Accurate yield predictions help renewable energy take centre stage in the European Green Deal

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The energy sector faces a dual challenge of meeting increasing energy demands while the climate crisis is forcing a transition to low-carbon-emitting energy sources. Nuclear power is one such option, but its drawbacks, including high building and maintenance costs, nuclear waste disposal, and safety concerns, have resulted in the sector's slow growth in recent years.

Renewable energy sources such as wind and solar power are now playing the key role in the energy transition, but their weather-dependent nature poses challenges to grid stability. Accurate yield predictions are crucial to maintaining the power grid system's balance between production and consumption.

Potsdam-based startup 4cast is developing real-time forecasting platforms that leverage data science and machine-learning models to predict the electricity output of individual photovoltaic or wind plants to entire parks. This allows renewable energy producers to generate higher revenue while facilitating grid stability.

The modern era is marked by an unprecedented thirst for energy, as people have become accustomed to the abundance of electricity with greater availability than ever before. Nearly every step in the daily routine of the modern individual would be impossible without consuming substantial amounts of energy. While the energy consumed by households is significant, it pales compared to industries' massive appetite for it.

Furthermore, this demand is projected to grow exponentially in the future. Experts have predicted that by 2050, Europe's electricity demand may double, further exacerbating the challenge of meeting this enormous demand[1].

Meeting the energy requirements alone is already challenging, but it seems nearly impossible in the face of the ongoing climate crisis. To prevent further environmental damage and ensure a sustainable future for further generations, it is imperative to fundamentally transform how energy is sourced and utilised.

The Paris Agreement, which has received global attention, represents a critical step in addressing the challenges of climate change[2]. The agreement mandates the reduction of greenhouse gas emissions, requiring a radical shift in the approach to energy generation and consumption.

Therefore, the options for energy sources have to be severely restricted, substituting fossil fuels with carbon-neutral alternatives when powering industries and stopping using greenhouse-gas emitting sources for generating electricity. Hence, it is evident that the future of energy production requires a much greater scale of electricity generation.

The EU introduced the European Green Deal[3] to meet the Paris Agreement by setting targets for member states in the energy transition including achieving net-zero emissions by 2050. However, due to the significant variation in energy mixes among the countries, there is substantial disagreement on the best way to accomplish this goal. For example, European countries hold fundamentally different opinions regarding the role of nuclear power in the future energy mix[4].

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Nuclear energy has been promoted as a cheap and more climate-friendly alternative to fossil fuels, emitting only a fraction of the carbon emissions of coal and natural gas.

However, there has yet to be a consensus within the EU about the role that nuclear energy should play in the coming years.

While Germany banned nuclear power from its energy mix in April 2023[5], and Belgium and Spain have at least plans to phase out by 2035[6,7], France remains heavily reliant on nuclear power, accounting for more than 70% of its electricity generation[8]. Poland also plans to reduce its dependence on coal by constructing its first nuclear reactor in 2033 to meet its energy needs[9].

However, taking a closer look shows how problematic it is to count on nuclear energy. For one, constructing and maintaining nuclear power plants is extremely expensive compared to renewable energy sources. Due to their dependence on water for cooling, nuclear power plants can face operational difficulties in areas with water shortages or high temperatures. This was apparent in 2022 when France had to temporarily shut down half of its reactors due to a combination of high maintenance needs, record-high temperatures, and water shortages in the summer[8,10,11].

In addition, nuclear power plants generate hazardous nuclear waste that remains radioactive for thousands of years, requiring expensive and intricate processes for safe storage and disposal. A widely accepted long-term nuclear waste storage solution is yet to be found[12].

Finally, nuclear accidents can potentially cause severe and devastating consequences, as seen in the 1986 Chernobyl disaster in Ukraine and the 2011 Fukushima disaster in Japan[13].

These drawbacks have led to a relatively slow growth of nuclear power in recent years worldwide. Thus, with nuclear power not playing a significant part in the energy transition, achieving the energy transition to a carbon-free future relies heavily on the two primary driving energy sources: wind and solar.

Despite their different energy mixes, this conclusion is a widespread consensus among the individual countries. Following the planned phase-out of nuclear energy and coal burning by 2038, Germany has set ambitious targets to generate 80% of its power through renewables by 2030.

To achieve this goal, Germany has introduced several bills to accelerate the rollout of wind and solar power, although it failed to meet the necessary intermediate threshold in 2022[14].

Meanwhile, struggling under the unexpected fallouts of nuclear power and growing critics within the country, France has been under pressure to reduce its dependence on nuclear power and increase the share of renewable energy in its energy mix[8]. The country has set targets for reducing greenhouse gas emissions by particularly focusing on expanding wind and solar power[15]. In addition, the government is investing 1 billion Euros in renewable energy innovation projects until 2030[15].

Even though Poland's energy sector still relies heavily on fossil fuels, the country has made remarkable strides in energy transition, particularly in the solar photovoltaic market, which grew from just 0.2GW to 7.7GW between 2016 and 2021. Since 2019, the country has provided subsidies for installing solar panels in private households[17] and has a well-designed offshore wind strategy with plans for at least 11 GW by 2040[18].

The increasing availability and affordability of renewable energy options are causing many industries to consider becoming self-sufficient. Worldwide, companies are starting to generate energy by installing solar panels and wind turbines. This step helps the companies decrease their carbon footprint while providing long-term cost savings and energy security. By generating their own electricity, industries can avoid fluctuations in energy prices and supply disruptions[19].

With the expansion of renewable power comes a new challenge: Fluctuations in electricity production due to weather-dependent wind and solar power pose a significant challenge to grid stability. Maintaining stability requires balancing between production and consumption[20], which can be achieved through storage systems, green hydrogen production, and adopting a more resilient, smart grid.

Accurately predicting electricity production plays a crucial part in this. Electricity is traded at cross-border energy markets through auctions in day-ahead and intraday markets[21]. This design of the electricity trading market incentivises producers to sell electricity at optimal prices for which they need accurate yield forecasts.

The challenge of ensuring the most accurate yield forecasts has spawned an entirely new market, with companies like Potsdam-based startup 4cast developing strategies to predict the electricity production of wind and solar plants. 4cast's experts have created a platform based on state-of-the-art machine-learning models that provides real-time forecasts of the electricity output of individual photovoltaic or wind plants to entire parks.

This technology has considerable potential to support the energy transition in Europe. It can boost the competitiveness of renewable energy producers on the market while simultaneously facilitating monitoring of the stress level fluctuations in electricity production induced by the power grid system.

In conclusion, achieving a sustainable and carbon-free future is complex and challenging, demanding a fundamental transformation in the energy generation while investing heavily in renewable energy, energy efficiency, and grid infrastructure.
A critical aspect of this transition is ensuring grid stability, which requires innovative methods to generate precise yield forecasts, such as those offered by companies like 4cast.

https://4-cast.de

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