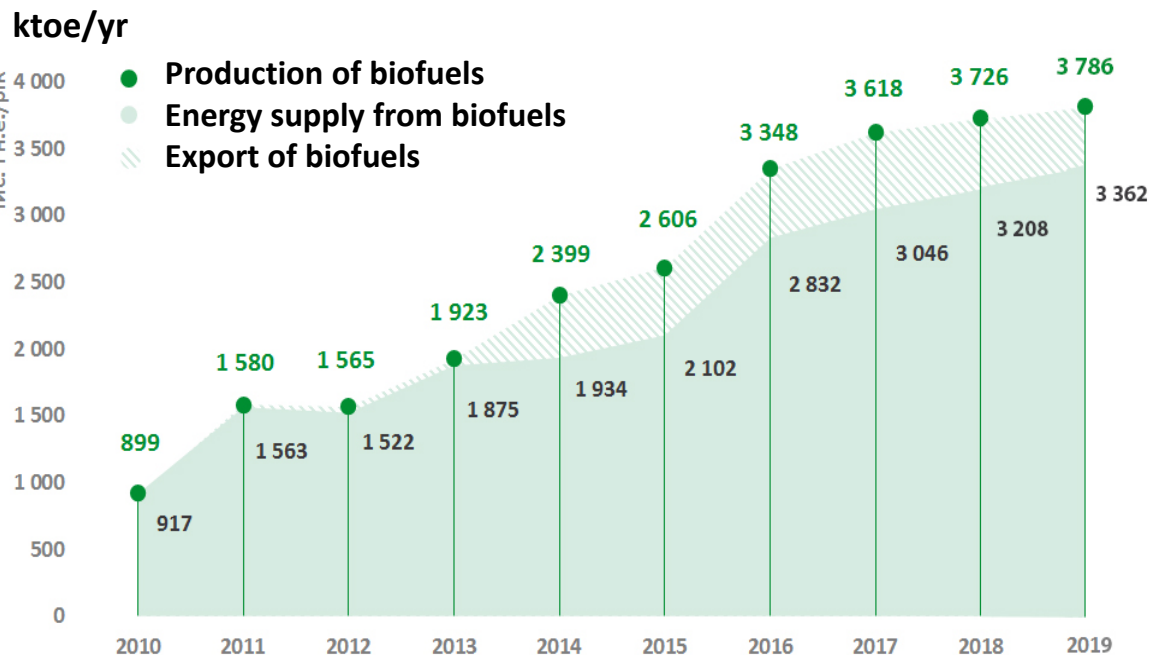
**UABIO**

# Structure of the primary energy supply in Ukraine



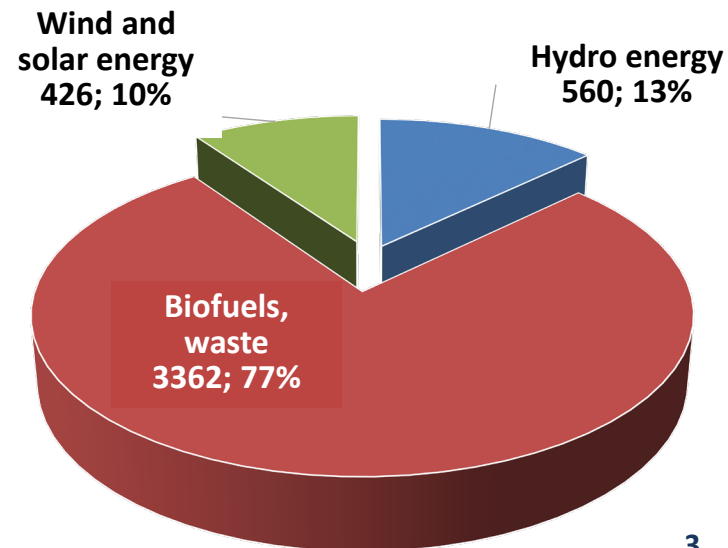
Source: State Statistics Service of Ukraine <http://www.ukrstat.gov.ua/>

# Development of RES in Ukraine – contribution of bioenergy



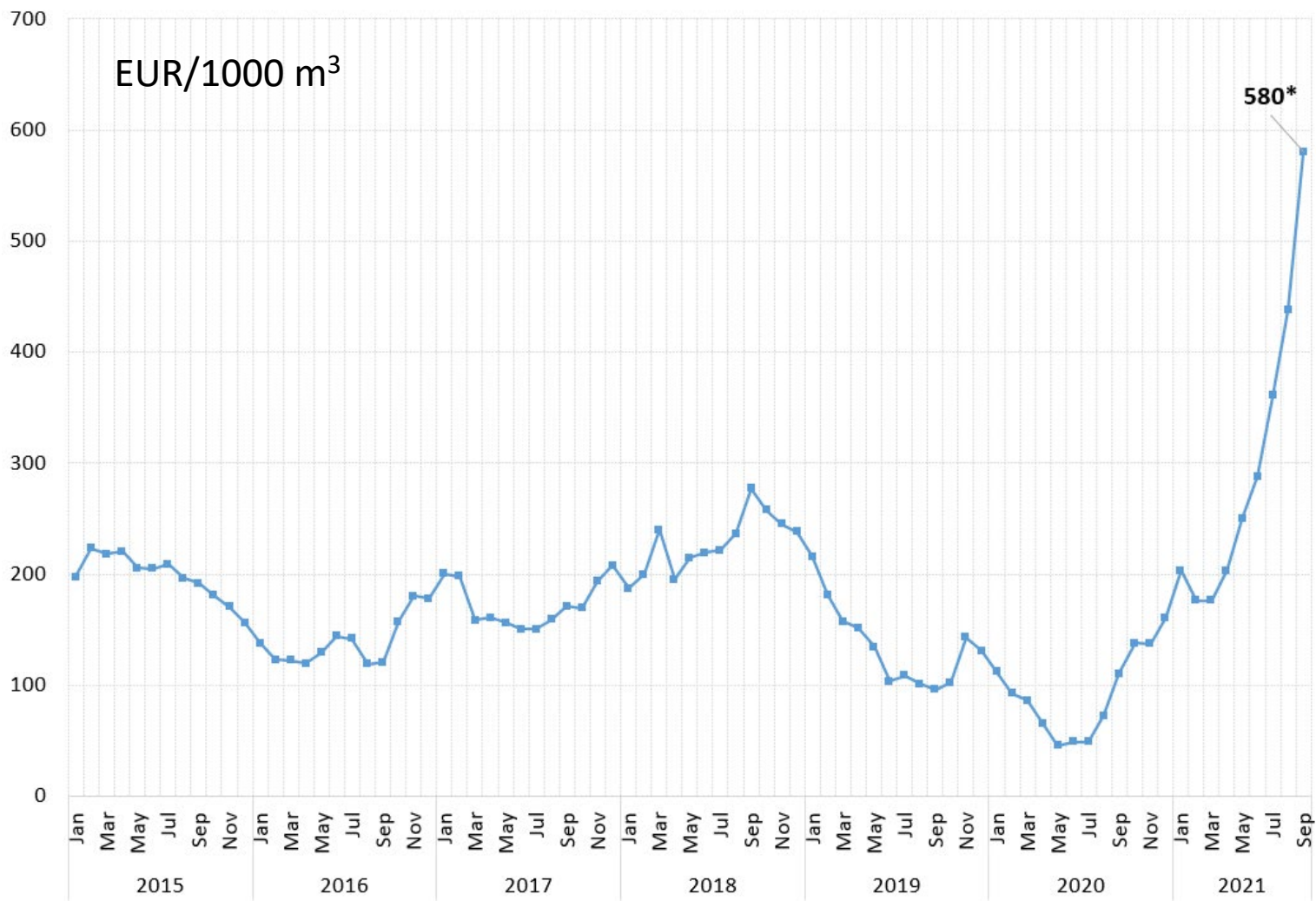
**Average annual bioenergy growth in Ukraine is 16%**

*Structure of the total primary energy supply from RES, ktOE*



□ Source: State Statistics Service of Ukraine

# Dynamics of natural gas price at TTF gas hub



\* as of 12.09.2021

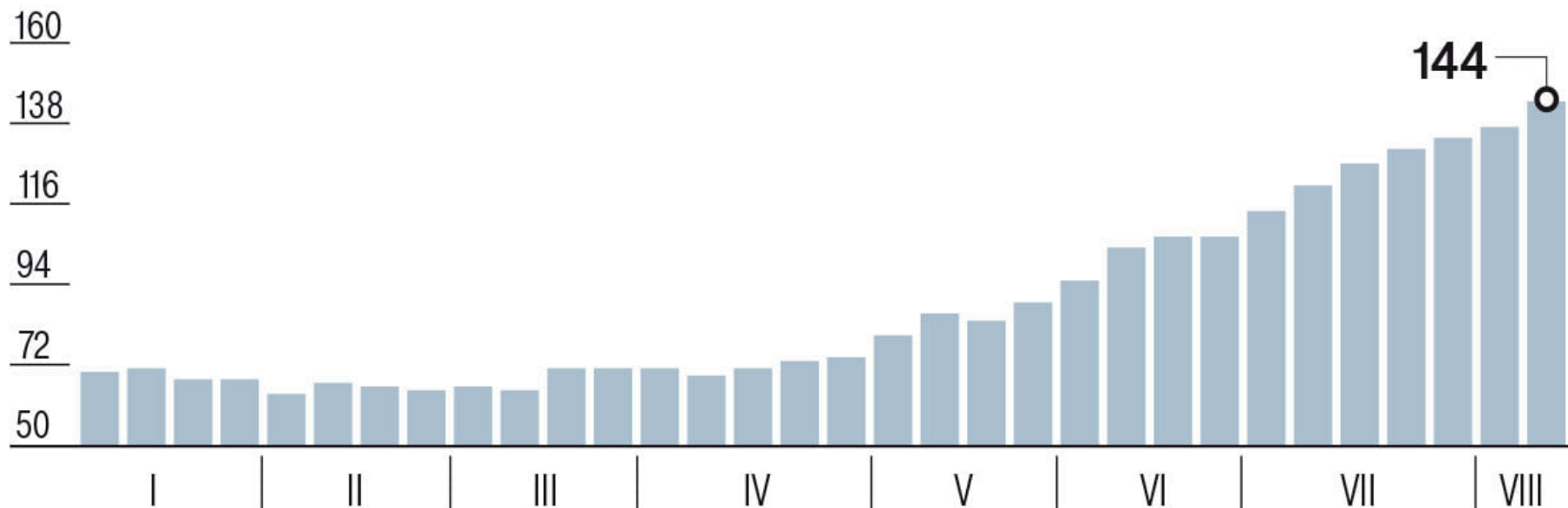
Sources: <http://my.elexys.be/>, <https://www.powernext.com/>

# Dynamics of power-generating coal price in Europe in 2021

USD/t

ЦЕНА ЭНЕРГЕТИЧЕСКОГО УГЛЯ В ЕВРОПЕ В 2021 ГОДУ (\$/ТОННА, 6000 ККАЛ, CIF ARA)

ИСТОЧНИК: «МЕТАЛЛ ЭКСПЕРТ».



**According to ITFU21, the coal price reached 168,8 USD/t on 07.09.2021**

<https://www.barchart.com/futures/quotes/ITFU21>

## Comparison of specific energy costs for traditional energy carriers and solid biofuels

Type of fuel or energy carrier	Average cost (as of August 2021), UAH/t, incl. VAT	Lower heating value, MJ/kg	Specific energy cost, UAH/GJ, incl. VAT
	A	B	A/B
Natural gas for population (year tariff)	7800-13500 UAH/1000 m <sup>3</sup>	34.0 MJ/m <sup>3</sup>	229-397
Natural gas for industry*	14000 UAH/1000 m <sup>3</sup>	34.0 MJ/m <sup>3</sup>	412
Coal	4950	25.0	198
Heavy oil	14500	42.0	345
Electricity for population	1.68 UAH/kWh	-	467
Electricity for non-household customers**	2.64 UAH/kWh	-	734
<b>Wood chips</b>	1600	10.1	158
<b>Firewood</b>	1400	13.4	104
<b>Wood pellets</b>	3650	17.0	215
<b>Sunflower husk pellets</b>	2900	17.5	166
<b>Straw bales, maize stalk bales</b>	1200	14.6	82

\* The cost is determined individually for each customer depending on the amount, order of payment and features of consumption. \*\* Small non-household customers supplied by power grids of JSC "DTEK Kyiv regional power grids» (1 voltage class), from 01.09.2021. The cost depends on a supplier. <https://koec.com.ua/page?root=23>

# Main indexes of Ukraine's power sector, 2020

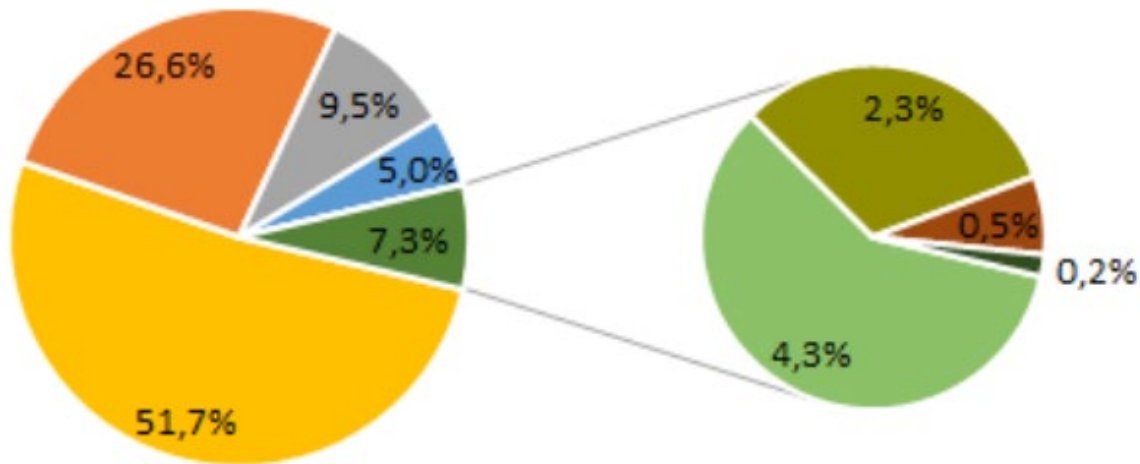
		MW	%
		<b>Production: installed capacity*</b>	Thermal PPs
	Nuclear PPs	13 835	25,3%
	Hydro PPs	4 829	8,8%
	PSPPs	1 488	2,7%
	CHP plants	6 105	11,1%
	Wind PPs	1 111	2,0%
	Solar PPS	5 363	9,8%
	Biomass/ biogas PPs	200	0,4%
		MWh	%
		<b>Production: amount*</b>	Thermal PPs
	Nuclear PPs	76 202,5	51,7%
	Hydro PPs	6 026,2	4,0%
	PSPPs	1 557,3	1,0%
	CHP plants	14 643,3	9,5%
	Wind PPs	3 094	2,3%
	Solar PPS	6 059	4,3%
	Biomass/ biogas PPs, other PPs	1 160	0,7%

\* Without Crimea power system and Donbas power system that is not under Ukraine's control.

PP – power plant, PS – pump-storage

Source: NERC <https://www.nerc.gov.ua/?id=61765>

# Share and structure of green electricity in the total power production, 2020



- Nuclear PPs
- Thermal PPs
- CHP plants
- Hydro PPs/PSPPs
- RES
- Solar PPs
- Wind PPs
- Biomass/biogas
- Small hydro PPs

PP – power plant, PS – pump-storage

Source: NERC <https://www.nerc.gov.ua/?id=61765>





# Energy (product) balance of Ukraine, 2019

## *Selected data for coal (not coke) / anthracite, kt*

- ❖ **DOMESTIC SUPPLY:** 30 237 kt, including:
  - Production – 19 747
  - Import – 12 000
  
- ❖ **CONVERSION:** 24 988 kt, including:
  - Thermal power plants – 21 990
  - CHP plants – 2 048
  - Boiler plants – 692 (*1400 MW, recalculation*)
  - Production of coke and briquettes – 258
  
- ❖ **OWN CONSUMPTION BY ENERGY SECTOR:** 237 kt, including:
  - Thermal power plants, CHP plants, boiler plants – 234
  
- ❖ **FINAL CONSUMPTION:** 5 008 kt, including:
  - Industry – 3 485

Source: State Statistics Service of Ukraine <http://www.ukrstat.gov.ua/>

# Coal thermal power plants (TPPs) of Ukraine

Name of power plant <sup>1)</sup> (name of energy producing Company)	Installed capacity (number of units), MW <sub>el</sub>	Fuel <sup>2)</sup>	Commissioning <sup>3)</sup>
Burshtynska TPP (Zakhidenergo)	2400 (12×200; 2 boilers)	coal (main fuel), gas, heavy oil	1969
Dobrotvirska TPP (Zakhidenergo)	500 (2×150 + 2×100; 8 boilers)	coal (main fuel), gas, heavy oil	1955
Ladyzhynska TPP (Zakhidenergo)	1800 (6×300; 6 boilers)	coal	1970
Trypilska TPP (Tsentrenergo)	4 блоки	coal	
Zmiivska TPP (Tsentrenergo)	2200 (6×175 + 3×275 + 1×325; 2 boilers)	вугілля	1960
Vuglegirska TPP (Tsentrenergo)	3600 (1200 <sup>4)</sup> (4×300 + 3×800; 7 boilers)	coal (main fuel), gas, heavy oil	1972
Kryvorizka TPP (Dniproenergo)	2820 (10×282; 10 boilers)	coal (main fuel), gas, heavy oil	1965
Prydniprovska TPP (Dniproenergo)	10 блоків	coal	
Zaporizka TPP (Dniproenergo)	3650 (1250 <sup>4)</sup> (2×300 + 2×325 + 3×800; 7 boilers)	coal (main fuel), gas, heavy oil	1973
Kurakhivska TPP (Skhidenergo)	1680 (1×200 + 6×210 + 1×220; several boilers)	coal	1941
Luganska TPP (Skhidenergo)	1450 (5×200 + 2×175 + 1×100; 7 boilers)	coal	1956
Slovianska TPP (Donbasenergo)	800 (1×80 + 1×720, 3 boilers)	coal	1954

1) Excluding TPPs on Donetsk region territory not controlled by Ukraine. 2) Pulverized coal combustion.

3) Later on, some additional equipment was installed; some modifications and replacement of equipment were done.

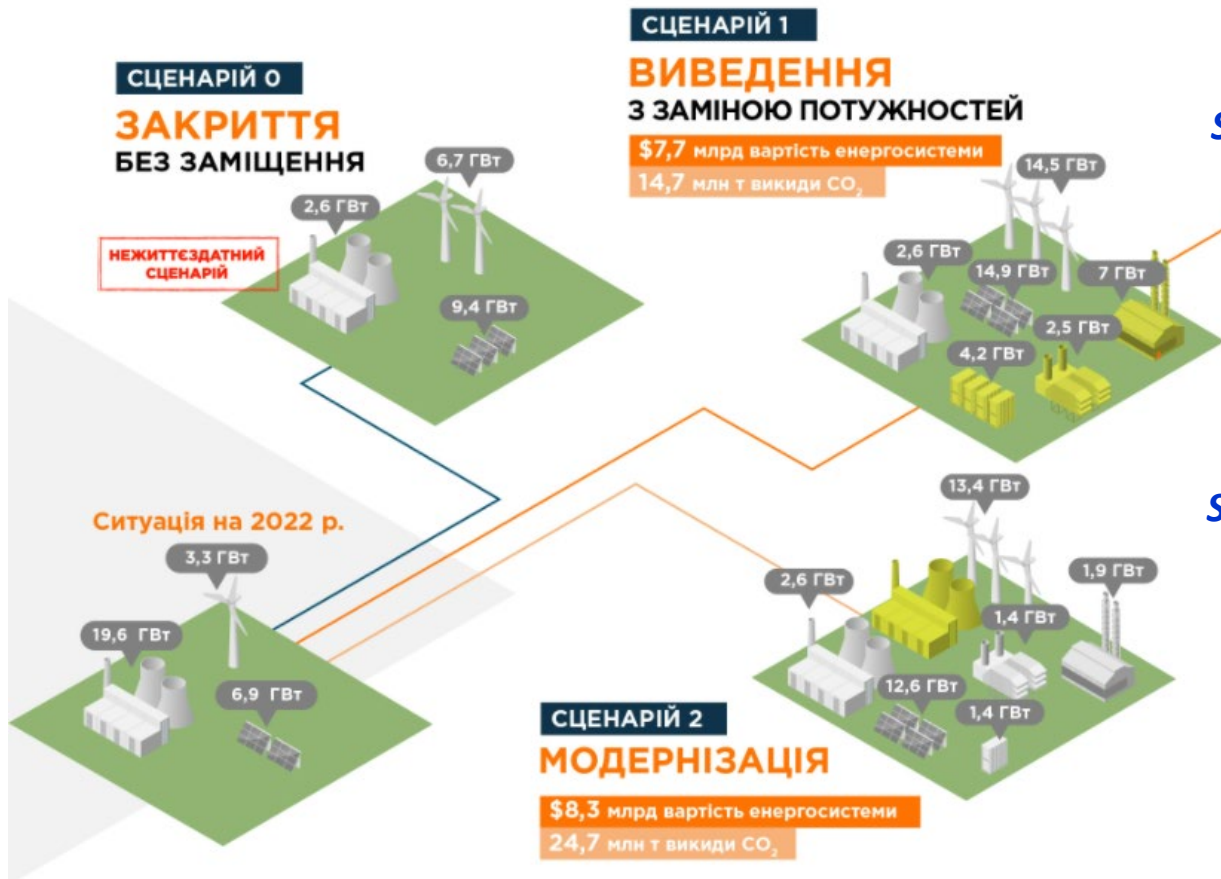
4) Operational capacity as several units are not in operation.

# Future scenarios for Ukraine's coal TPPs

## СЦЕНАРІЇ ДЛЯ ВУГІЛЬНОЇ ГЕНЕРАЦІЇ В УКРАЇНІ 2022-2031



Modelling with PLEXOS



**Scenario 1.** Removing of service with replacement of facility:  
85% – non-coal generation,  
39% – RES

**Scenario 2.** Ecological modernization:  
83% – non-coal generation,  
36% – RES

REPLACEMENT OF COAL TPPs WITH NEW FACILITIES IS MORE BENEFICIAL THAN THE MODERNIZATION

ЗАМІНА ВУГІЛЬНИХ СТАНЦІЙ НОВИМИ ПОТУЖНОСТЯМИ ВИГІДНІША ЗА МОДЕРНІЗАЦІЮ

<https://kosatka.media/uk/category/ugol/news/zakrytie-ugolnyh-tes-v-ukraїni-tri-scenariya-ot-eksperta> (06.2021)

# Coal CHP plants (CHPPs) of Ukraine



Name	Installed capacity, MW <sub>el</sub>	Fuel*	Commissioning**
Darnytska CHPP	160 (5 boilers, 3 turbines)	coal (main fuel), gas	1954
Myronivska CHPP	275 (5 boilers, 2 turbines)	coal	1956
Sumska CHPP	40 (6 boilers, 3 turbines)	coal (main fuel), gas, heavy oil	1957
Kramatorska CHPP	150 (several boilers and turbines)	coal, gas	1977
Kharkivska CHPP-2	150 (4 boilers, 3 turbines)	coal, gas	1957
Cherkaska CHPP	200 (14 boilers, 5 turbines)	coal, gas	1969
Chernigivska CHPP	210 (7 boilers, 1 turbine)	coal, gas	1974
Kaluska CHPP	200 (4 boilers, 4 turbines)	coal, gas	1968
Shostkinska CHPP	62 (6 boilers, 4 turbines)	coal	1962

\* Pulverized coal combustion.

\*\* Later on, some modifications and replacement of equipment were done.

# Gas CHP plants of Ukraine

Name*	Installed capacity, MW <sub>el</sub>	Fuel	Commissioning
Lvivska CHPP-1	41.3 (several boilers and turbines)	gas (main fuel), heavy oil	1954
Dniprovska CHPP	61.6 (10 boilers, 4 turbines)	gas	1940
Kharkivska CHPP-3	62 (several boilers and turbines)	gas	1970
Kharkivska CHPP-4	56 (9 boilers)	gas	1931
Kharkivska CHPP-5	470 (7 boilers, 3 turbines)	gas (main fuel), heavy oil	1990
Bilotserkivska CHPP	120 (3 boilers, 2 turbines)	heavy oil (main fuel), gas	1970
Kremenchutska CHPP	255 (6 boilers, 4 turbines)	gas (main fuel), heavy oil	1969
Kyivska CHPP-5	700 (9 boilers, 4 turbines)	gas	1976
Kyivska CHPP-6	500 (8 boilers, 2 turbines)	gas	1984
Mykolaivska CHPP	40 (7 boilers, 3 turbines)	gas (main fuel), heavy oil	1958
Novorozdilska CHPP	44 (8 boilers, 4 turbines)	gas, heavy oil	no data
Novoyavorivska CHPP	42.7 (3 turbines)	gas	2008
Odeska CHPP	68 (13 boilers, 4 turbines)	gas (main fuel), heavy oil	1984
Khersonska CHPP	80 (9 boilers, 5 turbines)	gas (main fuel), heavy oil	1967
Zuivska experimental CHPP	18 (3 boilers, turbines)	gas	1932
Okhtyrska CHPP	12.75 (6 boilers, 3 turbines)	gas, heavy oil	1960
Severodonetska CHPP	260 (7 boilers, 2 turbines)	gas	1977
Kirovogradska CHPP	15 (2 boilers, 1 turbine)	gas (it is planned to switch to coal)	1930

\* Without CHP plants in Crimea. Data on another ~4 CHP plants are not available.

# Assessment of bioenergy potential of Ukraine in 2019

Type of biomass	Theoretical potential, Mt	Potential available for energy (economic potential)	
		Share of the theoretical potential, %	Mtoe
Straw of grain crops	37.5	30	3.84
Rapeseed straw	5.9	40	0.81
By-products of grain maize production (stalks, cobs)	46.6	40	3.57
By-products of sunflower production (stalks, heads)	29.0	40	1.66
Secondary agricultural residues (sunflower husk)	2.6	100	1.08
Wood biomass (fuel wood, felling residues, wood processing waste)	7.4	95	1.73
Wood biomass (deadwood, wood from shelterbelt forests, biomass from APPR*)	8.8	45	1.02
Biodiesel (from rapeseed)	-	-	0.46
Bioethanol (from maize and sugar beet)	-	-	0.79
Biogas from waste and by-products of the agro-industrial complex	2.8 млрд м <sup>3</sup> CH <sub>4</sub>	42	0.99
Landfill gas	0.6 млрд м <sup>3</sup> CH <sub>4</sub>	29	0.14
Sewage gas (industrial and municipal wastewater)	0.4 млрд м <sup>3</sup> CH <sub>4</sub>	28	0.09
Energy crops:			
- willow, poplar, miscanthus (on 1 mln ha of unused agricultural land)	11.5	100	4.88
- maize for biogas (on 1 mln ha of unused agricultural land)	3.0 млрд м <sup>3</sup> CH <sub>4</sub>	100	2.57
<b>TOTAL</b>	-	-	<b>23.63</b>

46%

32%

\*APPR – agrarian plantations pruning and removal

# Estimation of bioenergy potential of Ukraine in 2050 (forecast)

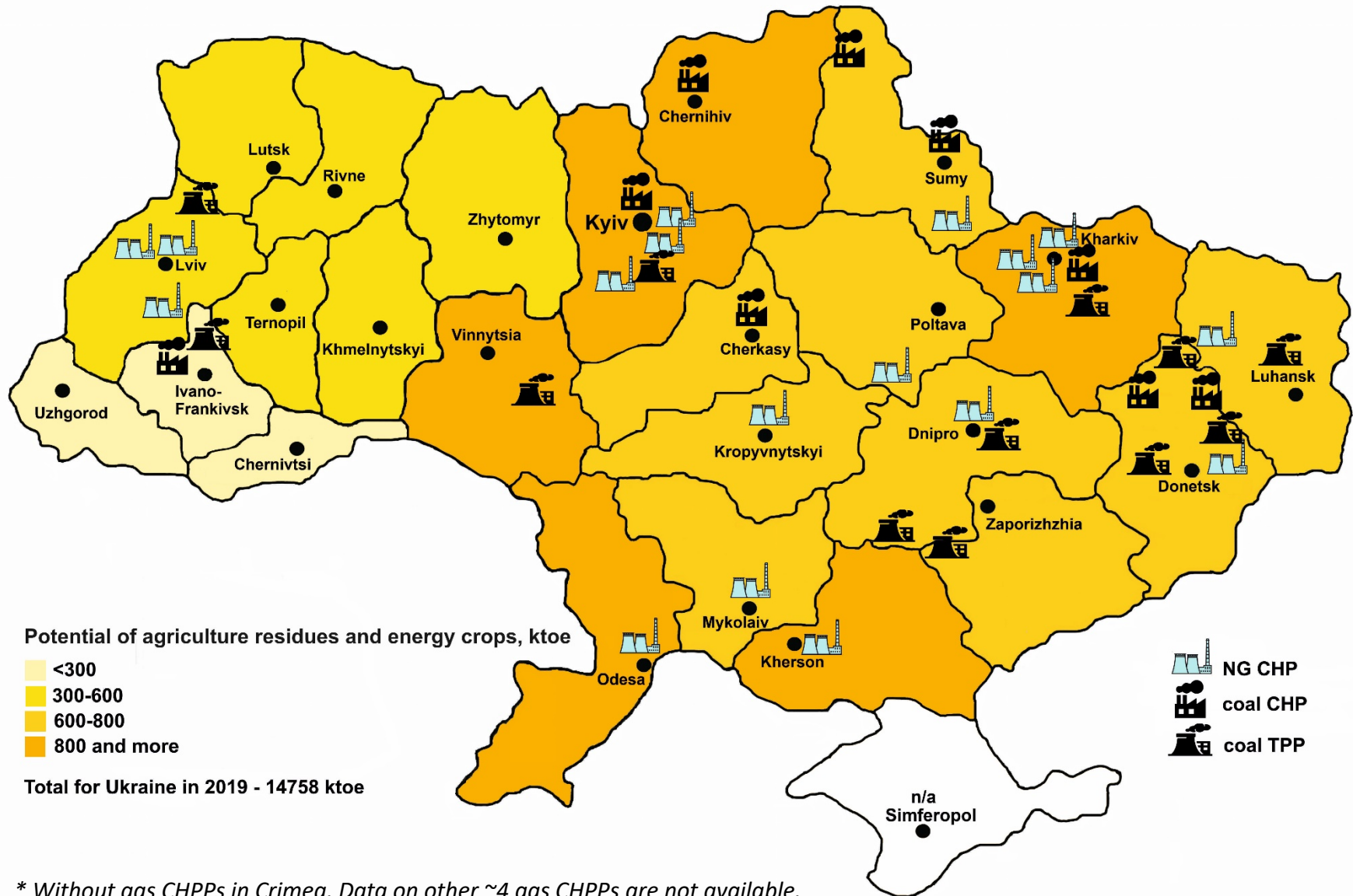
Type of biomass	Theoretical potential, Mt	Potential available for energy (economic potential)	
		Share of the theoretical potential, %	Mtoe
Straw of grain crops*	49,2	30	5,04
Rapeseed straw	5,9	40	0,81
By-products of grain maize production (stalks, cobs)*	58,1	40	4,45
By-products of sunflower production (stalks, heads)	29,0	40	1,66
Secondary agricultural residues (sunflower husk)	2,6	100	1,08
Wood biomass (fuel wood, felling residues, wood processing waste)*	12,3	96	2,88
Wood biomass (deadwood, wood from shelterbelt forests, biomass from APPR)	8,8	45	1,02
Biodiesel (I and II generation)*	-	-	1,10
Bioethanol (I and II generation)*	-	-	2,33
Biogas from waste and by-products of the agro-industrial complex	8,4 млрд м <sup>3</sup> CH <sub>4</sub>	83	5,92
Biogas from MSW*	0,7 млрд м <sup>3</sup> CH <sub>4</sub>	70	0,42
Sewage gas (industrial and municipal wastewater)*	0,4 млрд м <sup>3</sup> CH <sub>4</sub>	31	0,11
Energy crops*:			
- willow, poplar, miscanthus (on 2 mln ha of unused agricultural land)	34,5	100	14,65
- maize for biogas (on 2 mln ha of unused agricultural land)	7,5 млрд м <sup>3</sup> CH <sub>4</sub>	100	6,43
<b>TOTAL</b>	-	-	<b>47,90</b>

27%

44%

\* Components of the biomass potential, the growth of which is expected by 2050. Other components are left at their level estimated for 2018 according to the conservative approach.

# Potential of agrobiomass. Location of coal and gas CHP plants, coal TPPs in Ukraine's regions



\* Without gas CHPPs in Crimea. Data on other ~4 gas CHPPs are not available.



# Biomass CHP plants and TPPs in Ukraine

No	Name (year of commissioning)	Location	Fuel	Capacity, MW <sub>el</sub>
1	JSC «Kropyvnytsky OEP», <b>CHPP</b>	Kropyvnytsky city, Kirovograd region	sunflower husk	12.3 (33 MW <sub>th</sub> )
2	“Smilaenergopromtrans” Ltd, <b>CHPP (2010)</b>	<b>Smila town, Cherkasy region</b>	<b>wood chips</b>	<b>8.5 (10 MW<sub>th</sub>)</b>
3	“Combinat Cargill” Ltd, <b>CHPP</b>	Donetsk city	sunflower husk	2.0 (15 MW <sub>th</sub> )
4	«Biogasenergo» Ltd, <b>TPP (2013)</b>	Ivankiv urban village, Kyiv region	wood chips	19.0
5	“APK Evgroil” Ltd, <b>CHPP</b>	Mykolaiv city	sunflower husk	5.0 (10 MW <sub>th</sub> )
6	“Clear Energy” Ltd, Koriukivska <b>TPP (2016)</b>	Koriukivka town, Chernigiv region	wood chips	4.0
7	“Singa Energies” Ltd, <b>CHPP</b>	Berezanka town, Mykolaiv region	wood chips	5.1
8	PE Peresadko R.V., <b>PP</b>	Korolivka village, Ivano-Frankivsk region	wood chips	0.1
9	“Yugenergopromtrans” Ltd, <b>TPP (2018)</b>	Pereyaslav-Khmelnysky town, Kyiv region	wood chips	5.0
10	“Mebel-service” Ltd, <b>CHPP</b>	Polove village, Lviv region	wood chips	2.4
11	“Bio-TPP” Ltd, <b>TPP (2020)</b>	Rakniv town, Zakarpatska region	wood chips	6.0
12	Communal enterprise “Miskteplovodenergy”, <b>CHPP</b>	Kamianets-Podilsky town, Khmelnytsky region	wood chips	1.8
13	«Aiaks Dnipro» Ltd, 1st unit, <b>TPP (2020)</b>	Dnipro city	sunflower husk	16.0
14	“AGL Energy” Ltd, <b>TPP (2020)</b>	Nova Vodolaga urban village, Kharkiv region	sunflower husk	7.0
15	“Poliska <b>TPP</b> ” Ltd (2021)	Ovruch town, Zhytomyr region	wood chips	5.9
16	PE Stelmaschuk V.D., <b>mini-PP</b>	Delatyn urban village, Ivano-Frankivsk region	wood chips	0.1
17	«PGS-Energy» Ltd, <b>TPP (2020)</b>	Zaporizhzhia city	sunflower husk	2.7
18	«Bio Electrics» Ltd, <b>TPP (2020)</b>	Clubivka village, Khmelnytsky region	wood chips, sunflower husk pellets, maize stalk chips	6.0
19	JSC “Poez-Kernel Group”, <b>TPP (2021)</b>	Poltava city	sunflower husk	10.4

*PP – power plant; PE – private entrepreneur*

Sources: NERC, UABIO

# Smila CHP plant – an example of biomass retrofit

- Location: Smila town, Cherkasy region
- Installed capacity: 8.5 MW<sub>el</sub>
- Commissioning for operation on biomass: March 2010
- Current fuel: **wood chips**
- Former fuels: coal (1953), natural gas (1995)
- Feed-in tariff: since June 2010



Sources: [https://www.energo.ua/ua/assets/smilyanska\\_chp#](https://www.energo.ua/ua/assets/smilyanska_chp#)  
<http://septrans.com.ua/index.php/uk/pro-nas/istoriia>

# Conclusions

- ❖ Ukraine has significant potential of biomass for energy and good preconditions for bioenergy development.
- ❖ It is expedient to study the possibility of re-equipment of coal-fired boilers, individual units of coal-fired CHPPs / TPPs, and gas-fired boilers for biomass operation.
- ❖ It is necessary to overcome a number of legal barriers to accelerate the development of bioenergy in Ukraine.

# Invitation to the upcoming events of the AgroBioHeat project: 2<sup>nd</sup> virtual matchmaking event «Bringing VALUE to AGROBIOMASS»

On **November 3-4, 2021**, the 2<sup>nd</sup> virtual event on establishing business contacts will take place.

<https://bringing-value-to-agrobiomass-2.b2match.io/>

Virtual matchmaking event

**Bringing VALUE to AGROBIOMASS**

November, 3 - 4 · 2021

2<sup>nd</sup> edition

Participation is FREE

AgroBioHeat

This project has received funding from the European Union's Horizon H2020 research and innovation programme under Grant Agreement No. 818369

➔ **Additionally:**  
On **October, 27, 2021**, an international webinar will be held to present successful examples of the use of agrobiomass for heat, energy and the wider bioeconomy

***The aim of the event is to connect relevant stakeholders to facilitate new collaboration on sustainable utilization of biomass from agriculture and side streams from food production.***

***Participation is FREE***

**Thank you for your attention!**

**Georgii Geletukha, Doctor of Science**

Head of Board, Bioenergy Association of Ukraine

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