

# ECONOMICS AND BUSINESS MANAGEMENT

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## ENERGY TRANSITION IN THE UKRAINIAN POWER INDUSTRY – NO TIME TO DELAY

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The latest researches on the current development and prospects for the further spread of power technologies using renewable energy sources were analyzed. The trend of technology cost reducing due to an increase in production was traced. On the basis of the examined studies, conclusions regarding the economic impracticality of further developing of power generation capacities that use fossil fuels, primarily coal were drawn. An example of a planned conversion of an existing coal-fueled plant to a natural gas-fueled plant and solar photovoltaic installations plus storage capacities was given. The significant impact of the Inflation Reduction Act on the acceleration of energy transition in the United States was noted. Attention on a win-win-win scenario in which moving to clean energy as quickly as possible would lower the cost of the energy system compared to a fossil-fueled system, while providing more energy to the global economy and increasing energy access to more people all over the world was focused. The current state of thermal generation in Ukraine and the need for its post-war reconstruction in accordance with the requirements of the energy transition strategy were considered. Attention to the need to adjust the Recovery Plan of Ukraine proposed by the National Council for the Recovery of Ukraine from the Consequences of the War, in the part devoted to the recovery and development of heat generation, including its conversion to the use of biomass was paid. Proposals to create a level playing field by increasing the carbon tax rate for thermal generation along with tax incentives for the development of renewable energy sources have been made. The Carbon Border Adjustment Mechanism impact on companies selling goods within the EU was mentioned. Urgent actions to prepare a technical and economic justification for the reconstruction or new construction of capacities using renewable energy sources at existing sites of thermal power plants were proposed.

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## ЕНЕРГЕТИЧНИЙ ПЕРЕХІД В УКРАЇНСЬКІЙ ЕЛЕКТРОЕНЕРГЕТИЦІ – ЗВОЛІКАТИ НЕ МОЖНА

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Проаналізовано новітні дослідження присвячені поточному стану розвитку і перспективам подальшого розповсюдження технологій виробництва електроенергії, що використовують відновлювальні джерела енергії. Досліджено тенденцію до зниження вартості зелених технологій завдяки збільшенню обсягів їх виробництва. Обґрунтовано економічну недоцільність подальшого розвитку потужностей із виробництва електроенергії, що використовують викопне паливо, перш за все вугілля. Наведено світовий досвід заміщення існуючої вугільної електростанції на газову разом із встановленням сонячних фотоелектричних установок доповнених акумулюючими потужностями. Вказано на визначальну роль держави у стимулюванні пришвидшення процесу енергетичного переходу до використання відновлювальних джерел енергії, шляхом прийняття відповідних законодавчих актів, на прикладі схваленого у США «Закону про зниження інфляції». Сфокусовано увагу на запропонованому безпрограшному сценарії, відповідно до якого, прискорений перехід до використання чистої енергії дозволить: по перше, знизити витрати енергетичної системи

у порівнянні із поточними витратами системи, що базується на використанні викопного палива, по друге, забезпечити виробництво більших обсягів енергії для світової економіки, і по третє, збільшити доступність енергії для людей у світі загалом. Розглянуто сучасний стан теплової генерації України та необхідність проведення її післявоєнної відбудови відповідно до вимог стратегії енергетичного переходу до використання відновлювальних джерел енергії. Доведено необхідність корегування Плану відновлення України запропонованого Національною радою з відновлення України від наслідків війни, у частині присвяченій відновленню та розвитку теплової генерації, у тому числі, щодо її переведення на використання біомаси. Внесено пропозиції щодо створення рівних конкурентних умов шляхом підвищення ставки податку на викиди вуглецю для теплової генерації, разом із податковим стимулюванням розвитку відновлювальних джерел енергії. Зазначено вплив, який має завдати на компанії, що продають товари у ЄС механізм вуглецевого регулювання імпорту (СВАМ), та необхідність приведення екологічних податкових норм у відповідність до критеріїв ЄС. Запропоновано заходи щодо невідкладної підготовки техніко-економічного обґрунтування реконструкції або нового будівництва потужностей, що використовують відновлювальні джерела енергії на існуючих майданчиках теплових електростанцій, з метою забезпечення наявності, одразу після закінчення бойових дій та здобуття перемоги, готових проектів для залучення фінансування з боку європейських донорів.

### Statement of the problem

Currently, in the world in general and in Ukraine in particular, there is an opinion that Renewable Energy Sources (RES) are technologies, in general, extremely important for ecology and the global future, but economically unreasonable and ineffective, at least for now, and that they cannot develop without external support. This opinion did not occur in a vacuum; indeed until recently the cost of construction of power plants using renewables was quite high.

There were the Legislative acts adopted in Ukraine, which were aimed at stimulating investment in the renewable energy sources, specifically the construction of wind or solar power plants. In other words the state guaranteed investors the purchase of electricity at a fixed tariff, which would allow predicting profits and guarantee investors a return on investments.

Then the state realized that it is not able to fully meet its obligations, and the investor was asked to agree to a reduction in tariffs. This led to the fact that some investors sued the state in courts with the demand to fulfill their obligations, in accordance with the previously adopted legislative acts.

Companies that invest in renewable energy sources and with them some researchers in this field, continue to demand financial support from the state, and threaten to stop investing in the absence of it.

But, such a path is not rational. Of course, the state must fulfill its obligations under projects that were developed in accordance with previously adopted legislative acts. But in relation to new RES projects, the approach should be changed.

The state should definitely support the development of RES, for example, by providing preferential tax conditions along with interest compensation on loans. However, for new projects, the concept of "green tariff" in its current form should not be applied at all. The sale of electricity by RES producers must be carried out on the Wholesale Electricity

Market at market prices. That is, renewable energy sources should compete on equal terms with electricity from other sources and there is every reason to believe that renewable energy sources will emerge victorious in this competition.

The article sets out its goals to bring to light the economic expediency of energy transition in the power production and to designate the steps needed to use the Recovery of Ukraine from the Consequences of the War as a transition of Ukrainian fossil-fuel power industry into the renewable energy sources.

### Analysis of recent research and publications

**When constructing new generating capacities, there is no other economically feasible alternative to Renewable Energy Sources.**

First of all, in order to compare on a consistent basis the most economically expedient source of energy for the construction of a power plant, energy prices are expressed in levelized cost of electricity (LCOE) that represents the average revenue per unit of electricity generated that would be required to recover the costs of building and operating a generating plant during an assumed financial life and duty cycle [1].

LCOE helps to determine the minimum price at which electricity must be sold so that the power plant is break-even throughout its lifetime. If, during the construction of a power plant, an energy source is chosen with a levelized cost of electricity that is higher than that of alternatives, the price of the generated electricity will be uncompetitive and it will be difficult to sell it to the consumer.

The study "Why did renewables become so cheap so fast?" by Dr. Max Roser, director of the Oxford Martin Program in Global Development at the University of Oxford, published in December 2020, proves the advantages of green energy to fossil fuel technologies. The study provides the graphs of change in the cost of electricity between 2009 and 2019 (Fig. 1) [2].

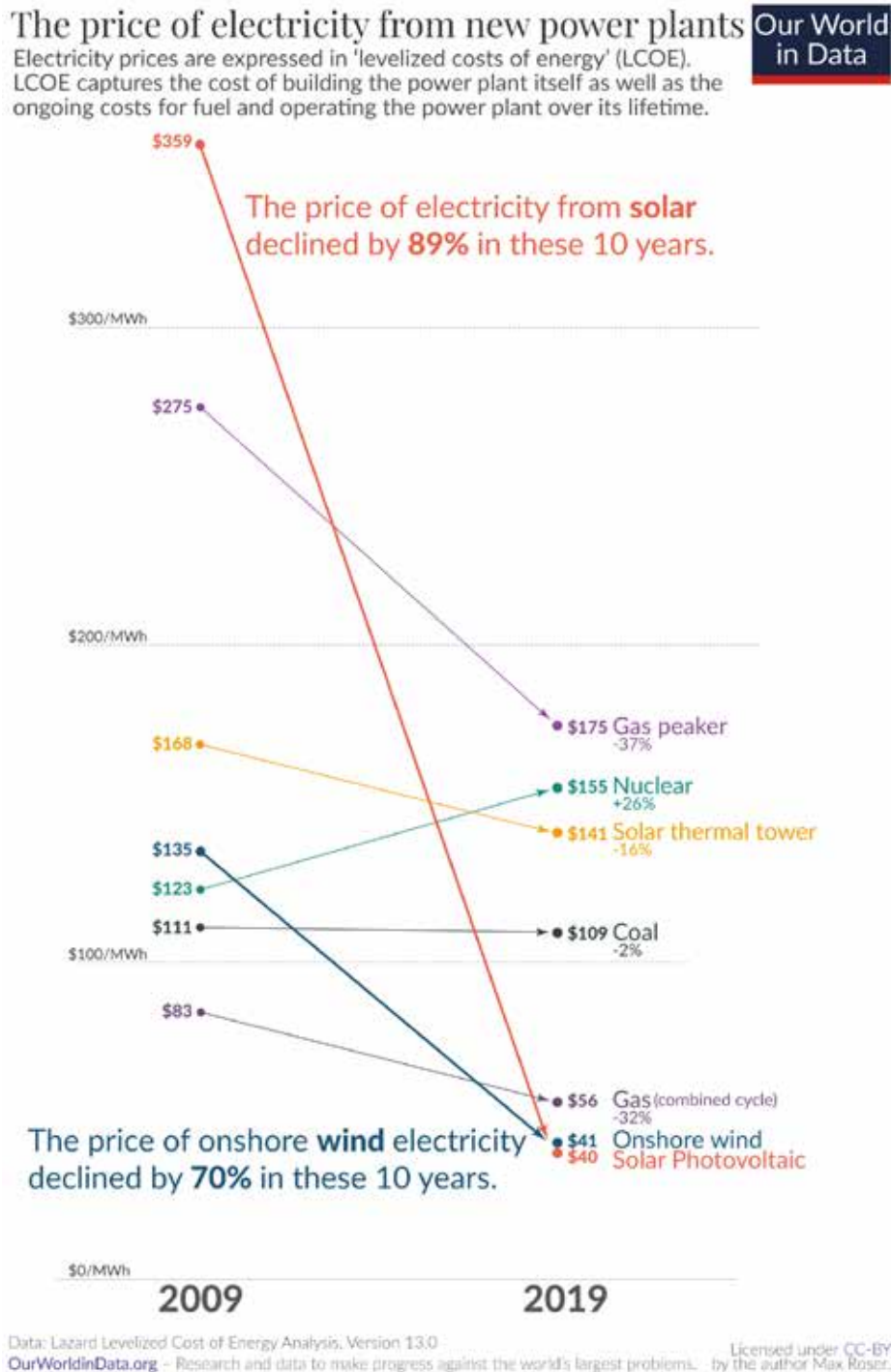


Fig. 1 – The price of electricity from new power plants

Note: all prices shown in the graphs are without subsidies

In 2009 the cost of electricity produced from utility-scale solar PV was \$359 per MWh. In 2019 the price became \$40 per MWh. The relative price has reversed: the price of electricity you need to recover expense with a new average coal plant is now much higher than the breakeven price by building a wind farm or a solar power plant.

The price of the fuel and the operating expenses of the power plant are the main costs of electricity produced from fossil fuels or nuclear energy. The operating costs of renewable energy plants are relatively low because they do not include the fuel expenses as their fuel does not have to be extracted. Renewable energy plants use as a fuel the sunlight and wind power and they get it for free.

What determines the cost of renewable energy is the power plant constructing and operating cost, in other words the cost of the technology, and it is through the technology cheapening that has caused the cost of renewable energy continue to fall so rapidly. The cost of technology is reduced due to an increase in production. More production means falling prices, which means more production, and so on in a circle. Statistics from past periods prove that each doubling of the installed cumulative capacity leads to a decrease of the solar modules price by 20.2% [2].

Coal-fired electricity has historically been cheap and remains relatively cheap, but it is not getting cheaper and has no chance of getting cheaper. There are two reasons why we should not expect significant changes in the future:

- firstly, conventional coal-fired power plants have globally average efficiencies of around 34%, the world's most efficient coal-fired steam power plant RDK8 (Germany) has 47.5% net thermal efficiency and there is little scope for it significantly improvements (e. g. steam turbines manufacturer GE Steam Power is testing the ultra-supercritical technology with 50% efficiency) [3];

- secondly, for all non-renewable power plants there is a lower bound of possible electricity cost decreasing. Even if the power plant operating expenses would decline, the price of the fuel means that there is a floor below which the price of electricity cannot slip.

Gas energy is more efficient than coal, and despite the cost reduction restrictions also related to the price of fuel would play a rather important role in balancing the energy system.

Nuclear power will continue to be important during the transition period as it can be complementary to renewables where these energy sources have their weaknesses: firstly, the intermittency of electricity from renewable sources remains a problem, and nuclear power with gas power must provide stable performance of energy systems. And secondly, the installation of renewable energy sources requires large areas, and the great environmental advantage of nuclear power plant is that it uses not so much land.

Thus, it is clear that the building of coal-fired power plants from scratch under current conditions is wasteful. However, all over the world there are coal-fired power plants that can continue to operate. **Following study is proving that the extension of the exploitation of coal capacities, in comparison with the construction of new RES capacities, is economically unfeasible.**

In January 2023 was published a joint study by ENERGY INNOVATION specialists and scientists from the University of California called "Coal Cost Crossover 3.0", devoted to the transition in the United States of America from coal generation to renewable energy sources. The study analyzed the costs of operating all existing US coal-fired power plants with a total installed capacity of 220 GW, compared with the costs of building wind and solar power plants that could replace them. This study finds that 99 percent of all coal-fired power plants in the U.S. are more expensive to operate on a forward-looking basis than the all-in cost of replacement renewable energy projects [4].

It should be noted that in a similar study, which was published in 2019, as of 2018 the continued operation of

only 62% of coal-fired power plants was economically unfeasible. Such dynamics are associated with a constant increase in production costs at coal-fired power plants and their decrease at RES power plants.

A clear confirmation of the validity of the research conclusions is the Integrated Resource Plan of NV Energy from Nevada, which includes converting the existing coal-fueled plant at the North Valmy Generating Station to a cleaner natural gas-fueled plant and the purchase, installation and operation of a company-owned 400 megawatt solar plant along with a 400 megawatt, four-hour battery storage system in Northern Nevada [5].

This project will create several hundred jobs in construction, and by accumulating capacity will help shift the produced energy to the times of day when it is most needed, serving the reliability needs of the area.

It should be noted the Inflation Reduction Act (IRA) signed on August 16, 2022 by President Joe Biden, which will have a very significant impact on the acceleration of the energy transition in the United States. The Production Tax Credit and the Investment Tax Credit are the two key tax credits provided by the IRA for new clean electricity resources. They put RES generation in more favorable conditions compared to other electricity producers.

However, despite the understanding of the energy transition inevitability the thermal power generation use is going on. One of the factors that slowing the energy transition process is a fear to lost profits giving up the steady business, but **acceleration of the energy transition process will bring additional profit.**

According to the study by a group of Oxford University scientists "Empirically grounded technology forecasts and the energy transition", published in the journal Joule on September 13, 2022, a transition to a carbon-free energy system by around 2050 would save at least \$12 trillion worldwide, compared to continuing to use fossil fuels at current levels. The study presents a win-win-win scenario in which moving to clean energy as quickly as possible would lower the cost of the energy system compared to a fossil-fueled system, while providing more energy to the global economy and increasing energy access to more people all over the world.

The "Rapid Transition" scenario proposed in the study shows a realistic future for a fossil-fuel-free energy system by around 2050 that would provide 55% more energy services worldwide than today, thanks to increased solar, wind, batteries, electric vehicles and clean fuels such as green hydrogen (produced from renewable electricity). In addition, the study shows that costs for key storage technologies such as batteries and hydrogen electrolysis are also likely to drop drastically [6].

This study has been conducted before Russia's invasion of Ukraine that caused the inflation surge around the world and revealed all risks of continuing to rely on expensive, insecure fossil fuels. The current energy crisis underscores the vulnerability of world economy confronted by the growing fossil fuels prices. The research confirms that the accelerating transition to clean energy as soon as possible will bring benefits both for the economy and the ecology.

As said mathematics professor Doyne Farmer, who led the research team: "There is a pervasive misconception that

switching to clean, green energy will be painful, costly and mean sacrifices for us all – but that’s just wrong. Renewable costs have been trending down for decades. They are already cheaper than fossil fuels in many situations, and our research shows they will become cheaper than fossil fuels across almost all applications in the years to come. And, if we accelerate the transition, they will become cheaper faster. Completely replacing fossil fuels with clean energy by 2050 will save us trillions” [7].

### **Current status of Ukrainian thermal power generation and recovery plans**

According to Draft Ukraine Recovery Plan, as of late 2021, about 20% of Ukrainian thermal power plants have been reconstructed, but the issue of bringing their environmental characteristics to modern requirements remains unresolved, and flexibility characteristics though slightly improved still remain inadequate for the current needs of the Integrated Power System (IPS) of Ukraine. The remaining units are maintained in working condition due to overhauls and current repairs, but their deterioration is constantly increasing and reaches the threatening limit in terms of the possibility of their further operation without reconstruction [8].

The recent studies prove that the reconstruction and extension of operation, as well as the construction of new capacities using fossil fuels, including natural gas, do not make economic sense.

Nevertheless, the Draft Plan for the Recovery of Ukraine proposed by the National Council for the Recovery of Ukraine from the Consequences of the War, on the contrary, envisages the ecological modernization of coal-fired power units and the commissioning of gas-fired power units. But it still contains a caveat that the expediency of ecological modernization, relative to alternative options (reconstruction or new construction on the existing site), is determined for each power unit during the preparation of the corresponding feasibility study.

In my opinion, wasting time, effort and money on the reconstruction or construction of coal-fired power plants in Ukraine is impractical. The only goal we should strive for can only be a full and accelerated transition to renewables, certainly taking into account the need to maintain the stable operation of the energy system.

In addition, the Head of the Permanent Representation of the European Investment Bank (EIB) in Ukraine, Jean-Eric de Zagon, in his speech during the 13th Energy Day of the European-Ukrainian Energy Agency (EUEA), dedicated to the prospects for the development of the Ukrainian energy industry, held in Vienna on October 14, 2022, noted that Ukraine should ensure a green transition within the framework of the National Recovery Plan of Ukraine in order to successfully integrate into the European economy. He also emphasized that the EIB will not consider new investments in projects related to fossil resources. The EIB aims to support projects on the development of green energy, the strengthening of Ukrainian power transmission capacities to the EU, and the reconstruction of energy infrastructure. The same approach will be taken by a number of large development banks and

financial funds, such as the IFU of Denmark or the FMO of the Netherlands [9].

In my view, in the Recovery Plan of Ukraine rather little attention is paid to the use of biomass, although, according to the data of the European Commission, biomass continues to be the main source of renewable energy in the EU, with a share of almost 60% [10].

In the Recovery Plan of Ukraine, biomass is supposed to be used only as a fuel for cogeneration. However, there is an experience of converting coal-fired thermal power plants units to use biomass. The DRAX GROUP North Yorkshire power station (Great Britain) is a case in point [11].

According to the Bioenergy Association of Ukraine, as of 2021, the energy potential of biomass in Ukraine was 24.87 million tons of oil equivalent per year – this is 29% of the total energy supply in Ukraine (86.36 million tons of oil equivalent in 2020). And what is important, as Ukraine is an agrarian state, this potential consists mainly of biomass of agrarian origin [12].

Currently, 12 GW of the installed capacity of Ukraine’s fossil fuel power plants are located in the occupied territory, that is, they are currently excluded from the formation of the country’s overall energy balance, and it is these capacities that can most painlessly be used as a basis for the post-war transition of Ukraine’s electricity industry to renewable energy sources.

To my mind, during the recovery of Ukraine from the consequences of the war, it is the state that should become a driving force and an example of abandoning coal in electricity production.

The majority of shares of PJSC “Centrenerg”, which includes three coal-fired power plants, are exactly state-owned. The activity of PJSC “Centrenerg” is and has been unprofitable, despite the fact that coal was purchased from state mines at below-market prices. In turn most of the state mines, work only through the support from the state, because the cost price of mined coal is much higher than market prices.

On the basis of the Secretariat of the Cabinet of Ministers of Ukraine, as of 2018, the state owned 102 mines, most of which were located in uncontrolled territories. Among the 33 mines controlled by the government, only 4 were profitable. According to the data of the study of the Secretariat of the Energy Community entitled “Investments into the past” published in May 2022, for the period from 2016 to 2020, the amount of state subsidies aimed at supporting Ukrainian mines totaled to 1,640.63 million euros [13].

If the state really wants to prove that it is an effective owner, it should close unprofitable mines, and direct the freed funds to social support for laid-off workers and the transfer of generating capacity to technologies without the use of coal, and with an appropriately prepared investment projects, the funds of the NextGenerationEU European Fund should be attracted. There is another way – privatization, but with a mandatory condition for the investor regarding the transfer of generating capacities to “green” production technologies. But in any case, the closure of state mines cannot be avoided. The idea of privatizing PJSC “Centrenerg” in a package with unprofitable mines should be forgotten forever – in today’s world, no one can be interested in it.

Furthermore, to stimulate investment in the Renewable Energy Sources the state should use the tax incentives, instead of the obligation to buy “green” electricity at a fixed rate. Thus, the state does not directly finance the development of RES, but only refuses additional revenues to the budget, and stimulates investors to develop business and increase their own profits.

On the other hand, the state must stop the fossil fuel technologies support. By “support” I mean the low Carbon Tax Rate. It should be aligned with the average European level. Of course, the increase of the Carbon Tax Rate will meet fierce opposition from the “coal” lobby, and their main argument will be the soaring cost of electricity for the final consumer and the decrease in the competitiveness of Ukrainian goods on world markets. But we must finally realize that Ukrainian enterprises must play on equal terms with foreign companies – learn to optimize production and energy consumption. There is no other way, Ukrainians should not forget how precious for the state and each of us turned out the “cheap”, initially gas from Russia, and then fuel and electricity from Belarus.

In addition, as of 1 October 2023 in the European Union will enter into force in its transitional phase the Carbon Border Adjustment Mechanism (CBAM). Starting from 01 January 2026, a tax on direct carbon emissions from the

production of goods will be gradually introduced. Thus, both foreign and local companies selling goods within the EU must play by the same rules and pay the same [14].

A tax on direct carbon emissions will be required to pay anyway. But if enterprises are paying to the Ukrainian budget taxes that meet all EU criteria, it will allow them to import goods without additional fees at all.

### Conclusions

- The myth about the high cost and economic unattractiveness of “green technologies” should not only be destroyed, but on the contrary, evidence should be spread as much as possible that the faster the energy transition takes place, the greater the economic profit it will bring.
- Ukraine should urgently prepare a program to get rid of outdated and unprofitable energy technologies and replace them with RES technologies.
- Also, immediately, without waiting for the end of the war, it is necessary to begin the development of a technical and economic justification for the reconstruction or new construction of RES capacities at the existing thermal power plants sites, in order to be able to offer ready-made projects for receiving financing from European donors by the time the hostilities end and victory is achieved.

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