Operating Artificial Intelligence for Demand-Side Flexibility

Position Paper

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Scope and purpose

This paper presents evidence-based insights on the use of Artificial Intelligence (AI)[1] in demand-side flexibility (DSF). It reflects the diversity of operational realities across the **Flexible Demand Management Industry (FDMI)**[2], ranging from companies with AI fully embedded in live operations to those still experimenting, testing, or relying primarily on advanced optimisation rather than machine-learning-heavy approaches.

The objective of the paper is twofold:

- To demonstrate that the **FDMI is an innovative and competitive clean tech industry as it already embeds AI in significant parts of DSF business models**, and is therefore an experienced interlocutor for any EU policy discussion on AI applications in the energy sector;
- To illustrate that **AI-enabled DSF constitutes a mature and system-relevant clean-tech activity**, whose regulatory treatment will directly affect European energy security, competitiveness, and decarbonisation.

The paper is structured under different thematic areas and concludes with insights relevant for EU policymakers. What emerges from this paper is not a uniform technological approach, but a shared operational logic: AI-enabled systems are used to manage/deal with the uncertainty, optimise constrained assets in real time, and coordinate large numbers of distributed resources under evolving market and grid conditions. Differences between FDMI players primarily reflect levels of maturity, emphasis on optimisation versus machine learning, and risk appetite, rather than disagreement on the opportunities that AI can offer in DSF.

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[1] Artificial Intelligence includes the following technical approaches:

- Machine Learning (ML)
- Deep Learning (DL) (a subset of ML)
- Symbolic / Rule-based AI
- Statistical approaches
- Logic-based and knowledge-based systems

[2] For an overview of the different market players and business models for demand-side flexibility, please have a look at the smartEn Map 2025 https://smarten.eu/wp-content/uploads/2026/02/the_smarten_map_2025_DIGITAL_S-1.pdf

PART I – AI use for operational and system value

1. AI as an operational backbone for optimisation and forecasting in demand-side flexibility

First, a striking pattern across FDMI companies is the degree to which AI is no longer positioned as a marginal efficiency enhancer, but as **an important layer without which DSF business models would simply not function**. This is most explicitly articulated by FDMI market players which coordinate hundreds of thousands of distributed energy resources (DERs) and argue that balancing the grid across multiple network levels while respecting user preferences is impossible without AI.

AI is indispensable to **managing the growing scale and heterogeneity of portfolios**, noting that traditional analytical approaches cannot cope with the speed, volatility, and dimensionality of modern electricity markets. The orchestration of EVs, heat pumps, batteries, e-boliers and other DERs under uncertainty creates optimisation problems that are computationally infeasible without advanced techniques. Even where FDMI players emphasise mathematical optimisation over machine learning, the reliance on automated, software-driven decision-making remains absolute.

Critical gains are the ability to integrate comfort constraints into bidding decisions or to reduce exposure to imbalance and underperformance risks. The consistent comparison with pre-AI approaches highlights **learning effects and operational maturation**. AI is not presented as an abstract optimisation exercise, but as a tool that materially improves outcomes under market conditions.

Several FDMI players already deploy AI-enabled simulations and optimisation in live operations rather than pilot or research settings, although some experimentation or testing phases are ongoing, which is a proof of the ongoing innovation cycle within the FDMI.

Approximately **20% improvement in forecasting error** is quantified following the introduction of AI. Forecast outputs are systematically used as inputs into optimisation engines for flexibility dispatch, bidding, and real-time control of different DERs.

The implication is clear: AI used for DSF[3] should be understood less as a novel technology awaiting cautious introduction and more as critical digital infrastructure already embedded in system operations.

2. AI adoption driven by the energy system needs

AI adoption is consistently framed by the FDMI as **a response to structural changes in the energy system** rather than a discretionary technology choice. Increasing decentralisation, higher volatility, growing data volumes, and stricter operational requirements are the primary drivers. Traditional analytical methods are insufficient to manage large portfolios of heterogeneous assets operating across multiple markets and network levels. AI enables **faster, more accurate decision-making and increases efficiency**.

AI deployment in DSF is not speculative experimentation but a necessary adaptation to the realities of a renewable-heavy energy system.

3. Optimisation and real-time decision-making as a physical system requirement

Continuous or near real-time optimisation[4] is not simply a design choice, but a physical necessity arising from the characteristics of flexible assets. All DERs operate under changing conditions driven by consumer preferences, weather variability, grid constraints, market signals, and state-of-energy limitations. These dynamics cannot be managed through static approaches.

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[3] This statement is valid only in the context of established AI applications, which are mature, well-proven, and already trusted in operational grid environments. It does not apply to generative AI (genAI), which is a recent technology with non-deterministic outputs and cannot yet be considered reliable for critical grid operations, beyond controlled pilot use.

[4] Commission Implementing Regulation (EU) 2023/1162 - this EU regulation defines near real-time metering and consumption data in the context of energy data access as: “near real-time metering and consumption data” means metering and consumption data provided continuously by a smart meter in a short time period, usually down to seconds or up to the imbalance settlement period in the national market, which is non-validated and made available through a standardised interface or through remote access.”

AI-enabled systems are used to **continuously reassess commitments, constraints, and opportunities, ensuring compliance with market rules and contractual obligations while adapting to real-time uncertainty**. This capability is essential to **deliver grid services reliably, particularly during fast-changing system events** such as frequency deviations, renewable output swings, or congestion management interventions.

More importantly, the continuous optimisation is implemented with predefined parameters, human supervision, and guardrails. **Automated re-optimisation does not replace accountability**, rather it enables flexible resources to respond at the speed required by the power system.

4. AI as system value beyond individual business optimisation

For several FDMI players the primary direct beneficiary of AI deployment is to improve their value proposition: **AI-enabled flexibility improves the quality, reliability, and predictability of services delivered to system operators, while also translating into tangible benefits for customers and end users**.

Major positive outcomes are **improved grid stability, more accurate and reliable flexibility delivery, enhanced comfort for building occupants during demand response events, and lower energy costs for consumers participating in flexibility programmes**. Several FDMI market players explicitly link better-informed bidding and dispatch decisions to reduced welfare costs and more efficient system operation. This framing positions **AI-enabled DSF as a system resource** rather than an individual optimisation tool. AI deployment delivers measurable and operationally relevant performance improvements. These include higher forecasting accuracy, faster and more reliable decision-making, improved risk management, and increased flexibility in volumes that can be confidently offered into markets.

The above outcome reinforces the need to assess AI in flexibility through a system-value lenses, rather than solely through the perspective of digital innovation or competition policy.

5. AI as indispensable infrastructure for scaling flexibility across Europe

AI is indispensable to scaling DSF across Europe. Automated forecasting, real-time control, coordination of large numbers of distributed assets, and multi-objective optimisation are repeatedly identified as functions that cannot be delivered at scale without AI.

Scaling flexibility involves managing thousands to millions of assets while respecting user preferences, technical constraints, and market rules. **AI enables this coordination in a way that is repeatable across markets and adaptable to local conditions**.

This evidence suggests that the scalability of flexibility, and by extension the scalability of electrification and renewables integration, is tightly coupled to the ability to deploy AI at scale under enabling regulatory frameworks.

Part II – EU AI regulatory frameworks

6. Crucial features of an EU enabling AI framework

Looking at 2030, smartEn believes that AI should be prioritised for **performance-critical functions** rather than specific technologies. Short-term market and customer forecasting, near real-time optimisation, portfolio bidding, and modelling of network stress and asset behaviour are crucial.

smartEn explicitly **cautions against prescribing AI methods or architectures**. Instead, it emphasise interoperability, harmonisation of flexibility requirements, and **outcome-based performance metrics** as the most important enablers of scale. This perspective reflects a mature industry stance: innovation is expected to continue, but policy should focus on what systems must deliver, not how algorithms are designed. AI contributes directly to market reliability and investability, strengthening the business case for flexibility as a dependable system resource.

smartEn warns **against overly restrictive, prescriptive, or fragmented regulation**. Particular concern is expressed about restrictions on access to technical data, mandates on specific AI approaches, or compliance obligations that ignore operational and economic realities. Such approaches could directly reduce flexibility volumes, increase costs, and slow the deployment of resources that already support grid stability and consumer outcomes.

The preferred alternative is outcome-based, technology-neutral regulation that safeguards system performance and accountability while **preserving room for innovation and adaptation**.

Any EU AI regulatory framework should rely on **transparency, auditability, performance guarantees and human oversight** to enable AI systems operating in grid-critical contexts.

In particular, it is important to **trace decisions, explain outcomes to system operators, and intervene or override automated actions when necessary** because trust and reliability is a functional requirement for system stability rather than an abstract ethical aspiration. This operational understanding applied by the FDMI sector aligns closely with existing EU AI governance objectives, suggesting that many principles of trustworthy AI are already being implemented in practice.

The sector fully supports robust **cybersecurity and data protection frameworks for both AI and non-AI software solutions**. At the same time, attention should be paid to the cumulative cost and compliance burden linked to cybersecurity and data protection obligations, which should be **proportional particularly for emerging and smaller FDMI market players**.

7. Structural and regulatory barriers to AI deployment

The main barriers identified by the FDMI to scale-up with the support of AI relate to **data access, regulatory fragmentation, and market design** rather than to technical feasibility. Relevant data[5] is often heterogeneous across system operators – Transmission System Operators (TSOs), Distribution System Operators (DSOs,) suppliers, Original Equipment Manufacturers (OEM), and platforms.

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[5] **Data Collection:** Fundamentally, data must first be collected, which means that appropriate digital components or related field data (e.g. market) are required to measure the necessary data. This (raw) data sets are often unstructured, incomplete, error prone, and stored in proprietary formats. As a result, data exchange across stakeholders or even internal data use across one application within a company is often not possible.
Data Provision: Providing high quality data in standardized, machine-readable formats is the essential foundation for any subsequent data use.
Data access: Furthermore, clear rules for data access rights, including the conditions under which data can be made available, unless this is already mandatory, must be firmly regulated.
Data exchange: Finally, data exchange must be enabled and governed in a standardized manner, for example via data spaces.

Divergent national requirements and limited harmonisation for data collection, provision, access and exchange across EU markets are barriers, which increase adaptation costs and slow cross-border scaling.

Conclusion

Taken together, the FDMI sector is already operating AI-enabled systems at scale, under real market and grid conditions, and with direct exposure to both operational and regulatory risk. Across the Flexible Demand Management Industry, AI, especially ML, is not a future-facing experiment, but an embedded component of how flexibility is forecast, optimised, and delivered today. smartEn members are not asking EU policymakers to anticipate hypothetical technological developments but instead highlighting how current choices on AI governance, data access, and market design are already shaping the performance of flexibility resources in Europe. In this sense, DSF is not peripheral to EU AI policy in energy but constitutes a live stress test.

If AI rules are compatible with the operational realities of flexible demand management, they are likely to be compatible with the wider energy transition. If they are not, the consequences will be immediate and tangible, such as, reduced flexibility volumes, lower system reliability, higher costs for consumers, and weakened European clean-tech competitiveness.

EU AI and energy rules must therefore treat AI used by the Flexible Demand Management Industry as critical operational infrastructure, not as discretionary or experimental digital technology. Regulatory approaches that constrain continuous optimisation, restrict access to essential technical data, or impose prescriptive design choices risk directly undermining system performance rather than enhancing trust or safety.

Based on the evidence provided, smartEn members should be recognised as credible, experienced, and necessary interlocutors in shaping EU AI and clean energy policy.

About smartEn - Smart Energy Europe

smartEn is the European business association of the Flexible Demand Management Industry. We integrate consumer-driven solutions in the clean energy system by unlocking demand-side flexibility. Our mission is to create opportunities for every company, building, and vehicle to support an increasingly renewable energy system.

Our membership consists of the following companies:

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