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ENERGY PRICING TARIFFS AND ELECTRICITY DEMAND IN THE DIFFERENT COUNTRIES

Azamat Botirov*; Samandar Fayziev**

*Associate Professor,
Department of corporate finance and securities,
Tashkent State University of Economics, Tashkent, UZBEKISTAN

PhD student,
Department of corporate finance and securities,
Tashkent State University of Economics, UZBEKISTAN
Email id: s.fayziyev1229@gmail.com

ABSTRACT

As can be seen from the article which discusses the state of pricing electricity in different regions in the world. Energy projects in the energy sector and the problems observed in it, the development processes of the energy sector, the status of thermal, wind and solar power plants in our country and their difference from each other in terms of their effectiveness, as well as alternative financing directions. The purpose of the study is to analyze the financing and sustainability of renewable infrastructure projects in the energy sector.

KEYWORDS: *Global Nuclear Generation, Electricity Demand, Electricity Prices, Financing, Energy Resources, Thermal Power Plants, Wind Farms, Nuclear Power Plant, Hydroelectric Power Plant, Renewable Energy Sources, Power Transmission Networks, Energy Commodity Market.*

INTRODUCTION

The report begins with an overview of the 2024-2025 forecast period of this report, global electricity consumption is expected to increase at the fastest pace in years, fuelled by robust economic growth, intense heatwaves and continued electrification worldwide. The 4% growth expected for 2024 is the highest since 2007, with the exceptions of the sharp rebounds in 2010 after the global financial crisis and in 2021 following the Covid-induced demand collapse. The growth is driven by strong electricity demand in multiple regions and countries, especially in the People's Republic of China (hereafter, "China"), India and the United States. We expect this demand trend to continue in 2025, with growth also at 4%. In both 2024 and 2025, the rise in the world's electricity use is projected to be significantly higher than global GDP growth of 3.2%. In 2022 and 2023, electricity demand grew more slowly than GDP.

Electricity demand in China is forecast to increase by 6.5% in 2024, similar to its average rate between 2016 and 2019. This still strong annual growth represents a modest slowdown from 7% in 2023 amid the ongoing restructuring of the Chinese economy. Electricity consumption in 2024 and 2025 is expected to be driven by robust activity in the services industries and various

industrial sectors, including a rapid rise in solar PV, electric vehicle (EV) and battery production, and the electricity-intensive processing of related materials. Continued expansion of 5G networks and data centres as well as strong EV uptake in the domestic market are also contributing factors. Over the last three years, China has been adding electricity demand roughly equivalent to that of Germany each year, on average, and this trend is expected to continue through 2025, with growth forecast at 6.2%.

LITERATURE REVIEW

Many foreign economists, including Eren Çam, Carlos David Yáñez de León, Matthew Davis, and Shrey Mehta. Keisuke Sadamori, Director of the IEA Energy Markets and Security (EMS) Directorate and Dennis Hesseling, Head of GCP, provided expert guidance and advice.[1]

The report also benefited from analysis, data and input from Marc Casanovas, Carole Etienne, Keith Everhart, Julian Keutz, Gergely Molnár and Frederick Ritter.

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ANALYSIS AND RESULTS

Despite the sharp rise in electricity use, solar PV alone is expected to meet roughly half of the growth in global electricity demand to 2025. Together with wind power generation, it will make up almost 75% of the increase. Global electricity generation from solar PV and wind is expected to surpass that from hydropower in 2024. This follows a massive 33% year-on-year increase in global solar PV generation and sustained growth in wind generation of 10%. The global energy transition is set to achieve another significant milestone by 2025, with total renewable generation poised to overtake coal-fired electricity output. The share of renewables in global electricity supply rose to 30% in 2023 and is projected to climb further to 35% in 2025. In the European Union, wind and solar PV generation is set to exceed fossilfired output in 2024. Wind and solar PV's combined share in total electricity supply is forecast to rise from 26% in 2023 to 30% in 2024, and to 33% in 2025. The primary driver is the rapid growth of solar PV, led by reduced prices of solar modules combined with strong policy support. The share of all renewable energies in total generation is expected to reach 50% in 2024.

Global nuclear generation is on track to reach a new high in 2025, surpassing its previous record in 2021. Nuclear generation is forecast to rise globally by 1.6% in 2024, and by 3.5% in 2025.

[1] Gunnarsdottir, I.; Davidsdottir, B.; Worrel, E.; Sigurgeirsdottir, S. (2021). "Sustainable energy development: History of the concept and emerging themes". Renewable and Sustainable Energy Reviews. 141: 110770. Doi:10.1016/j.rser.2021.110770. ISSN 1364-0321. S2CID 233585148. Archived from the original on 15 August 2021. Retrieved 15 August 2021. Retrieved 30 December 2020. 4. 2013, p. 8 Oskar Kowalewski, Pawel Pisany, What drove the growth of the corporate bond markets in Asia?, Research in International Business and Finance, Volume 48, 2019, Pages 365-380, ISSN 0275-5319, https://doi.org/10.1016/j.ribaf. 2019.01.014. Vera, Ivan; Langlois, Lucille (2007). "Energy indicators for sustainable development". Energy. 32 (6): 875-882. Doi:10.1016/j.energy.2006.08.006. ISSN 0360-5442. Archived from the original on 15 August 2021. Retrieved 15 August 2021.

This growth is supported by a steady increase in output by the French nuclear power fleet as maintenance works are completed, by the restarting of reactors in Japan, and by new reactors coming online in various markets, including China, India, Korea and Europe.

Economic headwinds, combined with a slowdown in manufacturing activity and mild weather in key regions, tempered global electricity demand in 2023 to an average annual growth rate of 2.5%, down from 2.7% in 2022. However, world electricity consumption is forecast to increase at a much higher pace in 2024, with growth set to reach 4% – the highest rate the world has seen since 2007, barring the exceptional rebounds in 2010 after the financial crisis and in 2021 following the Covid-19 pandemic demand collapse.

As in 2023, China and India are on track to post robust increases in electricity demand in 2024, driven by economic growth and rising cooling needs. The United States is also set to see significant demand growth, boosted by stronger economic activity, following a decline in 2023 driven by mild weather. After two consecutive years of decline, the European Union's demand is recovering, albeit at a moderate pace, as various energy-intensive industries ramp-up operations. The sustained increases in electricity consumption in these regions amid rising electrification, combined with robust growth in other emerging economies, is expected to support global electricity demand in 2025 at a similar rate of 4%.

Table 1 Regional breakdown of electricity demand, 2022-2025.

TWh	2022	2023	2024	2025	Growth rate 2022-2023	Growth rate 2023-2024	Growth rate 2024-2025
Africa	755	769	800	839	1,8%	4,0%	4,9%
Americas	6370	6326	6523	6667	-0,7%	3,1%	2,2%
of which United States	4332	4262	4392	4475	-1,6%	3,0%	1,9%
Asia Pacific	13869	14612	15435	16273	5,4%	5,6%	5,4%
of which China	8678	9283	9882	10498	7,0%	6,5%	6,2%
Eurasia	1328	1348	1369	1390	1,5%	1,6%	1,5%
Europe	3682	3596	3667	3762	-2,3%	2,0%	2,6%
of which European Union	2663	2578	2623	2692	-3,2%	1,7%	2,6%
Middle East	1228	1257	1292	1335	2,3%	2,8%	3,3%
World	27333	27907	29085	30267	2,5%	4,2%	4,1%

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In our Electricity 2024 report, we tracked the production cutbacks in energy intensive industries in the European Union amid soaring energy prices, specifically for 2021 and 2022. Some energy-intensive industries were particularly affected by rising energy prices and reduced their output, with production of chemicals and primary metals hit the hardest. After prices eased in late 2023, signs of a recovery in demand started to emerge across regions. Despite this, production curtailments and complete shutdowns continue to persist in various industries.

Overall EU industrial production was 3.3% lower in the first five months of 2024 compared to the same period last year. In May 2024, industrial output was down by 2.5% compared to May 2023. In Germany, for example, the largest economy in Europe, manufacturing during the first five months of 2024 declined on average by 5% compared to the same period in 2023. At the same time, energy-intensive industrial production recovered near 2023 levels in the January-May period, having jumped by 5% from the record lows observed in Q4 2023. However, they were still 14% below 2019 levels. In Germany, while production in the energyintensive paper (+1%) and chemical (+3%) industries were up y-o-y, the glass (-11%) and metals (-3%) sectors remained weaker. Nevertheless, production in all these energy-intensive industries were higher compared to Q4 2023, showing an overall trend of recovery.

Energy commodity markets experienced a slight easing in the first half of 2024 compared to 2023. This put downward pressure on wholesale electricity prices in many markets compared to the previous year, a trend that was also supported by robust generation from renewables in certain regions. While average wholesale prices returned to their pre-2021 levels in some markets, they remain elevated in others. The intense heatwaves many regions are currently experiencing may put upward pressure on prices in the summer due to increased electricity demand for cooling.

In many European countries, including France and Germany, wholesale electricity prices continued to decline in H1 2024. The average price in Europe was around USD 70/MWh, falling back to the H1 2021 level but remaining 40% above the H1 2019 average.

French prices in H1 2024 were further reduced by low seasonal electricity consumption and generation oversupply. The previously tight electricity market in France has eased as output from nuclear power plants continued to rise, the backbone of the country's electricity generation. Since mid-March 2024, the crosszonal transmission was restricted due to safety concerns. With limited import/export availability, this has partly isolated domestic wholesale prices. Prices in France were on average about USD 55/MWh lower than in Germany in Q2 2024. While futures prices indicate an expectation that the wholesale price spread shrinks, they also suggest higher prices in Germany than in France. The price spread between the two markets shrinks even more for winter delivery periods due to higher electricity demand during winter and elevated prices for natural gas, which more frequently sets the market prices as the marginal fuel.

In the United States, wholesale electricity price averaged in H1 2024 around USD 30/MWh, down almost 15% compared to the same 2023 period. Prices in the first six months of year reached levels last seen in H1 2019. Despite experiencing a mild winter on average, the United States faced short-term extreme weather conditions and spikes in electricity prices in some states

such as New York and the New England region due to the freezing of natural gas wells in early 2024. Over the outlook period, forward prices for 2024 and 2025 indicate a stable price level, with comparatively higher summer prices (Q3 2024) that are mainly driven by expectations of elevated electricity demand in the summer in many US regions due to heatwaves.

Table 2 Breakdown of global electricity supply, 2022-2025

TWh	2022	2023	2024	2025	Growth rate 2022-2023	Growth rate 2023-2024	Growth rate 2024-2025
Nuclear	2 685	2 761	2 805	2 903	2.8%	1.6%	3.5%
Coal	10 485	10 689	10 771	10 693	1.9%	0.8%	-0,7%
Gas	6 512	6 576	6 652	6 690	1.0%	**1.2%**	0.6%
Other nonrenewables	906	840	779	730	-7,3%	-7,2%	-6,4%
Total renewables	8 531	8 958	10 017	11 218	5.0%	11.8%	12.0%

Even though negative prices are still uncommon in many power markets, there has been a significant increase in 2024 in the frequency of negative wholesale price events in various regions. In some markets, such as South Australia, hours with negative prices seem to have become almost the new normal, with a share of around 20% since 2023. In some other markets like Southern California and in parts of Texas a share of negative prices above 5% have also become common. The phenomenon of negative prices is not exclusive to electricity markets, but they are much more common due to its characteristics. In electricity markets, supply and demand must be continuously balanced in the face of limited storage capacity and insufficient flexibility on the demand side, while at the same time certain sources of generation are subject to technical, economic, contractual or regulatory constraints. This can lead to situations where someone is willing to pay someone else to take their energy instead of shutting down production. In this sense, negative prices are an important market signal that encourages all those in a position to do so to reduce production and increase consumption.

There can be multiple factors that contribute to negative prices. Support schemes for renewable generation, for example, in the form of feed-in-tariffs and certificates of origin, or other contractual arrangements incentivising that the sent-out volume must be maximised, can contribute to negative prices. As a result, renewable generators under such schemes may continue to produce despite prices falling below zero. On the other hand, rooftop solar PV modules (or older generation wind turbines) are typically not economically curtailed due to technical limitations, so they are not responsive to price signals.

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Table 3 Global CO2 emissions from power generation, 2022-2025

Mt CO2	2022	2023	2024	2025	Growth rate 2022-2023	Growth rate 2023-2024	Growth rate 2024-2025
Total emissions	13 500	13 684	13 754	13 663	1.4%	0.5%	-0.7%

Negative prices have so far been in a moderate range, with extremely low prices occurring rarely. Despite the increasing frequency of negative price events, the vast majority are only slightly below zero. Following the guidance decision from the EU regulator ACER in January 2023, the minimum clearing prices for day-ahead markets across Europe have been standardised at EUR -500/MWh. However, extremely negative prices are still rare. Over the 12-month period ending in May 2024, the price in the Netherlands was negative for 377 hours. It hit the floor price of EUR -500/MWh for only 3 hours, compared to 239 hours between EUR -10/MWh and EUR 0/MWh. In Germany the hourly price fell as low as EUR -258/MWh, but almost 80% of negative prices were above EUR -15/MWh. In Australia the minimum allowed price is AUD -1 000/MWh (USD -665/MWh). This was reached for 26 hours in South Australia in 2019, and 21 hours in Queensland in 2021, but for less than 1 hour in each region in the 12-month period ending in May 2024. In Texas there were 29 negatively priced hours, some as low as USD -84/MWh, but about 70% were above USD -3/MWh.

Negative prices commonly occur during sunlight hours, while solar PV increasingly faces price cannibalization. The likelihood of negative prices is higher during daytime in many regions, such as South Australia, California and Germany. This is driven by the increasing share of solar PV generation that is not fully market-integrated, which faces a not sufficiently price-responsive demand side as well as limited energy storage. In South Australia, for example, where solar PV accounts for almost 20% of total electricity generation, the probability of having negative prices over the period June 2023-May 2024 was above 60% around noon hours. In Southern California, with a similarly high solar PV share in generation, this probability was above 30% at noon. The duration of negative price events also tends to increase when there is a higher solar PV share in supply. In Southern California, from June 2023 to May 2024, 80% of the total negative price events with consecutive prices below zero had a duration of more than 8 hours. This share was 60% in South Australia and 40% in Germany.

More negative prices do not necessarily correspond to lower overall electricity prices Negative prices tend to occur when electricity demand is quite low. Therefore, the total volume of energy traded at negative prices is rather limited, even when the corresponding fraction of time with negative prices is high. Moreover, very low negative prices are quite rare, and most of the negative prices are only slightly below zero. As a result, the impact of negative prices on the overall wholesale electricity cost is small. Nevertheless, consumers which have direct access to wholesale prices, such as large energy consumers in the industry and services sectors, can benefit from negative prices via shifting consumption.

CONCLUSION

Negative prices provide price signals for more flexibility, especially for storage and demand response Negative pricing sends a crucial market signal for flexible supply and demand, including storage, which should be enabled through appropriate market rules for incorporation into the power system. In this context, negative prices can provide incentives for generators to become more flexible in order to avoid losing money and for the consumers to invest in technologies to increase or shift their consumption. Negative prices can also provide market signals to invest in storage, through increasing arbitrage opportunities. In South Australia in Q4 2023, batteries (overall) received more money for charging during negatively price periods than they paid to charge during positively-priced periods. The prevalence of negative prices in South Australia has transformed charging from a source of cost for those batteries into a revenue stream.

While negative prices can incentivise investments in flexibility, they may not be enough on their own. Appropriate regulatory frameworks and market design, as well as updated tariff structures to ensure fair competition between different flexibility options, will be important to allow for uptake in flexibility solutions. Increasing digitalisation and aggregating demand flexibility via virtual power plants are further means of making demand more price responsive. Time-of-use tariffs and smart charging of electric vehicles are important factors that would contribute to greater flexibility on the demand side. Building out grids to resolve congestion issues and improving interconnections with other balancing areas to unlock the flexibility in these systems will also be crucial for increasing the system flexibility.

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