Energy security and state support mechanisms to promote energy efficiency and renewable energy in Ukraine

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Part 1 Ukraine and Energy Security

What is energy security?

- aka Security of Supply (SoS) (International Energy Agency)
- “availability of a regular supply of energy at an affordable price” (IEA)
- affected by
  - ***Dependency*** ≈ how much an economy relies on sources of energy that are not under its control (e.g., energy imports)
  - ***Vulnerability*** ≈ likelihood of domestic disruption in case some external energy source is reduced or cut off

Threats to energy security

- Heavy dependence on energy imports
- Little diversification of energy imports (e.g., they all come from one or very few countries)
- Gross domestic product (GDP) is very energy-intensive
- High share of electricity generation based on imported fuel out of total electricity generation
- Little diversification of energy sources/fuels (e.g., all energy comes from oil, or natural gas)
- Highly concentrated electricity supply (one or few power plants serve the entire country)

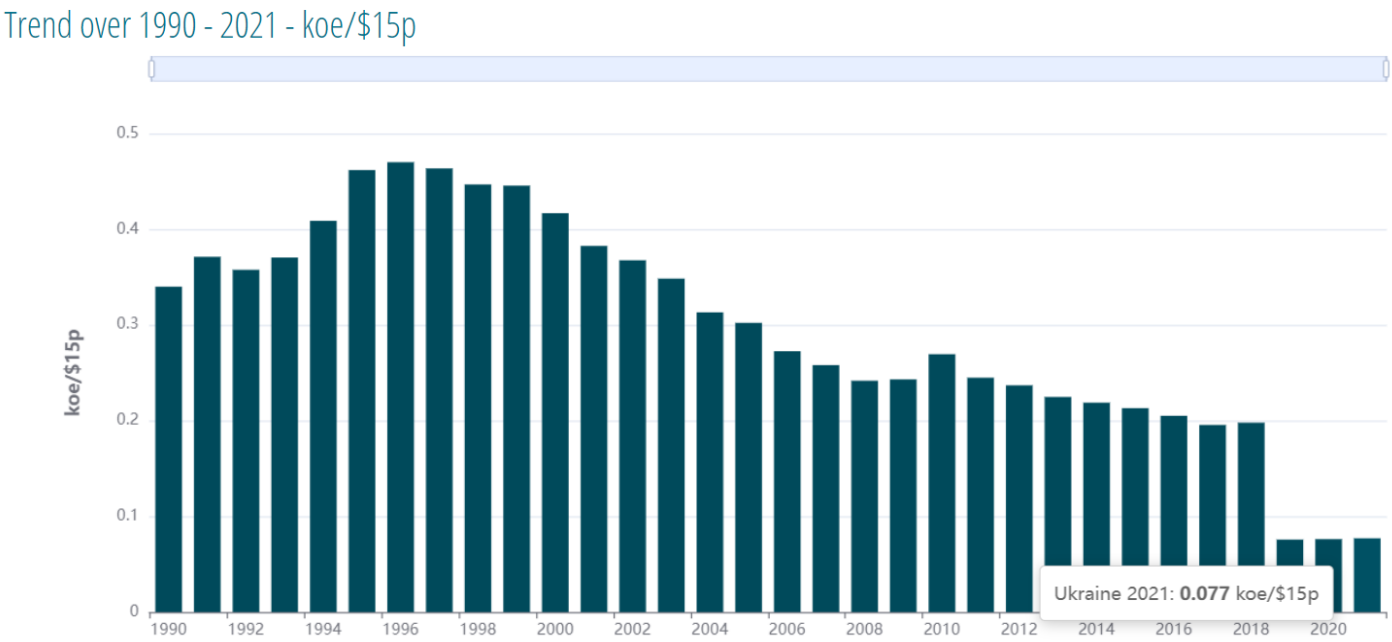
Pre-war Ukraine's profile — Quick facts

- population: **41.9** million
- the second-largest country in Europe by area: **603 549** km2
- Nominal GDP: $**200.09** billion (current US$); GDP per capita: USD **$4835.6** (current US$) in **2021**
- is one of the world's top agricultural producers and exporters: **46%** of sunflower oil and **54%** of sunflower meal global export (**#1** in the world); **9%** of wheat global export (**#5** in the world) in **2021-2022** marketing year
- has abundant mineral resources including oil, natural gas and coal, and great hydro and biomass potential
- transits the most natural gas in the world, playing a key role in delivering Russian gas to European markets

Pre-war Ukraine's Energy Profile —Quick Facts

- Ukraine depends on imports for…
  - …**83%** of its oil consumption
  - …**33%** of its natural gas consumption
  - …**50%** of its coal consumption
- and yet it is hydrocarbon-rich!
  - Main resources in the Carpathian region in the west, Dnieper-Donetsk region, and the Black Sea/Azov Sea.
  - Coal in the Donbass region (east), Lviv-Volyn region (extends into Poland) and Dnieper basin in central Ukraine.

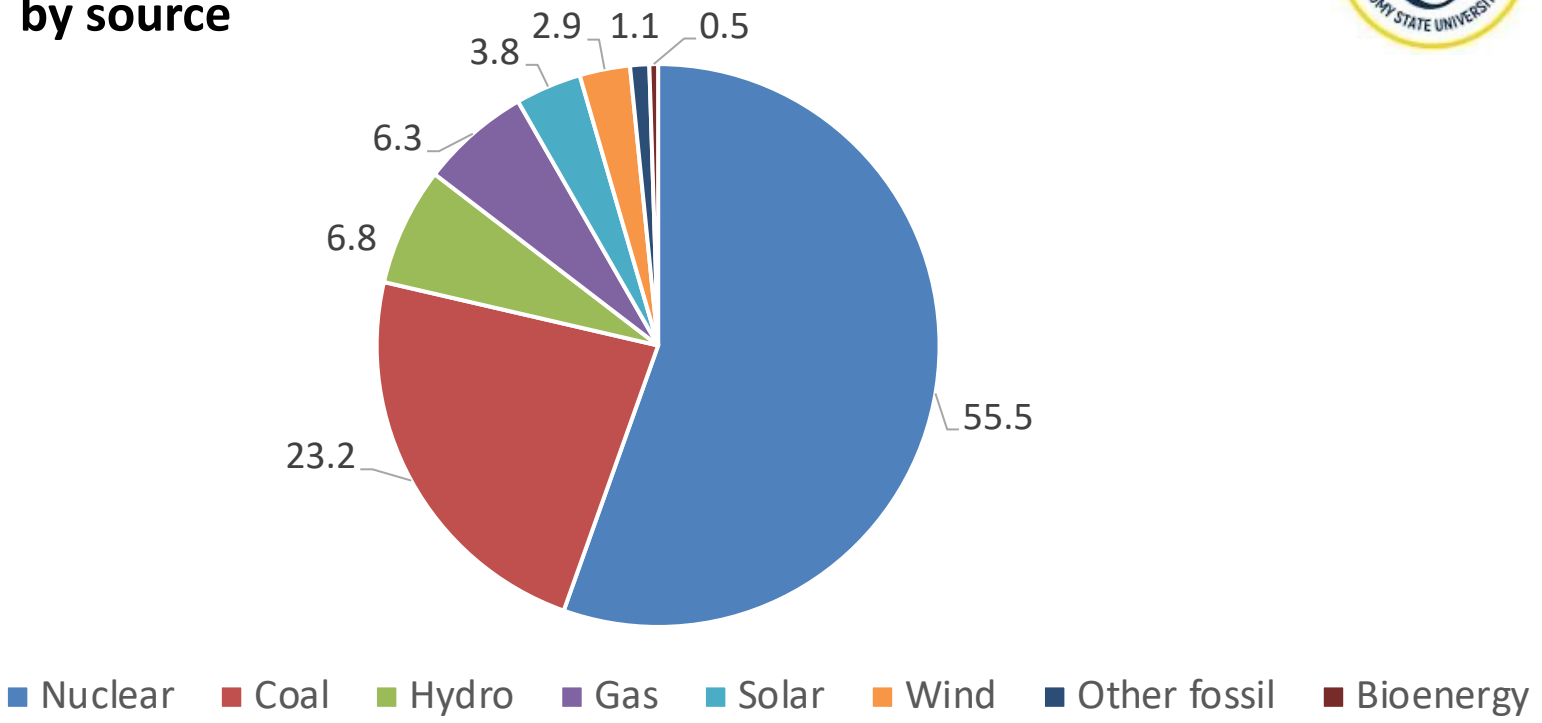
Energy intensity of Ukraine's GDP



Source: *https://yearbook.enerdata.net/; https://www.boell.de/*

Inefficient energy consumption for heating in Ukraine causes **EUR 2.7 billion** of losses annually (or **3% of the country's GDP**)

Distribution of electricity generation in Ukraine in 2021, by source



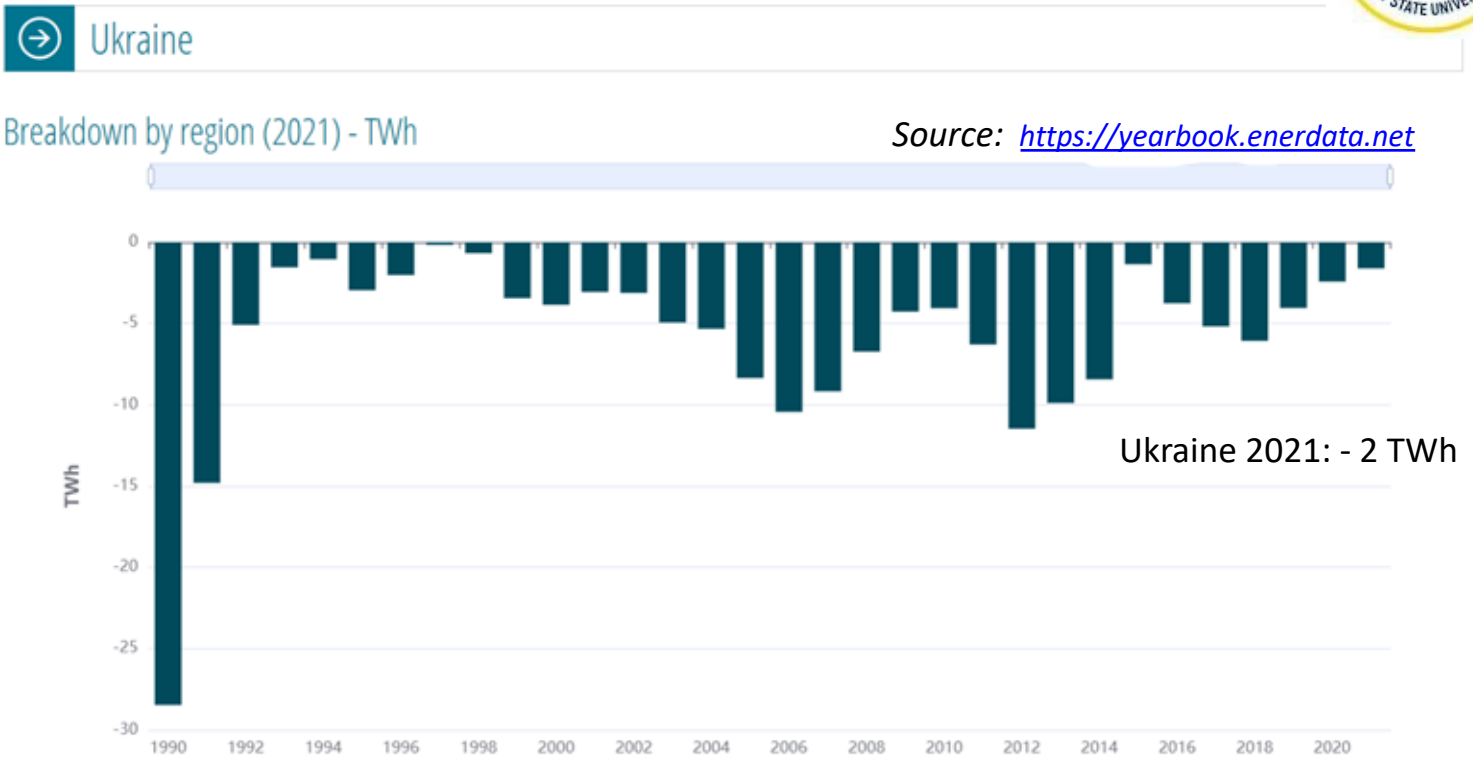
Source: www.statista.com

Major power plants of Ukraine

Map 1: Emissions and age of major power plants in Ukraine

Source: Carbon Brief/Heinrich Böll Foundation

Electricity balance of trade in Ukraine in 1990-2021



Source: https://yearbook.enerdata.net

Ukraine 2021: - 2 TWh

Energy as a strategic weapon:

Disruptions to Ukraine's natural gas supply

- **2006:**
  - Russia interrupts shipments of natural gas in mid-winter. It affected European supplies too
- **2014:**
  - Russia's occupation of Crimea, military action in the eastern part of the country
  - prolonged gas price dispute between Naftogaz and Gazprom (final rulings issued in 2017 and 2018)
  - sharp drop of shipments of natural gas through Ukraine, Russia switched to the Nord Stream
- **2015/2016:**
  - massive increases in natural gas price
- **24 February 2022**:
  - Russia invades Ukraine

Destruction during the war in Ukraine

- Since **February 24, 2022**, Russia has destroyed **50%** of Ukraine's energy infrastructure. Almost all *thermal and large hydropower plants* were under shelling and partially or totally destroyed. Nuclear power plants are under threat too.
- **4700** Russian missiles were launched during **270** days of war.
- The *most significant attacks* on Ukraine's energy infrastructure:
  - **October 10**: **84** missiles (**43** missiles destroyed),
  - **November 15**: **96** missiles (**77** missiles destroyed; **2** people were killed in Poland)




Damaged electricity infrastructure in Ukraine

Consequences of damaging energy infrastructure of Ukraine

- The damage in November **2022** only towards the energy infrastructure was nearly $**7 billion**.
- **10 million** Ukrainians (almost 25% of the population) were without electricity in November 2022 as winter sets in and temperatures plummet
- Planned power outages and emergency blackouts in almost all regions: no electricity, no water (pumping), no internet for every **2-4** hours and more
- **The common joke: the Ukrainians are the most romantic nation in Europe now**

Consequences of damaging energy infrastructure of Ukraine

- All oil-refinery plants in Ukraine were destroyed or severely damaged. Before the war, Ukraine produced all kinds of oil products.
- Large industrial plants (metallurgical, chemical, machine-building etc.) situated in the east and south of Ukraine were destroyed (Azovstal in Mariupol, Avdiivka Coke Plant, Severodonetsk Azot Chemical Plant, etc.)
- **Nuclear blackmail** by Russia:
  - ***Chornobyl NPP*** (March **2022**)
  - ***Zaporizzya NPP*** (**20%** of electricity generation in Ukraine, the biggest NPP in Europe, **6** nuclear reactors)

Ukraine's electricity demand, generation and export during the war

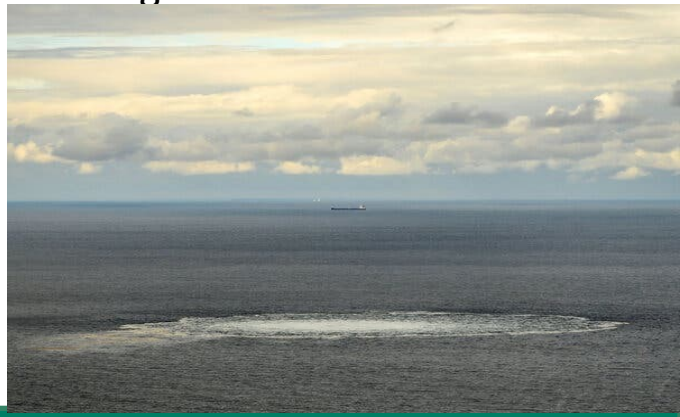
- During March-August 2022, Ukraine exported **1,335,717 MWh** of electricity in four directions – Poland (**54%**), Moldova (**26%**), Romania (**11%**), Slovakia (**9%**).
- *Causes:* migration of refugees abroad (**15.35** million border crossings from Ukraine to other countries as of **November 15, 2022**) and disruption in business activity.
- Due to attacks on energy infrastructure, Ukraine stopped electricity export on **October 11, 2022** Today it imports electricity from Slovakia.

War in Ukraine: impact on global energy security

- ✓ *growing energy crisis and inflation* due to high energy prices
- ✓ *changes in the players' positions* at the world energy market:
  - disruptions in Russian gas supplies to Europe (by **80%** between May and October **2022**):
    - Ukraine transferred the biggest volumes of the natural gas to Europe
    - Nord Stream pipeline sabotage on September **26, 2022**
  - embargo on Russian crude oil imports to implement until the end of **2022**
- ✓ *changes in energy policy*: EU cuts the supply of Russian natural gas and other fossil fuels and accelerates transition to renewables

Further consequences:

- economic crisis since the trade flows decreased due to sanctions and military actions
- famine threat and rising social tensions in African and Asian countries



Part 2 Energy efficiency (EE) and renewable energy (RE) as a way to increase Ukraine's energy security

Pre-war situation:

- Largest final energy consumers: ***industry*** and ***households/residential sector***
- Due to outdated *industry's* structure (metallurgy, coalmining, heavy engineering, etc.) its energy intensity is **3-4** times higher than in the EU
- Energy intensity of the *housing sector* is **2-3** times higher than in the EU (only **11.4%** of houses were built in **1991-2021**). It causes energy poverty (**13-15%** of population in **2021**)
- Annual national economy's losses from high energy intensity exceeds $**1** billon.
- National obligations to become carbon neutral until **2060**, carbon tax, carbon emissions trading (carbon intensity: **0.134** kCO2/$15p in **2021** – among TOP-10 with the lowest carbon intensity)
- Renewables: **14%** (including large hydropower) of Ukraine's power output in **2021**

State support mechanisms for energy efficiency promotion in Ukraine

- ***for households and homeowners' associations***:
  - state "warm loans" program
  - local co-financing programs for energy efficiency measures
  - Energy Efficiency Fund
  - IQ energy program *(closed in 2020)*
- ***for public organizations***: Energy Service Companies (ESCO) mechanism
- ***for industrial enterprises***: Decarbonization fund

State “warm loans” program for the population: results

480 mln m3 – annual energy savings (gas equivalent)

2021: *target audience* – private homes

new equipment – energy (electricity and heat) storage systems, electric chargers for electric cars, smart electricity meters

compensation of funds - **20%** for solid fuel boilers, **35%** - for energy efficiency measures

Indicator	2020	2014-2020
Families participated	113,000	850,000
Money invested	1.04 bln UAH	8.5 bln UAH
Money compensated from the state/local budget	384 mln UAH/ 94 mln UAH	3.3 bln UAH/ 540 mln UAH

Energy Efficiency Fund: results

- **2 Programs: EnergyHome and RenewHome**
- **82 162** participants (households) with **864** projects (**Sept 2019-Feb 2022**)
- Total value of submitted projects: **7.9 billion UAH**
- Amount of grants: **4.9 billion UAH**
- Energy savings: **436.2 million kWh/year**
- Reduction of CO2 emissions: **116.4 thousand tons/year**

Energy Service Companies (ESCO) mechanism for public entities: results

- **552 ESCO agreements** have been concluded in **57** cities worth more than **1.25 bln UAH**:
  - **2018** - **210** contracts worth **218** mln UAH
  - **2019** - **200** contracts worth **641.5** mln UAH
  - **2020** - **122** contracts worth **389.8** mln UAH
- **Program's efficiency (for 242 ESCO contracts):**
  - **60** mln UAH of savings
  - **35,000** Gkal of heat savings

Decarbonization fund for industrial enterprises:

- In **2019-2020**, the annual income of the CO2 emissions tax increased from **50 mln UAH to 0.9 bln UAH**
- None of the current budget programs supported reducing CO2 emissions by implementing energy efficient projects
- Decarbonization fund's means will be exclusively spent on projects aimed at improving energy efficiency and reducing CO2 emissions

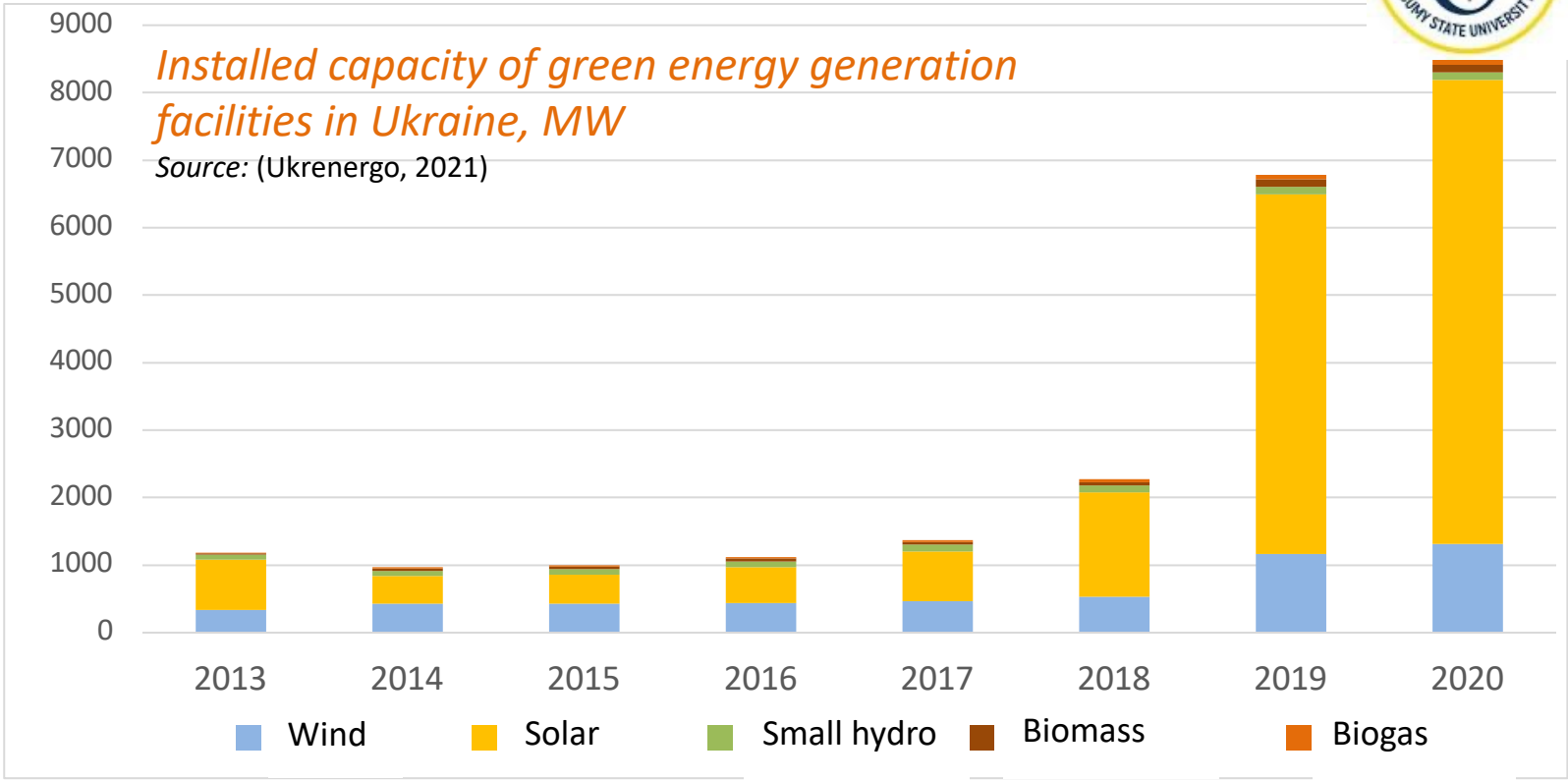
State support mechanisms for renewable energy promotion in Ukraine
Pre-war condition:

- **feed-in tariffs (**the highest in Europe) for industrial (since **2009**) and household (since **2015**) green energy facilities
- **allowances to the feed-in tariff** for using domestic equipment for green power plants construction;
- land tax and custom duties **privileges**;
- **green auctions** for industrial green power plants;
- **commercial bank loans** for constructing green energy facilities
- the **Ukraine Sustainable Energy Lending Facility** (since **2009**) set up by The European Bank for Reconstruction and Development

Renewable energy promotion in Ukraine: results

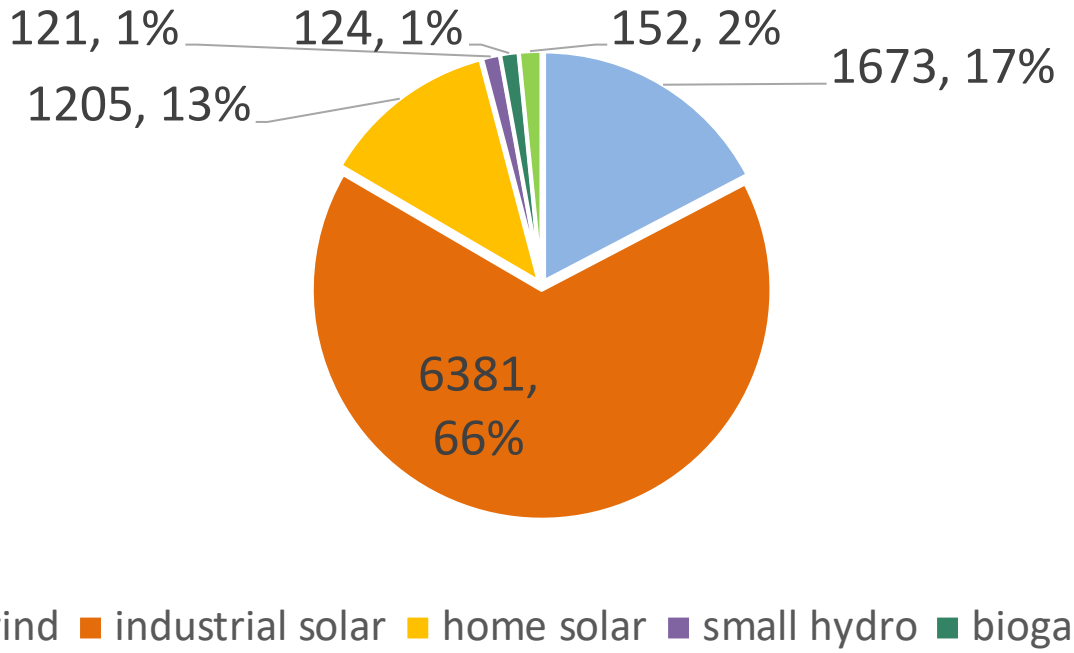
Installed capacity of green energy generation facilities in Ukraine, MW

Source: (Ukrenergo, 2021)



Renewable energy promotion in Ukraine: results

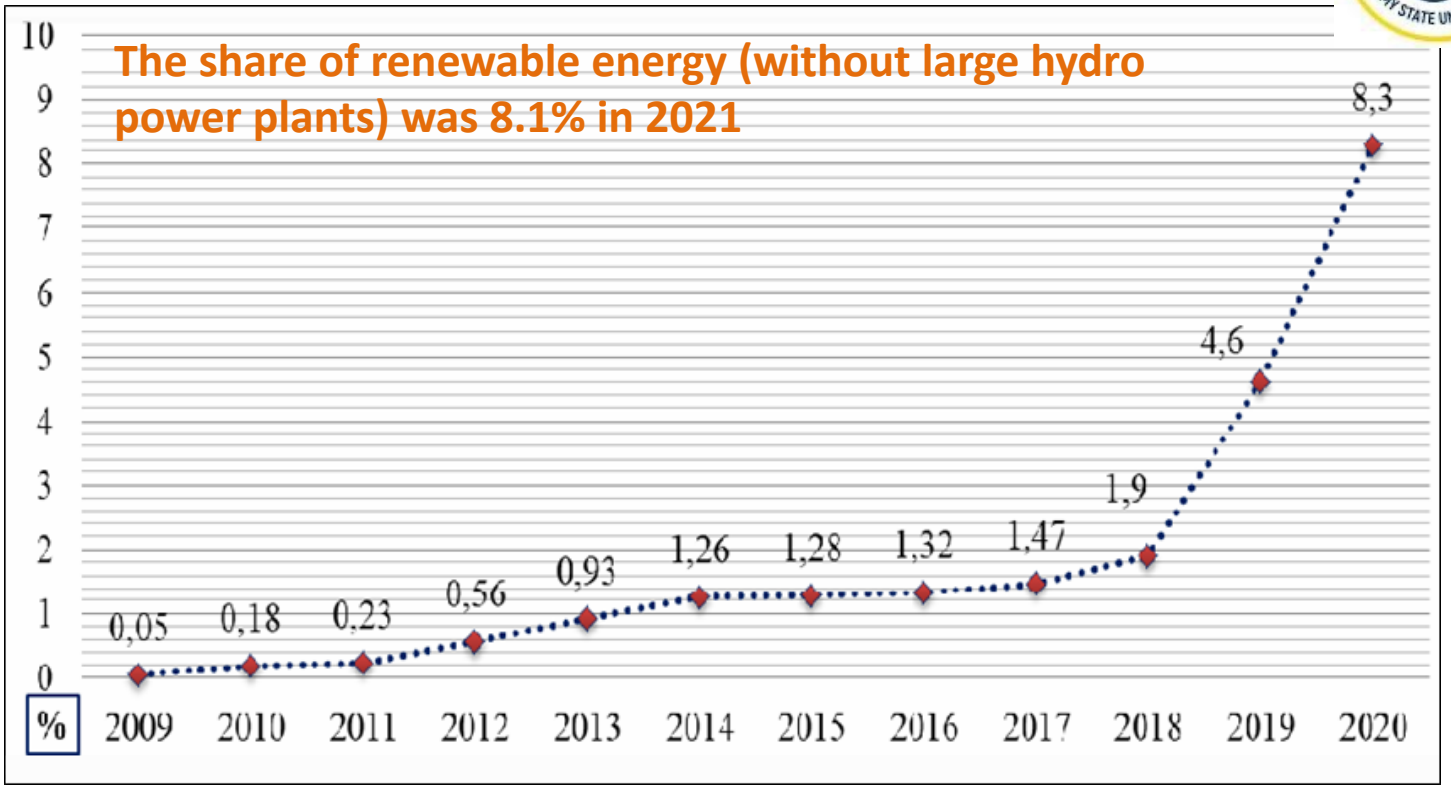
Green energy installed capacities in Ukraine in 2021, MW



Renewable energy promotion in Ukraine: results

- Increase in the installed green energy capacity, in particular by **21%** during the crisis year **2020**
- In **2017-2021**, green electricity generation increased more than **6 times**, and the total installed capacity of renewable energy facilities reached **9,656 MW** as of January **1, 2022**
- **2020** – primary growth of the ***industrial*** *green energy facilities*, **2021** – primary growth of the ***home*** *photovoltaic solar power plants*
- **2021** - annual emission of CO2 was reduced by more than **10.3** million tons, which is equivalent to emission from **2.2** million cars
- Before **2022**, Ukraine had a **boom in solar PV installations in the household sector** due to high feed-in tariffs, even in COVID-19 times
- **2020-2021** - emerging of the ”**green-coal” paradox**

Share of renewables in electricity generation in Ukraine



Consequences of the feed-in tariff use in Ukraine

- **Renewable energy share** accounted for about **14%** (including large hydropower) of Ukraine's power output in **2021**
- Payments for the feed-in tariff is a **great burden for the state budget**: the share of renewable energy in the market increased to **8 % in 2020**, which is **26%** of the market money turnover. It caused problems with payments during **2020-2021**.
- **Disproportion of solar PV development** compared to other green power technologies: about **80%** in the structure of renewable energy installed capacities (without large hydropower) in **2021**
- **Increasing imbalances in the United Energy System of Ukraine** due to growing share of green energy

Impact of the Russian-Ukrainian war on energy efficiency and renewable energy sectors in Ukraine

- **Suspension of the loan programs** on implementing energy efficiency and renewable energy projects for the households and business entities
- **Reduction of feed-in tariff payments (by 15%)** for green energy producers
- **Regulatory restrictions on the operation of renewable energy facilities** due to the discreteness of their energy generation
- **Destruction of green power capacities**: **30-40%** of all RE power plants are affected as of August 2022. The United Energy System of Ukraine has lost approximately **4%** of generating capacities, and another **35%** of capacities is located in the occupied territories.

Impact of the Russian-Ukrainian war on energy efficiency and renewable energy sectors in Ukraine

- In **May 2022**, green energy generation by wind farms in Ukraine has been reduced **3** times compared to the same period in **2021**, and by solar capacities - by **40%**
- As of **October 2022**, the war had an impact on nearly **90%** of Ukraine's wind power capacity and **30%** of its solar power capacity.
- *For example*: the Russian invaders destroyed **a solar energy plant in Merefa** (**3.9** MW), close to Kharkiv, and they also stole the **Tokmak solar energy plant** (**50** MW) in the Zaporizzhia region

Part 3 Outlook

Post-war energy security targets of Ukraine:

- demining of energy facilities (30% of Ukraine's territory is contaminated with mines)
- energy efficient restoration and development of energy infrastructure, industry, and housing stock
- diversification and reduction of energy import
- renewable energy deployment
- development of energy storage capacities and smart grids
- eradication of energy poverty
- decarbonization of the national economy

Post-war state programs for energy security in Ukraine: Future of energy efficiency and renewable energy

- the **Ukraine Recovery Plan through 2032** (**2022**):
  - $**130 billion** of investment;
  - **5-7** GW of new solar and wind power plants;
  - **30+** GW of RE facilities for the production of renewable hydrogen;
  - **3.5** GW of hydroelectric and pumped hydroelectric plants
  - **- 65%** - CO2 reduction (from **1990**) to **2032**
- President's program "**Big Thermomodernization**" (**2021**):
  - $**10 billion** of investment
  - **50,000** multiapartment buildings involved
  - **5**-year term of implementation

Post-war continuing state programs in Ukraine:

- President's program "**Big Construction**" (restoration and updating of roads, schools, kindergartens, stadiums and hospitals, etc.)
- **Energy Efficiency Fund** programs "**EnergyHome**" and "**RenewHome**" (restoration of destroyed or damaged homes and renovation of outdated housing stock) for homeowners' associations
- the **"warm loans" program** and **local co-financing programs** to enhance energy efficiency measures by households
- **ESCO mechanism** for public entities
- **Decarbonization fund** programs for industrial enterprises

Changes in energy efficiency policy:

- emphasis on restoration of damaged energy facilities with the use of energy efficient technologies
- encouragement of development of decentralization energy systems, energy storage capacities
- stimulation of implementing new energy efficient technologies through information support
- accounting of decarbonization effects of energy efficient measures
- ensuring investment support of energy efficiency measures, diversification and enrichment of financial opportunities for different stakeholders to implement and participate in energy efficient projects

Changes in renewable energy policy:

- Reducing feed-in tariff rates decrease the role of this instrument in renewable energy development in Ukraine
- Rising electricity prices motivate energy producers to become prosumers
- These changes necessitate updating the government levers to develop the industry (replacing the feed-in tariff for business with green auctions, net metering and other incentives) and create a favorable investment climate after the war.

Investment support is crucial for renewal of green energy industry and enhancing energy efficiency measures in Ukraine

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