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The evolution of green energy utilization in Romania

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Abstract. *The solar sector is characterized by rapid, decentralized growth, significantly fueled by a "prosumer" movement and government initiatives such as the "Casa Verde" program. With a revised national target of 3,140 MW by 2030, solar offers high scalability and lower entry barriers. Conversely, wind energy remains the industrial "heavy lifter," providing high-volume generation essential for grid stability. While wind investment has recently stalled, the emergence of the Black Sea as an offshore frontier and the maturation of Power Purchase Agreements (PPAs) present significant opportunities for utility-scale development.*
Both sectors face shared challenges, including lengthy permitting processes and grid congestion, necessitating the adoption of Battery Energy Storage Systems (BESS) and "renewable acceleration areas." Ultimately, the choice between solar and wind investment depends on the investor's profile: solar provides agility and faster deployment, while wind offers the industrial scale and high output required for long-term regional dominance. This dual-track evolution is defining Romania's path toward a green, net-zero economy.

Keywords: solar, wind, power, energy, targets.

JEL Classification: Q42, Q48, Q58, G11, L94, O13.

1. Introduction

Romania's energy market is currently navigating a pivotal transition, driven by the dual imperatives of European Union (EU) decarbonization goals and the need to modernize a legacy infrastructure heavily dependent on fossil fuels. As a member of the EU, Romania's renewable energy policies are largely dictated by international obligations and national strategies designed to foster a sustainable, integrated energy market. Within this framework, "renewable energy" is legally defined as power derived from non-fossil sources, specifically highlighting wind, solar, and geothermal energy. While Romania achieved significant greenhouse gas (GHG) reductions since the early 1990s, progress has recently stalled, necessitating a more aggressive deployment of clean energy technologies to reach net-zero by mid-century.

The solar energy sector in Romania has emerged as a dynamic and rapidly expanding segment of the market. This growth is characterized by a mix of large-scale industrial projects and a burgeoning prosumer base, individual households and businesses that both consume and produce electricity. The rise of prosumers has been a significant market driver, supported by national initiatives like the "Casa Verde" program, which provides subsidies for residential photovoltaic installations.

Solar energy offers several distinct market advantages: it provides a path to increased energy independence, significantly lowers electricity costs for participants, and contributes directly to mitigating climate change through CO2 emission reductions. Furthermore, the industrial ecosystem is adapting to support this growth; for example, specialized production sites like ArcelorMittal's Berrioplano facility are now manufacturing specialized structures for solar panels.

Wind energy remains a critical pillar of Romania's renewable strategy, particularly for large-scale electricity generation. The country possesses substantial natural potential for both onshore and offshore wind, yet the sector has faced more volatility in investment than solar. Recent data indicate that investment in new renewable capacity, including wind, has stalled and must accelerate to meet 2030 targets.

Unlike the more decentralized solar market, wind projects typically require massive capital investment and complex coordination with the national grid operator, Transelectrica. While wind energy is essential for replacing retiring coal-fired power plants, which still provide nearly one-fifth of Romania's power, it faces stiffer competition for available grid connection capacity and is more sensitive to high-voltage transmission limitations.

Despite their differences, both solar and wind sectors are hampered by shared administrative and technical bottlenecks. A primary obstacle is the lengthy permitting process; in Romania, obtaining the necessary licenses for renewable projects often takes significantly longer than the two-year limit recommended by the EU. These delays create a "waiting list" for grid access, where developers of both solar and wind projects compete for limited connection capacity within an aging infrastructure.

Technically, the intermittent nature of both sources requires a modernization of the grid. The market is increasingly looking toward Battery Energy Storage Systems (BESS) as a

necessary complement to renewable energy. These storage solutions are vital for stabilizing the grid and ensuring that the variable output from solar (peaking during the day) and wind (variable by weather) can be efficiently distributed to consumers without compromising system security.

The future of Romania's energy market depends on harmonizing financial support with regulatory reform. The OECD suggests that while subsidies for renewables and electric vehicles are helpful, they must be part of a broader "policy mix" that includes consistent carbon pricing and the removal of fossil fuel subsidies to create a truly competitive market. By 2030, Romania aims for renewables to meet 36% of its energy needs for heating and cooling, a target that will require a coordinated push in both the solar and wind sectors. As the legislative framework evolves to simplify licensing and attract foreign investment, the competition between solar's decentralized growth and wind's industrial-scale potential will define the nation's path toward a green economy.

2. The solar energy market

Romania is undergoing a historic energy overhaul, marking its most profound shift since the post-communist era. Driven by EU mandates, regional instability, and a wealth of natural resources, the nation is transitioning from a country of potential to a European leader in renewables. At the heart of this evolution is the solar photovoltaic sector, propelled by explosive capacity growth, a surging prosumer movement, and massive utility-scale investments. The foundation of Romania's solar growth is anchored in its obligations as an EU Member State. The nation's renewable energy policy is dictated by the INECP (Integrated National Energy and Climate Plan), which serves as the roadmap for a decarbonized economy and an integrated energy market.

Romania defines solar energy as a power producer from non-fossil sources, identifying solar alongside wind, geothermal, and ambient energy. It is legally aligned with the EU laws and has created the regulatory certainty required to attract foreign capital. Currently, the government has set an ambitious target to reach a renewable energy share of 34% to 36% by 2030. To achieve this, the national photovoltaic target was recently revised upward from an initial 1,400 MW to a projected 3,140 MW by 2030.

While Romania has made tangible progress regarding the carbon footprint by reducing greenhouse gas emissions from 1990 to 2010, the progress has been paused for the moment. In 2023, the total installed capacity is approximately 18.4 GW, with solar power currently accounting for roughly 8.4% of that mix. The conditions for installing solar panels are favorable, and non-agricultural lands can be used in order to expand the business, suggesting this is only the beginning. Romania boasts an ideal climate for solar energy, particularly in its southern regions. The country receives an average of 1,600 kWh/m² of solar irradiation annually. When combined with relatively low land costs and favorable topography, these factors make Romania one of the most cost-effective locations in Central and Eastern Europe (CEE) for solar development. Perhaps the most visible shift in the Romanian market is the rise of residential or commercial entities that both produce and

consume their own electricity. This movement has transformed the energy market from a centralized model to a decentralized, participatory ecosystem.

The economic incentives for this change would be the national programs, the energy independence needed after the war struck in Ukraine, and the climate change mitigation contribution that can motivate the citizens.

While the small-scale installations are rising, the expansion in this field is done by the industrial solar parks. The major participants are the Ministry of Energy, by setting strategy and policy, the Regulatory Authority, issuing licenses in order to regulate the market, Transelectrica, the state-owned transmission system operator, managing the high-voltage grid and cross-border transmission, and the major distributors like Electrica, Enel, E.On and Hidroelectrica. Because solar is an intermittent resource, the market is pivoting toward Battery Energy Storage Systems (BESS). Integrating BESS is viewed as essential for maximizing economic efficiency and ensuring grid stability. Without storage, the surge in solar production during peak daylight hours could overwhelm an aging infrastructure that was originally designed for constant-load fossil fuel plants. For investors, the market is more accessible than ever. Platforms like PF Nexus are currently facilitating global connectivity for Romanian solar deals. Verified subscribers can analyze live deal flows ranging from 45 MW to as large as 1.4 GW.

The future of solar in Romania is tied to the future political decisions. The OECD recommends that the government complement its renewable subsidies with consistent carbon pricing, removal of fossil fuels, and infrastructure digitalization.

3. The wind energy market

While solar energy has recently captured the public imagination through residential prosumer growth, wind energy remains the industrial heavy lifter of Romania's green transition. As the nation aligns itself with European Union (EU) decarbonization mandates, the wind sector is being repositioned as a vital pillar for achieving a sustainable, net-zero economy. Romania possesses some of the most significant wind potential in South-Eastern Europe, making it a hotspot for large-scale utility projects and international investment.

Wind energy has historically been the primary driver of Romania's renewable electricity generation. As of late 2023, the country's total power capacity stands at approximately 18.4 GW. Within this mix, wind energy has long maintained a more substantial share than solar, providing the high-volume output necessary to balance the national grid as traditional coal plants are phased out. In August 2023, renewable resources, predominantly hydropower and wind, accounted for roughly 40% of the total generated power delivered by producers. This solid foundation is essential for meeting the targets set in the Integrated National Energy and Climate Plan (INECP), which aims for a renewable energy share of 34% to 36% by 2030. However, the market currently faces a paradox: while the natural resource is abundant, investment in new capacity has recently stalled and must accelerate rapidly to meet these end-of-decade goals.

Romania's wind energy potential is not uniformly distributed but is concentrated in high-performance corridors. In Dobrogea, between the Danube River and the Black Sea, the wind assured the perfect conditions for wind energy production, due to its consistent and high wind speeds. The coastal and offshore areas of Black Sea represent the next frontier. Romania is actively working to establish a legal framework for offshore wind, which is expected to unlock gigawatts of new capacity. While solar relies on 1,600 kWh/m² of irradiation, wind projects benefit from Romania's varied topography, allowing for diverse turbine placements in both mountain passes and open plains. The success of wind energy is entirely dependent on the capacity of the national grid to absorb and transport large volumes of electricity from rural generation sites to urban industrial centers.

Because wind is an intermittent resource, the market is increasingly focused on Battery Energy Storage Systems (BESS). Managing the sudden surges in power when wind speeds peak, storing excess power generated during low-demand periods, and ensuring the grid remains at a stable 50Hz frequency(which is critical for industrial equipment safety).

Obtaining the necessary environmental permits, construction licenses, and grid connection approvals in Romania often takes significantly longer than the two-year limit recommended by the EU. These delays can stretch projects into five-year cycles, increasing capital costs and financial risk. To solve this, the government is planning to designate renewable acceleration areas.These are specific geographic zones where environmental impact assessments have been pre-conducted, and administrative procedures are streamlined.

A massive shift is occurring in how wind projects are financed. Historically, developers relied on government-backed certificates. Today, the market has matured toward Power Purchase Agreements (PPAs).

Industry leaders like Rezolv Energy are at the forefront of this shift. As the PPA (Power Purchase Agreement) market in Southeast Europe matures, it's becoming much easier for corporations to lock in long-term contracts for clean energy. A major game-changer here is the Virtual PPA (VPPA) model. This setup allows companies based anywhere in Europe to effectively buy the "green" attributes of wind power generated in Romania, regardless of where their offices or factories are actually located. Because of this flexibility, Romania has turned into a regional investment hotspot; it allows international brands to hit their sustainability goals immediately by tapping into Romanian wind farms, even if the renewable capacity in their own home countries is still lagging behind.

4. A comparison of the two sectors

In Romania, the competition and synergy between solar and wind energy are at the heart of the nation's green transition. While wind energy has traditionally anchored the renewable sector, solar energy is currently undergoing a more rapid, decentralized expansion. This comparison explores their roles, targets, and the infrastructure supporting their growth.

Wind energy has long been the primary driver of Romania's renewable electricity generation. In 2023, wind remained a larger contributor to the overall energy mix than

solar. Together with hydropower, these sources accounted for approximately 40% of the total generated power delivered by producers as of August 2023. In contrast, solar power has historically played a smaller role, currently making up roughly 8.4% of Romania's total 18.4 GW capacity. However, the sector is at a pivotal "crossroads," with the government significantly raising its solar ambitions due to favorable conditions like high irradiation and low land costs.

The government's shifted priorities are clearly visible in the Integrated National Energy and Climate Plan (INECP), which targets a total renewable energy share of 34% to 36% by 2030. The national target for photovoltaic (PV) energy has been aggressively revised upward from 1,400 MW to 3,140 MW by 2030. While wind remains critical, the focus is expanding toward offshore wind in the Black Sea, where the government is currently developing a legal framework to unlock massive new capacity.

A major point of comparison is how these technologies are integrated into the market. Solar growth is increasingly driven by prosumers, individuals, and businesses that produce and consume their own energy. Supported by subsidies like the "Casa Verde" program, this decentralized growth offers benefits like lower costs and energy independence. Wind projects are almost exclusively large-scale, utility-led endeavors. They require high-voltage transmission managed by Transelectrica and are essential for replacing the base-load power lost from retiring coal plants.

On the natural resources topic, Romania enjoys an average of 1,600 kWh/m² of annual solar irradiation, with prime locations concentrated in the southern regions, while resources are most potent in the Dobrogea region and along the Black Sea coast. These areas offer high capacity factors and are the primary focus for the next generation of onshore and offshore farms.

Both sectors share common technical and administrative hurdles that require urgent attention. The intermittent nature of both wind and solar makes Battery Energy Storage Systems (BESS) a market necessity. Integrating storage is vital for stabilizing the grid and ensuring economic efficiency. For both technologies, the licensing process often exceeds the EU-recommended two-year limit. The government is considering renewable acceleration areas to fast-track permitting for both solar and wind. The INECP emphasizes the need for smart metering and smart network technologies to handle the bidirectional energy flow from solar prosumers and variable wind generation.

5. Conclusion

To conclude, the choice between solar and wind investment in Romania is not a matter of one being objectively better than the other, but rather which aligns with an investor's risk profile, scale, and time horizon. Both markets are currently "hotspots" driven by the maturation of the Power Purchase Agreement (PPA) market and the urgent need to replace retiring coal-intensive infrastructure.

Solar energy is arguably the better investment for those seeking faster deployment and diversified risk. Romania's high annual irradiation (1,600 kWh/m²) and the government's

aggressive upward revision of PV targets (from 1,400 MW to 3,140 MW by 2030) create a high-growth environment. There are low entry barriers and rapid scalability. Developers like Rezolv Energy are proving that solar can also play in the big leagues, with plans for Europe's largest solar plant in western Romania.

Wind energy is the superior investment for large-scale institutional players focused on utility-scale dominance. While investment has recently stalled, this creates a vacuum that savvy investors can fill as the government pushes for 2030 targets. The Black Sea is the next big area for massive energy projects. Investors who get involved now can help set the rules and technical standards for offshore wind power. By starting early, they can gain a first-mover advantage in a market that is known for producing a high and steady amount of electricity. Wind is basically the backbone of the power grid. Since it pumps out such a huge amount of energy, it's a perfect fit for the Virtual PPA model. This is where big international companies basically buy up the green bragging rights from Romanian wind farms to hit their global sustainability targets.

If you are an investor looking for agility and shorter permitting cycles, solar is currently more attractive. Its decentralized nature and strong prosumer support make it less vulnerable to the massive grid-congestion issues that plague large wind farms. However, if you are a long-term institutional investor, wind offers the scale and high output necessary to dominate the regional energy market.

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