Dispatchable power: critical for the energy transition

Concerns over grid stability, energy affordability, and security of supply are growing. ETN Global's latest white paper, *The critical role of dispatchable power generation for a sustainable and secure energy transition*, looks at how Europe can strike a balance between avoidance of energy shortages and meeting of climate targets, identifying four key challenges that must be addressed

Flexibility challenge

The European electricity landscape is undergoing a significant transformation, shifting from a fossil fuel dominated system to one primarily based on variable renewable energy (VRE) sources. As more of these non-dispatchable renewable energy sources are integrated, the grid must become more flexible to balance periods when the wind is not blowing and/or the sun is not shining.

This challenge is further amplified by the rising demand for electricity, due to increasing electrification in households, industry and mobility.

By 2030, Europe will need much more flexibility to manage the daily, weekly, and monthly variability in electricity supply and demand, as highlighted by the European Commission's Joint Research Centre (Figure 1).

According to ENTSO-G (European Network of Transmission System Operators for Gas) the flexibility in energy to support the aforementioned changes needs to increase by 40-65% by 2050.

As Europe relies increasingly on renewable energy, the grid will need to be much more robust and capable of compensating for peaks and troughs in demand to ensure that a reliable electricity supply is always available. Without enough flexibility, the grid could experience issues such as blackouts, especially as overall demand rises, and the renewable energy share becomes more prominent.

This necessitates significant investments in dispatchable energy solutions, energy storage systems, and smart grids, to maintain grid stability and ensure reliable, affordable, and low-emission electricity supply.

Grid stability challenge

As the integration of VRE sources increases, managing VRE deficits becomes crucial to stabilise the electricity grid. A mismatch between instantaneous demand and supply can jeopardise the balance of the electricity system if not backed up by demand response together with dispatchable generation and storage systems.

To meet flexibility requirements, we need sustainable dispatchable power generation technology that can provide reliable flexibility services, including load following, peaking, backup capacity (spinning reserve), grid services (rotating inertia, frequency control), and medium-to-long-term storage solutions as well as black start capabilities.

As shown in Table 1, thermal turbines are just such a technology, able to provide clean and flexible generation and cover electricity grid requirements. Thermal turbines can operate as clean generation options either with the deployment of post combustion CCS or by using clean fuels – eg, sustainable hydrogen or e-fuels. Such fuels can be stored for long periods before reconversion to power and heat via dispatchable thermal turbines, making them an essential part of decarbonisation strategies. Indeed, power-to-hydrogen-to-power remains the only viable option for long term energy storage at large scale with the current state of technology.

Changing future needs could see dispatchable thermal turbines integrated with ultra-fast response technologies such as batteries and flywheels. These integrated systems can improve

"The technology for dispatchable, carbon-neutral power generation, via hydrogen, other sustainable fuels, or CCUS, is already available or well under development. The real challenge is the lack of long-term policy frameworks and economic incentives to support investment in newly built capacity or to extend the life of existing assets. This is critical, as reduced operating hours make it increasingly difficult to sustain commercial viability. Bridging this gap is essential to securing Europe's energy future."

Christer Björkqvist, Managing Director, ETN Global

Four calls to action by ETN Global

1. Flexibility
We urge the EU policymakers to implement policies that will enable a two-fold increase in the availability of flexible resources, such as dispatchable energy solutions, smart grids and energy storage, by 2030, while preparing for a five-fold increase by 2050.

2. Grid stability
We urge the EU policymakers to recognise the critical role of dispatchable generation technologies, such as thermal turbines, in ensuring grid reliability and stability. These technologies, particularly when fuelled by hydrogen and other carbon-neutral options, must be supported through targeted incentives and regulatory frameworks to secure their integration into the energy mix.

3. Carbon-neutral fuel
We urge the EU policymakers to prioritise the rapid deployment of hydrogen and carbon-neutral fuels as essential components of Europe's energy transition. This requires targeted investments in hydrogen and other low-carbon/carbon-neutral fuel production, infrastructure development, and the testing and scaling of hydrogen-fuelled turbines and synthetic fuel technologies.

Clear policies and financial incentives are needed to make these fuels more affordable and widely available, ensuring their integration into the energy grid.

4. Ageing fleet
We urge the EU policymakers to implement appropriate financial incentives and supportive regulatory frameworks that encourage the extension of the operational lifespan of existing dispatchable thermal turbine fleets to ensure energy security for the future.

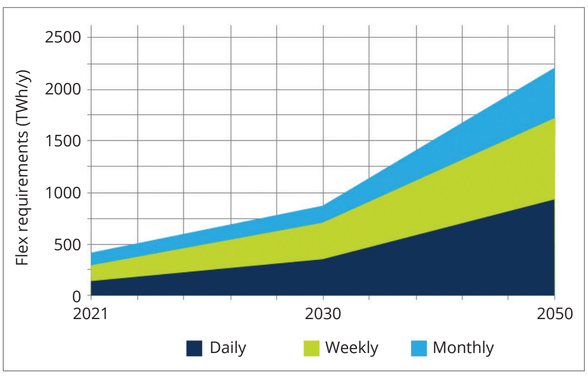

Figure 1. The increasing demand for daily, weekly and monthly flexibility according to the European Commission's Joint Research Centre. (Source: **D. Koolen, M. De Felice, and S. Busch**, *Flexibility requirements and the role of storage in future European power systems*, Publications Office of the European Union, Luxembourg, 2023, JRC130519)

Scan this QR code for a link to the ETN Global white paper, *The critical role of dispatchable power generation for a sustainable and secure energy transition*

Table 1. Flexibility matrix of clean thermal generation options (vertical axis) and the flexibility services they can provide (horizontal axis)

	Primary control reserve (FCR)	Secondary reserve (aFFR)	Tertiary reserve (mFFR)	Daily flexibility	Seasonal flexibility
Combined cycle + CCS	Yes, conditional	Yes, conditional	Yes, conditional	Yes, optimal	Yes, optimal
Combined cycle, H_2/e-fuel	Yes, conditional	Yes, conditional	Yes, optimal	Yes, optimal	Yes, optimal
Open cycle, H_2/e-fuel	Yes, conditional	Yes, optimal	Yes, optimal	Yes, optimal	Yes, optimal
Battery integration	Yes, optimal	Yes, optimal	Yes, optimal	Yes, optimal	Yes, conditional

Suited to provide the service:
Yes, optimal   Yes, conditional (spinning reserve/seasonal storage)

response times and reduce the need for spinning reserves, leading to significant reductions in emissions and fuel consumption.

Despite the vital role of flexible thermal turbine-based capacity in guaranteeing the security of electricity supply and resource adequacy, current policies lack detail on the critical role this technology can play in providing the required dispatchable capacity in present and future energy systems.

It is nevertheless promising that several European countries, in recent energy and climate plans, identify hydrogen and decarbonised dispatchable turbine technologies as having a role to play.

Carbon-neutral fuel challenge

Transitioning to carbon-neutral fuels is the cornerstone of decarbonisation efforts and is already well underway, with turbine manufacturers and asset owners collaborating to demonstrate the technical feasibility of low-carbon fuel/carbon-neutral fuel and CO_2 capture technologies.

Biofuels and synthetic fuels provide a market-ready option today. Several full-scale tests have proven the capability of modern dispatchable turbines to operate with biofuels — eg, fatty acid methyl ester (FAME), hydrotreated vegetable oil (HVO) — and other synthetic fuels derived from green hydrogen. When combined with the use of post-combustion carbon capture, a negative carbon balance could be achieved.

Hydrogen is a particularly promising fuel. Thanks to modern combustion systems, NO_x emissions can be kept low – even if 100 vol % of hydrogen is used, and can be even further reduced to almost zero using post-combustion treatments.

Surplus electricity can be converted into hydrogen via water electrolysis, which can subsequently be re-electrified with thermal turbines or converted into synfuels like ammonia, e-methanol, and e-methane.

Despite its potential as a secure, and dispatchable option, the widespread adoption of hydrogen-fired turbines faces significant barriers, including the limited availability and high costs of hydrogen. While full-scale testing of 100% hydrogen turbines has begun, efforts remain constrained by these challenges. To build confidence and attract future investments, it is essential to conduct large-scale operational testing. Achieving this will require a sufficient and reliable supply of hydrogen to be available in the coming years.

Ageing fleet challenge

According to ENTSO-E (European Network of Transmission System Operators for Electricity), flexible generation, currently dominated by dispatchable thermal turbines, will see a net decrease in capacity from 2025, if no remedial actions are taken.

This substantial reduction in flexible capacity, mainly triggered by economic decommissioning, will inevitably create a substantial adequacy risk. Appropriate incentives and targeted interventions will be necessary to mitigate these risks.

Extending the lifespan of existing dispatchable thermal turbine plants is technically feasible for many, but it is not commercially viable under current market conditions due to high capital investment requirements, uncertainty about fuel price and availability, and revenue risks, all of which complicate investment decisions. MPS