Analysis of waste heat and geothermal heat potentials for district heating in Ukraine

Volodymyr Kramar, Oleksandra Tryboi

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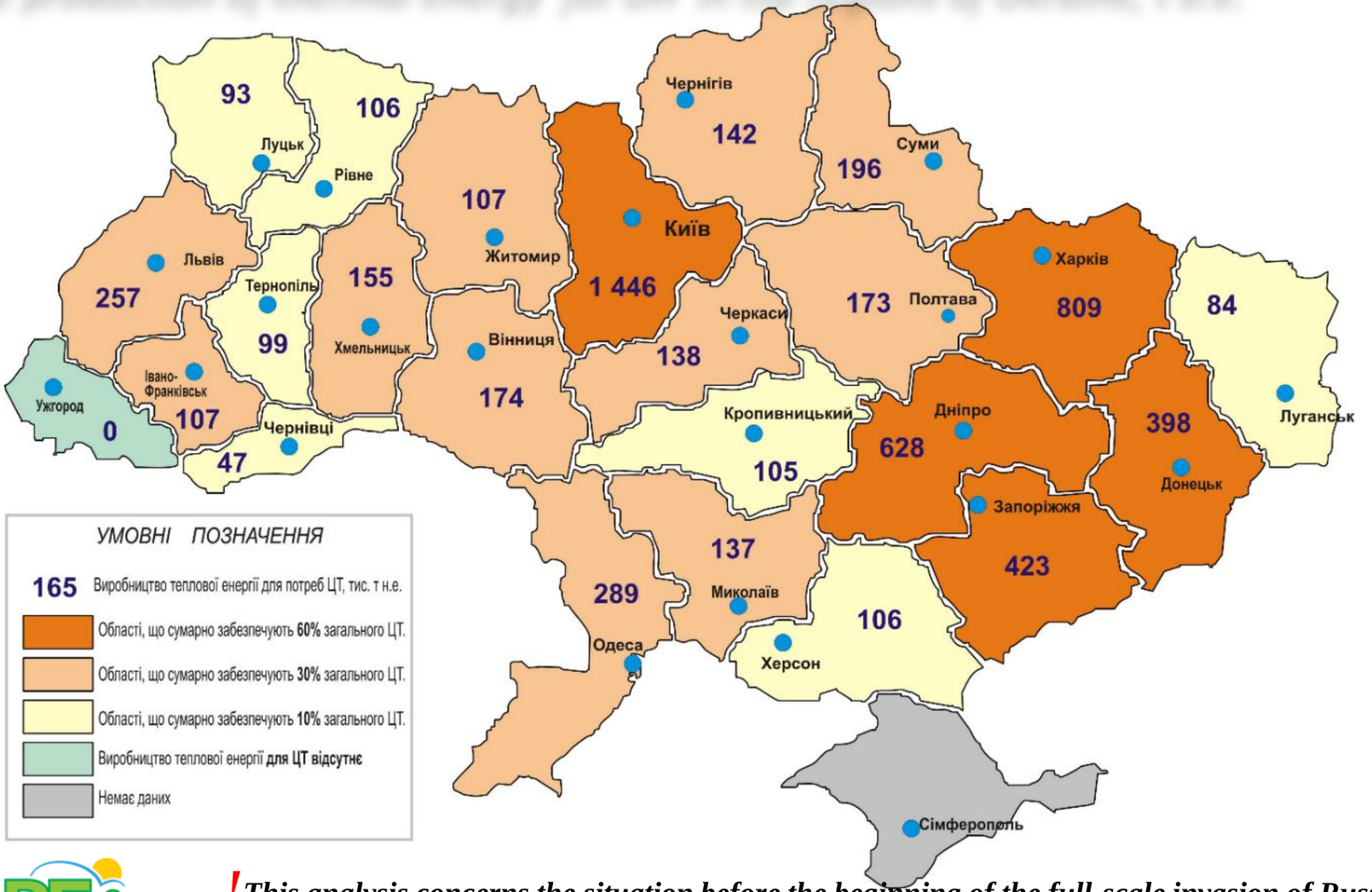
Current state and volumes of DH in Ukraine

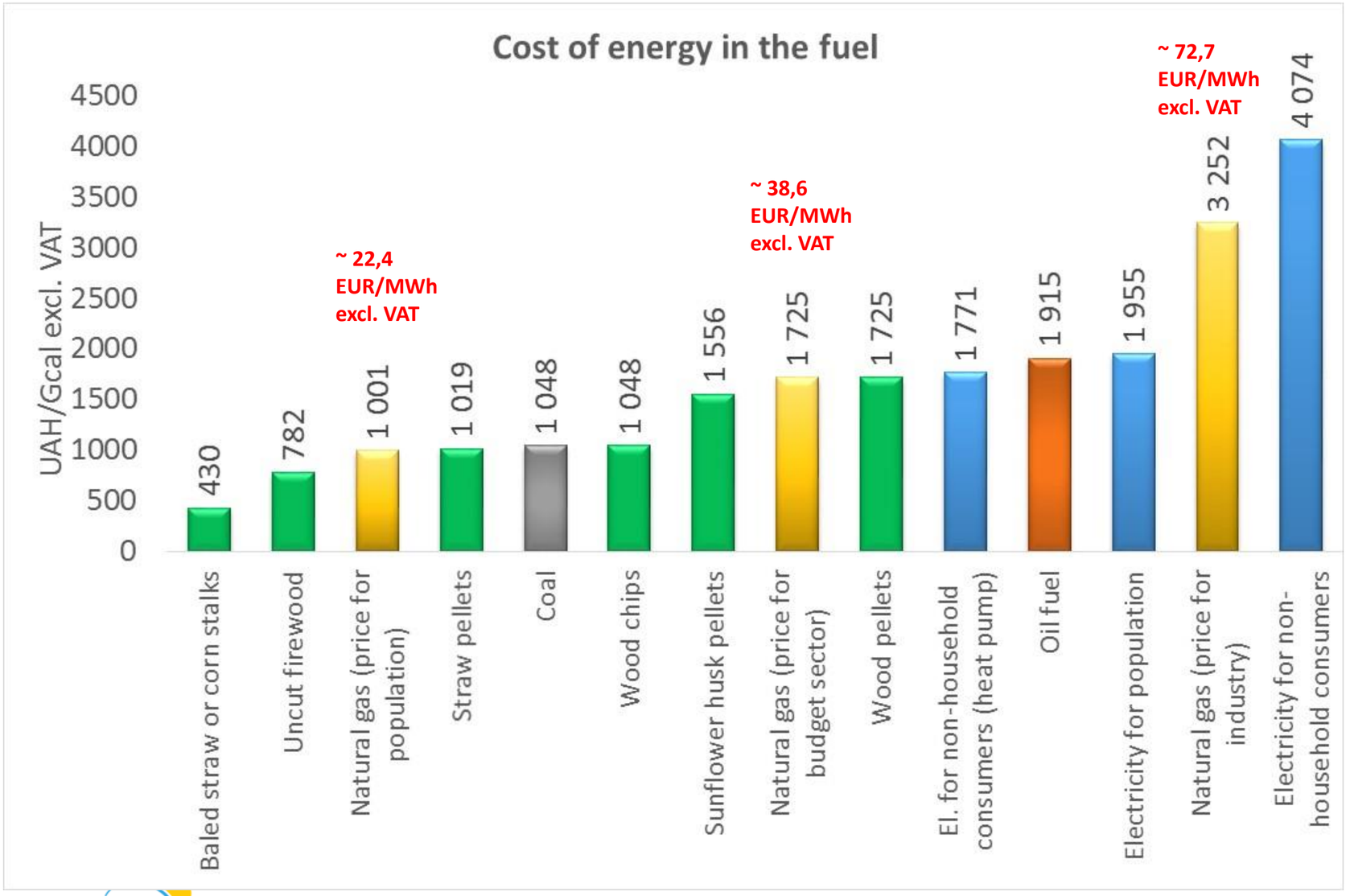
The production of thermal energy for DH in the regions of Ukraine, t o.e.



- *DH in Ukraine covers about 35-40% (according to some estimates - up to 50%) of the population;*
- *According to our estimate, the thermal energy production for DH is about 6.2 million t o.e.;*
- *There are 5 regions that provide about 60% of total DH energy in Ukraine: Kyiv, Kharkiv, Dnipro, Donetsk and Zaporizhzhia regions;*
- *In these same regions, there is the largest concentration of industrial enterprises, which can potentially be sources of waste heat for DH*

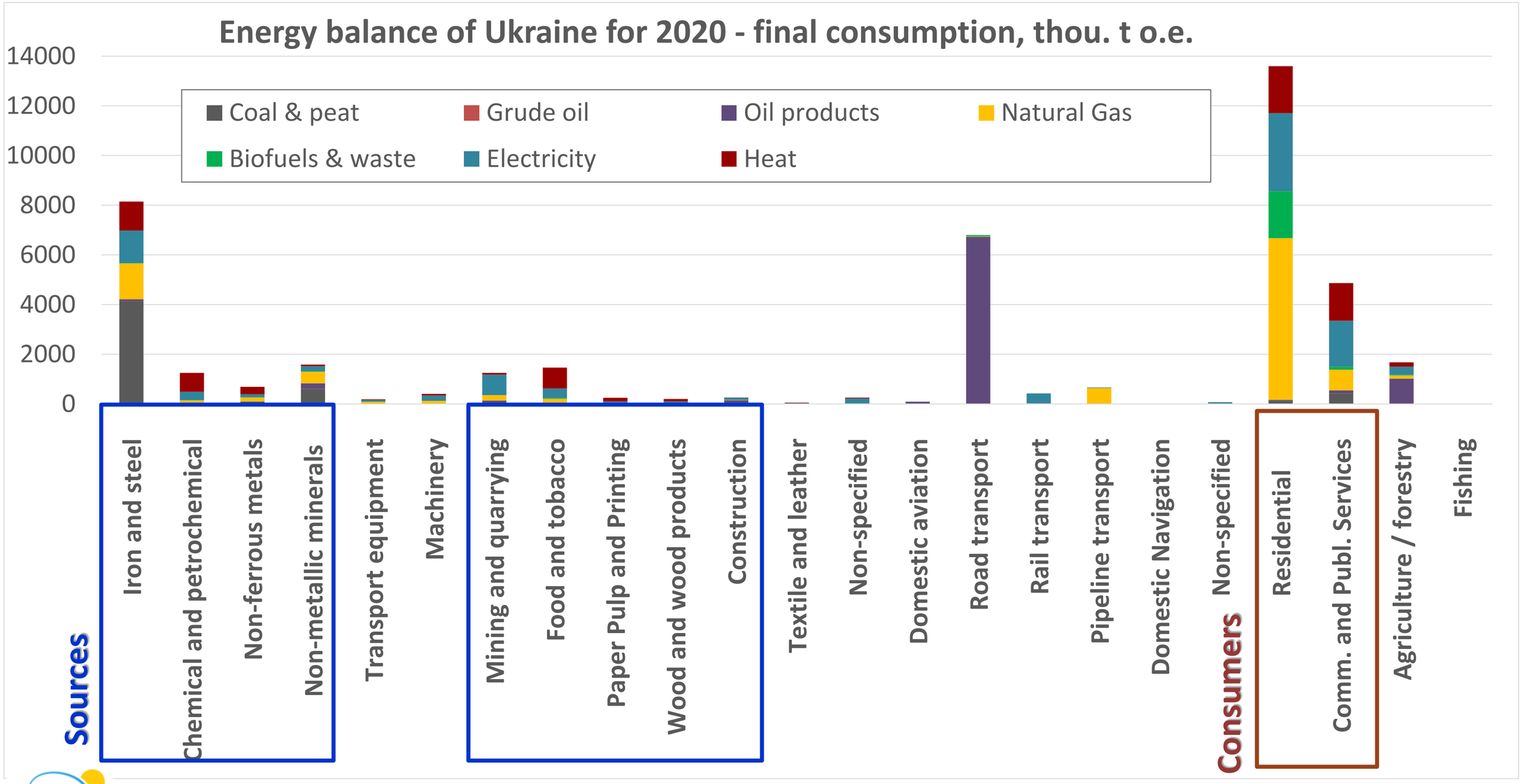
***!** This analysis concerns the situation before the beginning of the full-scale invasion of Russia in Ukraine on February 24, 2022. It also does not include the territory of the Republic of Crimea, parts of the Donetsk and Luhansk regions occupied by the Russia in 2014.*

Energy price competition for new solutions in DH



- ***About 80% of the DH service volumes are supplied for the population;***
- ***Heat tariffs for the population are based on subsidized prices of natural gas (the primary fuel in DH);***
- ***Even most types of biofuel cannot compete with the heat tariff for population, which is based on the subsidized price of natural gas;***
- ***Any new projects, including the use of waste and geothermal heat, will be compared to the current price situation in DH, which is 80% shaped by subsidized natural gas prices.***

Potential sources of waste heat in industry



Potential sources of waste heat in industry

INDUSTRY	Output of waste heat	Possible utilisation of waste heat
	(thousand Gcal, estimated in 2010)	
Ferrous metallurgy, including coke plants	11,700	5,500–6,150
Non-ferrous metallurgy	170	81–85
Fuel industry without coke plants	470	330–360
Chemical and petrochemical industry	5,700	3,900–4,400
Construction materials industry	840	670–740
Metalworking and mechanical engineering	420	200–230
Other industries	875	420–460
In total	20,175	11,100–12,425
Possible primary fuel saving – 1.3-1.44 million t o.e.		

- *Ferrous metallurgy has the greatest potential of waste heat- about 58% of the total estimated in the industry of Ukraine,*
- *chemical and petrochemical industry- 28% of total waste heat,*
- *the building materials industry (4%),*
- *the fuel industry without coke plants, and metalworking + mechanical engineering (2% of the total potential each),*
- *non-ferrous metallurgy (up to 1% of the potential)*
- *the rest of the industries - about 4-5% of the total potential*

Geographical localization of industrial waste heat sources

Cities with the biggest number of large industrial enterprises

CITY	Number of enterprises
Zaporizhzhia	21
Kyiv	18
Kharkiv	17
Dnipro	16
Odesa	13
Lutsk	11
Zhytomyr	10
Lviv	9
Kramatorsk, Kremenchuk	7
Bila Tserkva, Kamianske, Poltava, Kherson	6
Kryvyi Rih, Kropyvnytskyi, Melitopol, Nikopol, Cherkasy	5
Vinnytsia, Haysyn, Sumy, Chernivtsi	4

- *It should be noted that currently there is no assessment of the potential of secondary heat resources for each industrial enterprise in open information sources. Obviously, such estimates can be obtained as a result of an energy audit of the enterprise, which will take into account the current level of use of secondary energy resources by the enterprises themselves.*

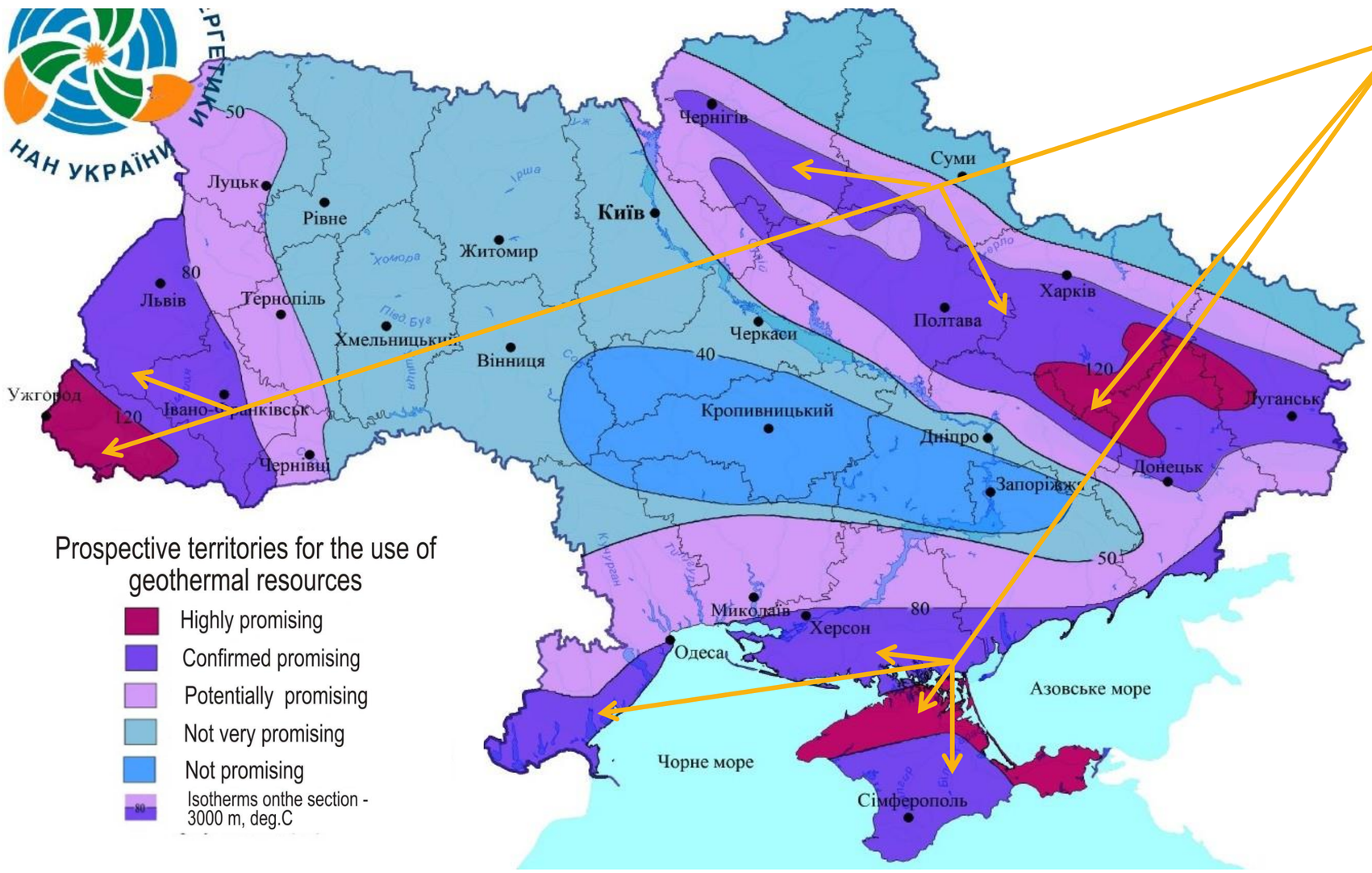
- *Regarding the implemented examples for use of industrial waste heat for DH, only two are currently known:*

1) ***the supply of hot water from the industrial site of Zaporizhstal Metallurgical Plant to consumers in some areas in the city of Zaporizhzhia, although the specific source of waste heat is not mentioned.***

2) ***use of coke gas at the "Avdiivka Coke Chemical Plant" CHP, including for providing hot water to the plant and the city of Avdiivka.***

A study of the location of more than 500 enterprises of various industries in relation to possible consumers of heat for DH showed that enterprises with the greatest assessed potential, are not too close to potential consumers. It should also be taken into account that these enterprises are located, as a rule, in industrial zones of cities, where there are other enterprises, railways and other objects that will have to be passed by to lay DH networks to consumers. The length of such networks in the vast majority of cases will exceed 1 km.

Overview of geothermal energy potential in Ukraine



- ***The most promising areas of geothermal sources are in the east of Ukraine (bordering the Poltava, Kharkiv, Donetsk, Luhansk and Dnipropetrovsk regions), as well as the Prykarpattia and Zakarpattia regions, the areas near Crimean peninsula;***

- ***The temperature range of geothermal resources in the most promising regions is from 65 to 130 °C, which makes it applicable for DH at least part of the heating period.***

Overview of geothermal energy potential in Ukraine

Thermal potential of existing geothermal wells of Ukraine when used in geothermal heat supply and DHW systems (temperature of thermal water - 60–70 ˚C)

№	Region	Number of wells	Potential heat production	
			MWh/a	Million m^3 of nat. gas equivalent
1	Dniro	2	14,710	1.6
2	Zakarpattia	4	25,000	2.7
3	Ivano-Frankivsk	4	29,500	3.2
4	Lviv	10	73,550	7.9
5	Poltava	4	29,500	3.2
7	Kharkiv	5	34,500	3.7
8	Kherson	5	34,500	3.7
	Total	34	240,760	26.0

- ***If to consider the total technically available potential of geothermal energy in the most promising areas: it is 15.8 thousand GWh per year, which is equivalent to replacing 2.2 billion m^3 of natural gas. But the specified amount is only 4% of the total geothermal potential of Ukraine.***
- ***In general, the assessments of the geothermal energy potential of different authors differ significantly, perhaps due to the different assessment methods.***

- ***Hydrothermal resources are the most widespread and currently suitable for technical use as a source of geothermal energy in Ukraine. Potential geothermal resources of thermal waters amount to 27.3 million m^3/day, and their thermal energy potential is about 84 million Gcal/year (8,4 million toe/year).***

Development and Prospects of geothermal energy for DH in Ukraine

- From 1978 to 2002, 9 geothermal energy facilities were built in Ukraine, including on the Crimean Peninsula (5), in Zakarpattia (3) and in the Kherson region (1). The total thermal capacity of these facilities was 11.2 MW, electric capacity was 0.17 MW. **As of 2020, only 2 of them were operating in Zakarpattia (0.25 MW each) and one of 1 MW in Crimea. Since 2002, no new installations have been put into operation, and in general geothermal energy has not developed**.

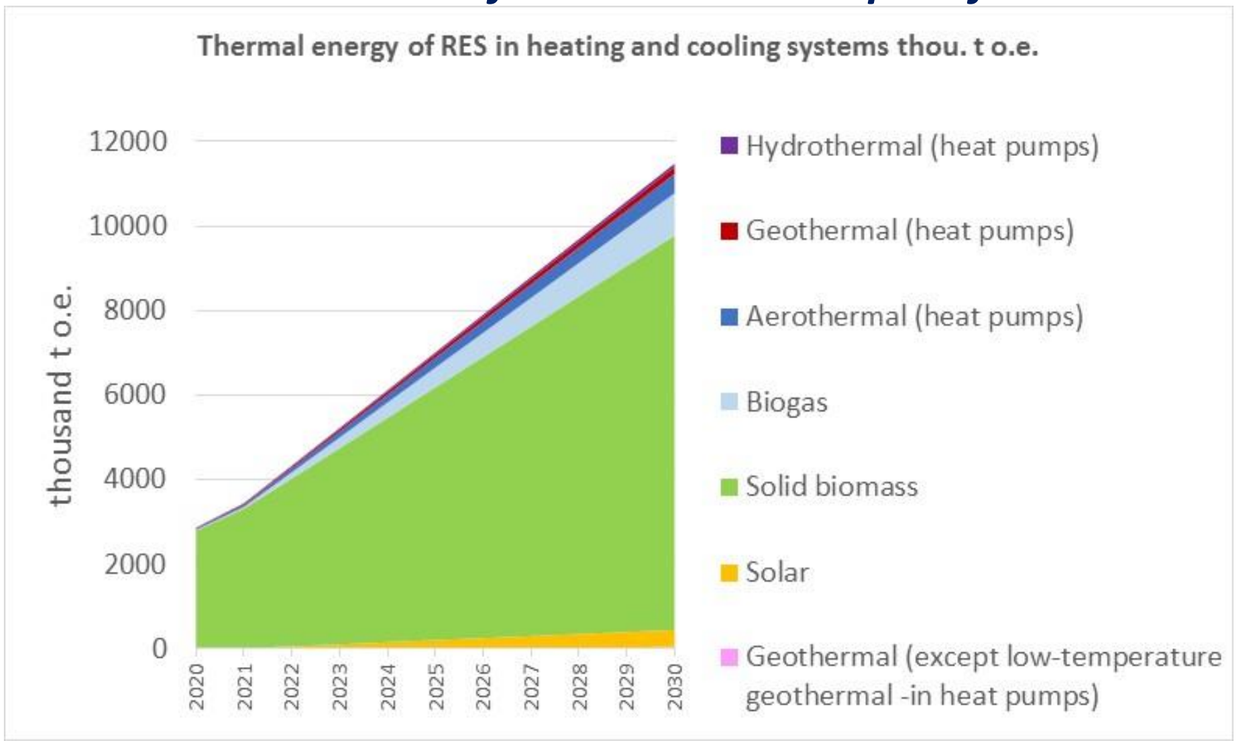
- More recent studies (2016) **identified 15 promising geothermal plants in 6 regions of Ukraine**, including 5 electric and cogeneration plants with a capacity of 5 to 14.2 MW, and 10 thermal ones of 1 to 11 MW thermal. That is, despite the considerable accumulated data on the geothermal resources of Ukraine, specialists have not identified so many promising objects. In any case, there are no developed big prospect of large-scale involvement of these resources in DH and appropriate replacement of any significant share of fossil fuels.

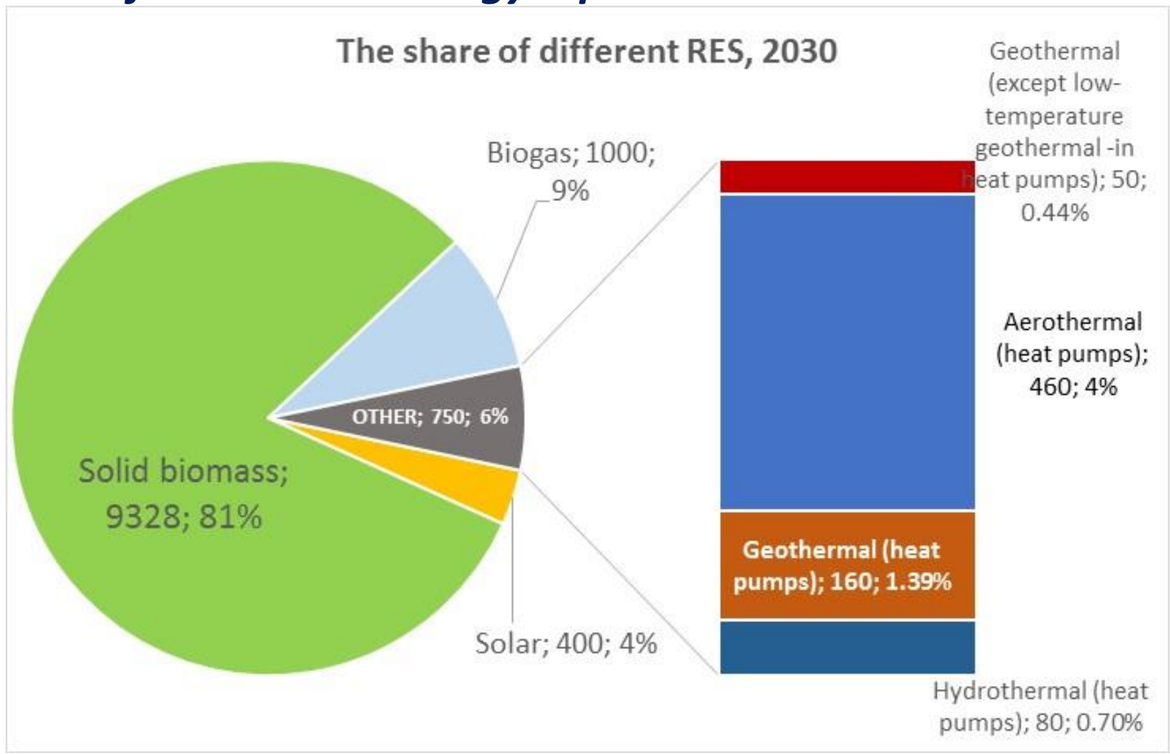
- The promising geothermal resources near such large cities in the west of Ukraine as Lviv, Ivano-Frankivsk, Chernivtsi, Uzhgorod, as well as smaller cities Mostyske and Berehove are noted in the one assessment. The potential heat capacities of geothermal energy for the cities of Uzhgorod (120.4 MW), Mostyske (27.3 MW) and Berehove (21.5 MW) are proposed. A negative circumstance that may affect such prospects is that the cities of Zakarpattia region, including Uzhgorod, practically abandoned DH, switching to autonomous and individual space heating.

- Some active projects are known in Ukraine, when wells with a depth of about 50 m are used for heating individual objects using the heat pumps.

Plans for the use of industrial waste heat and geothermal energy in the Energy strategies

Draft National action plan for the development of renewable energy up to 2030





- ***The planned total share of geothermal energy in the total RES for heating and cooling systems is about 2%, or 210 thousand t o.e. in 2030;***
- ***In addition, about 20 MW of electric power based on geothermal sources is forecast starting from 2025 (4 MW), which will allow the production of 100 GWh of electricity in 2030 (with the share 0,23% in electricity from RES)***

The most important conclusions

1. The experience of waste heat use at industrial enterprises of Ukraine is very little described in open sources.
2. Enterprises with a big possible waste heat potential are not close to potential consumers. They are located, as a rule, in industrial zones of cities, there may be many obstacles for laying of DH networks to consumers. The length of networks in most cases will exceed 1 km.
3. The largest concentration of enterprises with a big possible waste heat potential is observed in those cities and regions whith the largest DH supply (Kyiv, Zaporizhzhia, Kharkiv, Dnipro, Odesa). This generally promotes the use of industrial waste heat for DH.
4. It should be taken into account that any alternative solutions in centralized heating, when determining the feasibility of their implementation, will be compared with the base situation, with a reduced (subsidized) cost of energy for population in the heat tariff.
5. The specificity of geothermal energy projects, in contrast to most RES, consists in high risks and the duration of the first development period. The full implementation of such a project usually lasts from 5 to 10 years with significant investments without a guarantee of a positive result. This circumstance causes problems of attracting private capital. Therefore, for the successful development of geothermal energy projects, is important the participation of both the public and private sectors. Hope only for the commercial investments, even in the most economically developed countries, is rarely successful.

Thank you for your attention!

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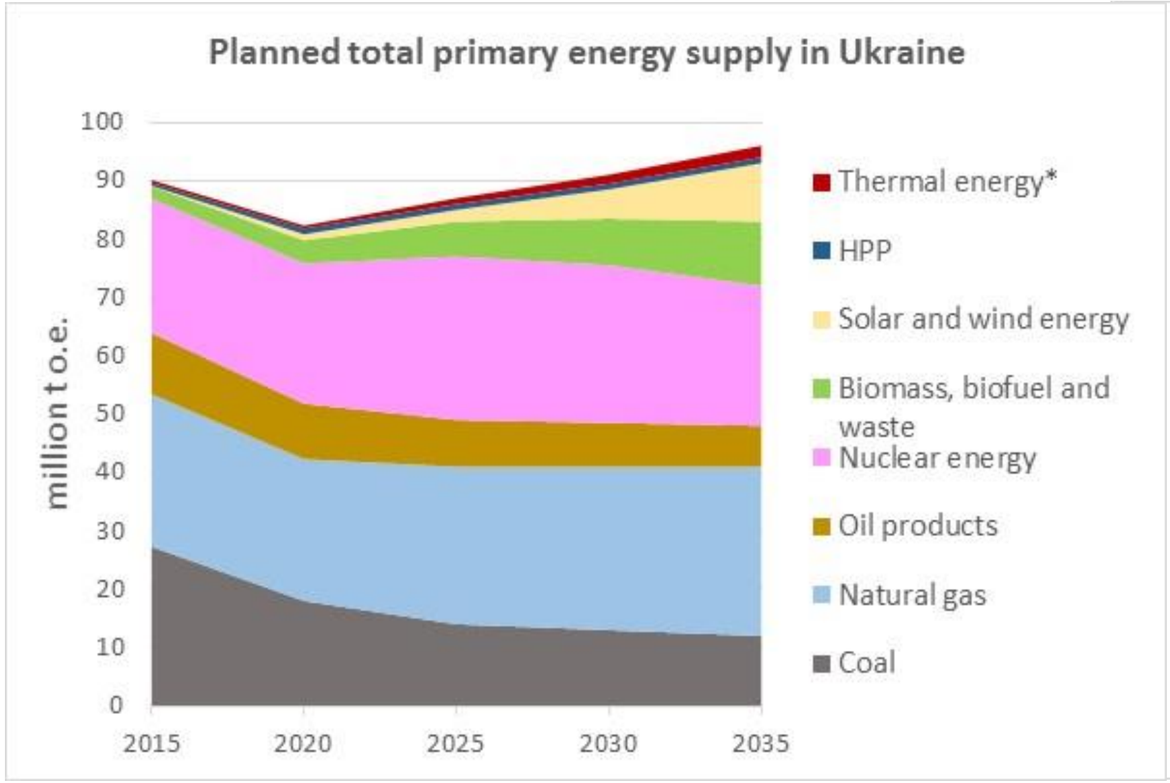
Geographical localization of industrial waste heat sources

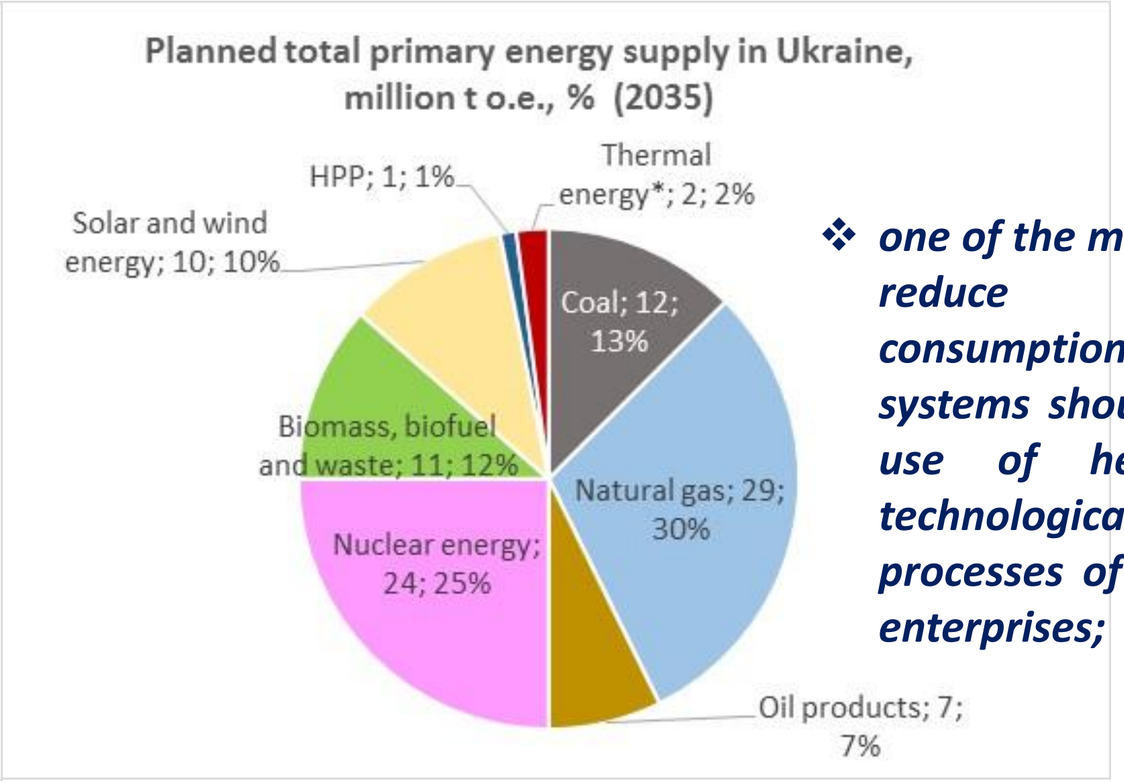
A study of the location of more than 500 enterprises of various industries in relation to possible consumers of heat for DH showed the following:

- ***Enterprises of the metallurgical industry***, although they are located mainly in medium and large cities of the southeast and east of Ukraine, where DH and dense urban development exist, are located relatively far (as a rule, more than 1 km in a straight line) from a multi-storey building, where DH networks may run.
- ***Enterprises of the chemical and petrochemical industry***, as well as cement factories (2-3 km) are even more distant from potential consumers (mainly, further than 2 km).
- A little closer (on average about 1.7 km) to potential heat consumers are ***brick factories***, and about 1 km - ***glass factories***, ***factories for the production of paper, plywood, MDF***.
- ***Food industry enterprises*** are relatively closer to potential consumers of waste heat, although the average distance for them is about 1 km. As a rule, bakeries and breweries, food factories (up to 1 km), oil industry enterprises (1 km) can be located closer to multi-storey buildings, and a little further away - milk processing plants, cheese and butter production, meat processing plants, tobacco factories (on average 1-1.5 km).
- Enterprises with the greatest assessed potential, are not too close to potential consumers. It should also be taken into account that these enterprises are located, as a rule, in industrial zones of cities, where there are other enterprises, railways and other objects that will have to be passed by to lay DH networks to consumers. **The length of such networks in the vast majority of cases will exceed 1 km.**

Plans for the use of industrial waste heat and geothermal energy in the Energy strategies

Energy Strategy of Ukraine (ESU) for the period up to 2035





- ***one of the measures to reduce energy consumption in DH systems should be the use of heat from technological processes of industrial enterprises;***

- ***the term "thermal energy" means "thermal energy of the environment and waste resources of man-made origin";***

- ***The planned share of thermal energy in the total primary energy supply is 2% in 2035***

Regional and municipal programs for RES development and energy efficiency improvement

- ***More than 40 different documents were reviewed. As a result, only a few measures were found that more or less relate to the considered issues:***
  - 1. The use of steam from cooling of the PT-50/60-130/7PR1 turbogenerator No. 2 of "Chernihivska CHP" LLC of the firm "TechNova", for heat supply of the city Chernihiv (2010-2015) .
  - 2. Zaporizhzhia boiler houses - installation of heat utilizers for PTVM-30 boilers (2010-2015). **IMPLEMENTED**
  - 3. “Heat supply of microdistricts No. 1, No. 2 and the quarter of dormitories from the Zaporizhzhya NPP. Central heating point". Zaporizhzhia region Energodar, str. Kurchatova, 1 (2010-2015).
  - 4. DHW supply of the Komunarsky district using waste heat from the **central sewage treatment plant** (Construction of a heat pump station) (2021-2030).
- ***Thus, only 1 planned measure (number 4) would imply a new project for the utilization of industrial waste heat and the supply of this heat for DH. This heat cannot be used directly, but by increasing its potential by heat pumps***
- ***No plans to implement geothermal energy projects were found (except a few based on ground heat pumps and not deep wells)***