sympower

The Power of Flexibility

How Demand Response is Driving Efficient, Stable and Sustainable Grids

Table of content

Acronyms

The following acronyms are used in this whitepaper:

DR
Demand Response

DSF
Demand-side flexibility

BM
Balancing Markets

C&I
Commercial & Industrial

BESS
Battery Energy Storage Systems

TSO
Transmission System Operator

DSO
Distribution System Operator

HVAC
Heating, Ventilation, and Air Conditioning

FFR
Fast Frequency Response

FCR
Frequency Containment Reserve

aFRR
Automatic Frequency Restoration Reserve

mFRR
Manual Frequency Restoration Reserve

RR
Replacement Reserve

Introduction

The climate crisis is set to reshape our world, and our energy systems are no exception. The energy transition marks a drastic shift from fossil fuels like gas, coal, and oil to cleaner, renewable energy sources such as wind, solar, and hydro. But this transformation is far more than a technological change. It demands a united effort to build the systems and infrastructure needed to embrace renewable energy. Only through collective action can we ensure that this transition is not only successful but also equitable and impactful.

At Sympower, we are driven by the vision of creating a truly sustainable energy system.

This whitepaper is a reflection of that commitment, and we're thrilled to share it with you as we work together towards transforming our energy systems.

Climate Crisis, the Energy Transition, and the Grid

To combat CO_2 emissions from electricity generation, transitioning from fossil fuels to renewable energy sources like solar and wind is essential. Yet, the very nature of these renewables presents a challenge: their output depends on the weather, making it intermittent and difficult to predict. This unpredictability increases the complexity of maintaining a stable electricity grid, where supply and demand must remain perfectly balanced at all times to prevent disruptions.

Grid stability hinges on maintaining a consistent frequency of 50 Hz, and any imbalance – whether caused by unexpected demand spikes, generation outages, or inaccurate forecasts – can destabilise this frequency. These fluctuations can lead to costly blackouts or even damage devices connected to the grid. As renewable energy becomes a larger share of our electricity mix, managing grid balance is becoming significantly more complex.

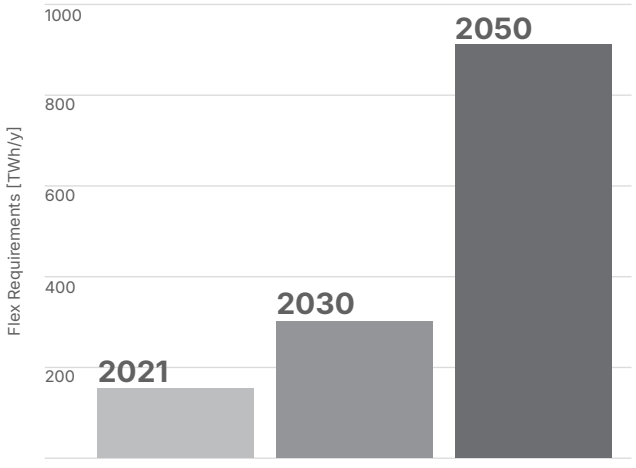
Traditionally, large thermal power plants, such as coal and gas facilities, provided grid stability by rapidly adjusting their output to match supply and demand. These plants also created inertia in the grid (the grid's resistance to changes in frequency), thereby stabilising the system. However, as we phase out fossil fuels in favour of renewables this inertia decreases, making it harder to manage frequency fluctuations and increasing the need for flexible capacity.

This shift towards renewable energy drives an urgent need for system flexibility across multiple timescales, from short-term adjustments (hourly or daily) to longer-term solutions (seasonal or multiannual). According to the International Energy Agency (IEA), the demand for daily flexibility is expected to increase more than fourfold by 2050 (as shown below). To create a secure and sustainable energy system, it's vital to integrate enough clean and flexible resources to complement intermittent renewable generation.

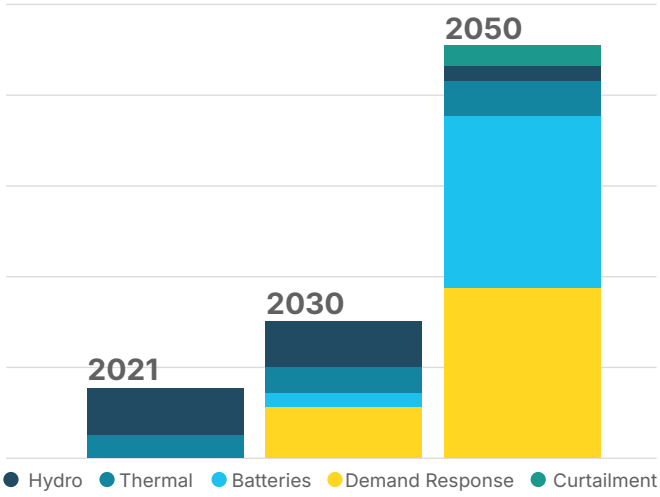
Demand-side flexibility (DSF) plays a critical role in meeting this challenge by strategically adjusting or reducing energy consumption during critical moments. A key mechanism of DSF is Demand Response (DR) which ensures the balance between supply and demand. In fact, the IEA projects that ~40% of daily flexibility will be provided by Demand Response programs by 2050. Aggregating distributed resources, such as industrial machinery, can deliver substantial contributions to grid stability.

This whitepaper highlights the immense potential of Demand Response while also examining the role of Battery Energy Storage Systems (BESS), which are anticipated to contribute an additional 40% of daily flexibility needs. Together, these solutions are critical to achieving a resilient and sustainable, energy future.

Graph 1: Daily flexibility requirements in Europe.



Graph 2: Flexibility needs coverage by technology.



Sources of data: Graph 1, *Joint Research Center of the European Commission – Flexibility requirements and the role of storage in future European power systems, 2023.* ***Graph 2,*** *IEA - World Energy Outlook 2023, Announced pledges scenario*

What's in It for You?

This whitepaper offers an exploration of how Demand Response can revolutionise the energy landscape, tailored to meet the priorities of key stakeholders. Whether you're a commercial & industrial (C&I) business, electricity user, regulator or transmission system operator (TSO), this document offers insights relevant to you.

- **C&I Electricity Users:** Explore how DR can boost your operational efficiency, cut energy costs and support your sustainability initiatives.
- **Regulators:** Discover how DR contributes to a sustainable, more reliable energy future - delivering societal and environmental benefits that align with policy objectives
- **TSOs:** Learn how DR enhances grid stability and enables the integration of renewable energy, paving the way for a more resilient energy system.

Each section is filled with actionable insights and practical examples, making it a reliable resource for energy opportunities.

As the world tackles one of the most pressing energy challenges—electrifying consumption while integrating intermittent renewables—this whitepaper showcases how C&I users can play a pivotal role in the transition. By embracing demand response programs and adopting cutting-edge flexiblity technologies, businesses can stabilise the grid while unlocking significant cost savings, improving operations and creating a new revenue stream. Together these strategies are building the foundation for a future that is stable, resilient and truly sustainable.

What is Demand Response

Before we jump into it, let's ask the most obvious question: What is demand response? It might sound a bit daunting at first, but here is the simplest way to think about it:

Demand response (DR) is when electricity customers adjust their energy use from their usual pattern in response to market signals. This could mean using less electricity when prices are high or when they receive incentives, or selling their ability to reduce or increase demand in an organised market.

At its core, DR revolves around what is known as flexible loads. Many industries have systems and processes that don't need to operate at full power all the time. A few examples include:

- **Cold Storage:** Cutting back on refrigeration for short periods during peak demand, while still keeping everything at the right temperature.
- **Commercial Buildings:** Adjusting HVAC settings or lighting levels based on signals from the grid.
- **Data Centres:** Adjusting server activity or delaying non-essential tasks to off-peak times
- **Pulp and Paper:** Temporarily easing off on energy-intensive processes that aren't critical to production, so the overall output isn't greatly affected.
- **Metal Production:** Timing smelting or casting operations to match demand response signals.
- **Wood Processing:** Temporarily reducing high-energy tasks like drying or processing

Even households can get involved in explicit DR programs, choosing to reduce or shift their energy use when the grid signals it. By tapping into this flexibility, consumers can earn money while also keeping the grid stable.

There are two main types of demand response:

- **Explicit Demand Response:** This is when consumers commit to providing dispatchable flexibility that can be traded, much like the flexibility of power generation. It's done on energy markets – whether wholesale, balance or reserves – and is typically handled by an aggregator. This could be an independent service provider or a supplier.
- **Implicit Demand Response:** Consumers react to price signals. They can choose prices hourly or short-term market pricing, reflecting changes in the market and network. With these signals, energy use can be adjusted either automatically or manually to save money.

How Consumers Participate in Demand Response

Participating in Demand Response isn't just about helping to keep the electricity grid stable. It's also a way for industrial energy users to earn extra revenue. **By adjusting their electricity use or production based on grid operator signal or market prices, businesses can turn their flexibility into a valuable asset.**

There are several energy markets that can monetise their daily flexibility. While there are many energy markets consumers can participate in, here are some of the most lucrative ones:

1. **Balancing Markets:** These markets deal with sudden shifts in supply and demand to keep the grid frequency steady at around 50Hz. The different types of balancing markets are explained below

2. **Day-Ahead Trading:** This happens the day before electricity is delivered. The price for each time period is set by the last accepted bid on the market. Businesses can monetise their flexibility by adjusting their schedules based on hourly price fluctuations.

3. **Intraday Trading:** This takes place on the same day electricity is delivered. Prices change in real-time, as each transaction determines its own rate. Unlike the day-ahead market, there's no set price—just a continuous flow of bids and offers. This gives participants a chance to make the most of shifting energy prices quickly.

4. **Congestion Markets:** These markets help solve local transmission bottlenecks. Participants get paid to adjust their energy use in areas where the grid is overloaded. For every change in a congested area, an opposite adjustment is made elsewhere to keep everything balanced.

5. **Capacity Markets:** These exist to ensure there's enough electricity supply to meet future demand, sometimes years in advance. Demand Response participants can sell their ability to reduce consumption during critical periods

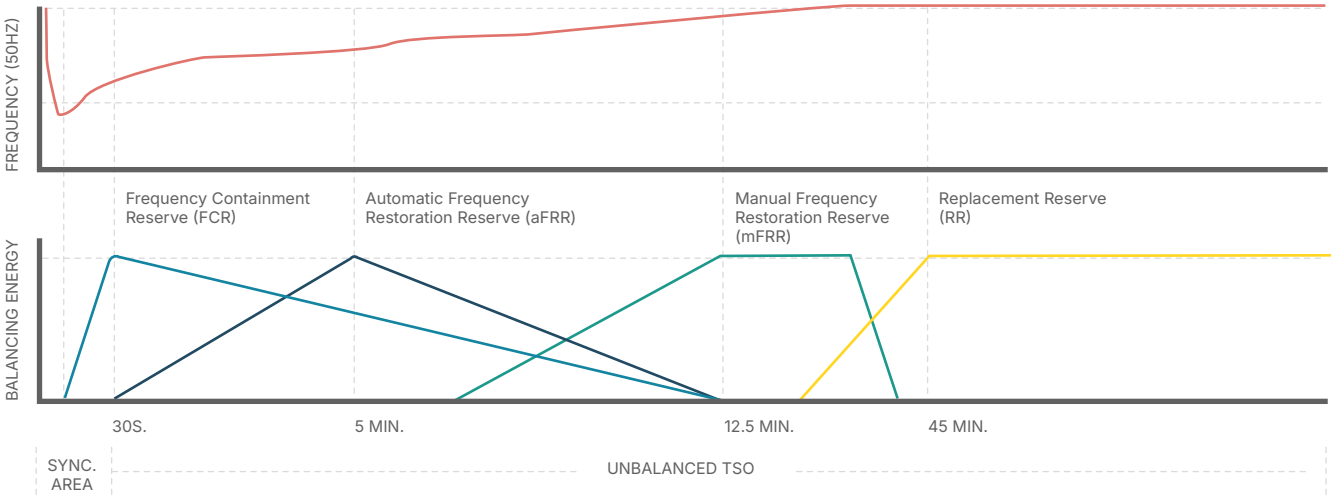
6. **Imbalance Mechanisms:** These discourage poor forecasting by imposing penalties on companies that use more or less energy than planned. However, in some countries, if your imbalance actually helps the grid, you can be financially rewarded instead.

Making the Most of Balancing Markets

One of the most direct ways for businesses to monetise their flexibility is through balancing markets. Grid operators use different types of reserve to keep everything running smoothly:

- **Fast Frequency Response (FFR)** delivers ultra-fast reaction times to stabilise frequency deviations.
- **Frequency Containment Reserve (FCR)** corrects imbalances within seconds, ensuring rapid and reliable intervention.
- **Automatic Frequency Restoration Reserve (aFRR)** provides medium-term stabilisation, responding to sustained frequency deviations.
- **Manual Frequency Restoration Reserve (mFRR)** ensures balance over longer periods, addressing ongoing disruptions.
- **Replacement Reserve (RR)** steps in as the final safety net, managing extended grid requirements when other reserves are insufficient.

These balancing mechanisms, summarised in the table below, allow businesses to earn revenue by reducing, shifting, or even increasing their energy use when needed. They key is matching the right assets to the right market requirements, making flexibility a real financial opportunity.



In this whitepaper, we go beyond Balancing Markets (BMs), and explore the wider benefits of Demand Response. The data and examples provided highlight how DR generate value not only in BMs, but across all energy markets.

What are Battery Energy Storage Systems?

Alongside Demand Response, Battery Energy Storage Systems are set to become one of the key providers of short-term flexibility by 2050, as highlighted by the IEA in the graph above. These large-scale batteries play a crucial role in keeping the grid stable, reacting to frequency shifts in just milliseconds. In fact, BESS can respond to grid frequency changes in about a quarter of a second–making them absolutely essential for real-time stability. With costs dropping, response times becoming faster, and storage capacity growing, BESS are becoming more cost-effective and adaptable than ever.

Beyond the immediate savings and operations perks, BESS have a much bigger role to play in the transition to cleaner energy. Their ability to **store excess renewable energy** helps tackle one of the biggest challenges of renewables like solar and wind: their unpredictability. Whether it's a cloudy day or the wind isn't blowing, **BESS can step in and release stored** energy to keep the grid steady and ensure a reliable supply of renewable energy. This makes them the perfect partner for DR, as both technologies work hand in hand to balance the grid in real time while cutting reliance on fossil fuels. Together, BESS and DR create a powerful combination for stabilising energy systems and making renewables more reliable.

BESS also offer financial benefits for commercial and industrial energy users. By discharging stored energy during peak demand times, businesses can reduce their energy costs, offer more financial advantages. However, BESS still faces some challenges. Right now, **most large-scale batteries rely on lithium**, which has significant environmental and social impacts due to its energy-intensive extraction. On top of that, scaling up battery storage on a national or global level requires investment and strong market confidence. The good news is that advancements in battery technology and recycling initiatives are helping to ease these concerns, paving the way for a more sustainable future. BESS will continue to play an essential role in the energy transition, working with commercial & industrial assets to enhance DR strategies.

Across Europe, BESS projects are seeing a surge of investment, with over 50GW of capacity expected to be added by 2030*. This growth will boost renewable integration, enhance grid stability, and drive further adoption of demand response. In fact, the International Energy Agency projects that by 2030, DR and BESS together could meet nearly half of the world's grid flexibility needs. By 2050, that figure could rise to over 75% (as shown in the graph above).

** In this whitepaper, we focus mainly on DR while highlighting how BESS complements DR. Together, these technologies offer a smarter, more flexible energy system that accelerates the transition to a cleaner future.*

*Source: https://www.statista.com/statistics/1334680/europe-battery-storage-capacity/

1. Benefits of DR for Commercial & Industrial Customers

1.

Benefits of DR for Commercial & Industrial Customers

Demand Response offers significant financial and operational benefits for businesses with flexible energy resources—all while supporting the shift to a more sustainable energy system.

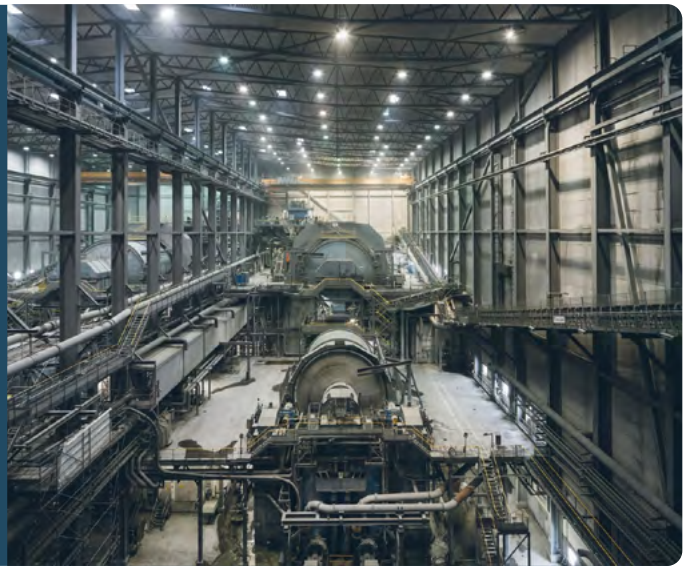
Additional Revenue Stream

Taking part in DR can be a lucrative opportunity, with revenues reaching up to 10% of the electricity costs of a flexible asset. Several factors influence how much revenue a business can generate:

- **Price:** Balancing market prices fluctuate depending on grid demand and available flexibility. Prices tend to spike during peak demand, certain seasons, or grid stress events. Depending on the market, businesses can earn revenue through either a capacity component (payment for availability) or an energy component (payment for activation).
- **Availability:** The more hours per day an asset is available for Balancing Markets, the greater the earning potential.
- **Activations:** Assets that can be activated more frequently typically generate higher revenues.
- **Speed of Response:** Assets that can respond to grid signals faster are eligible for more types of programs, leading to higher payouts.
- **Market type:** There are two main payment structures: 'pay as bid' (each bid is paid individually) and 'pay as cleared' (all participants receive the price of the last accepted bid).
- **Optimised Bidding:** Specialist providers like Sympower fine-tune bidding strategies, helping businesses maximise their earnings by leveraging real-time market conditions.

CASE STUDY

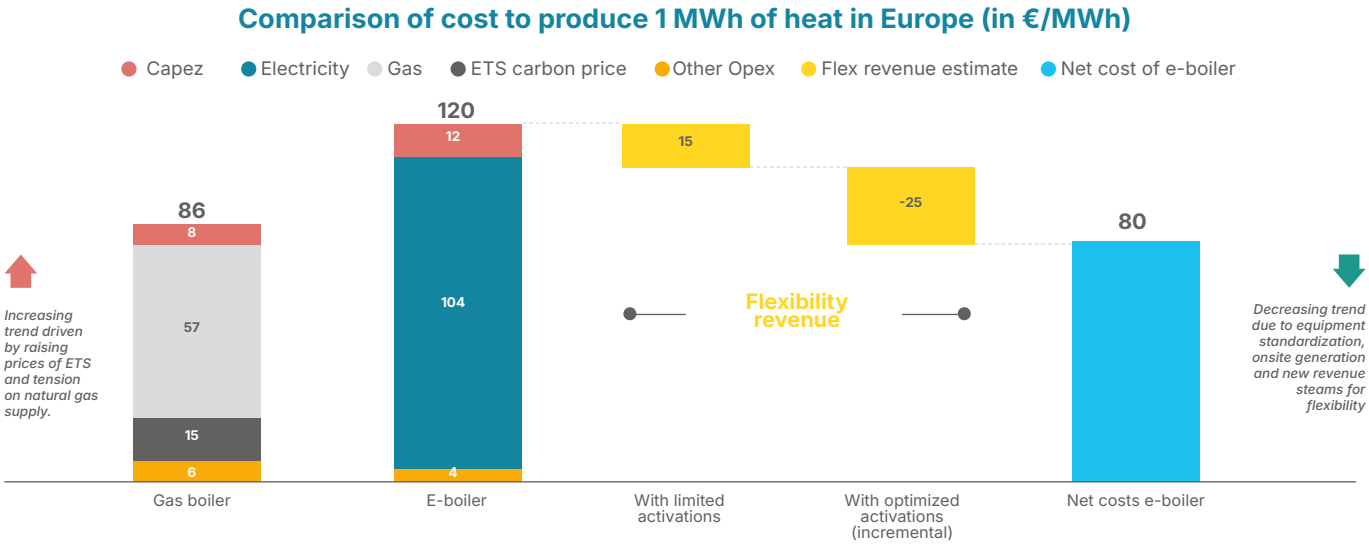
One of our customers, Boliden Aitik (Sweden's largest open-pit copper mine, mining and enriching around 45 million tonnes of ore annually), is active with 8 MW in the Swedish primary reserve market (FCR-D up). In the first eight months of participation, Boliden generated significant revenue through rapid response when the grid faced pressure. By being available to react quickly in critical moments, Boliden plays a vital role in helping stabilise the grid and highlighting the potential for high annual revenue (depending on market prices).



Making Electrification More Cost-Effective

For businesses committed to reducing their carbon footprint, DR provides a practical solution to offset the costs of industrial decarbonisation through measurable returns on investment. As seen above, **DR generates additional revenue, making decarbonisation investments more financially viable**. For instance, pulp and paper companies could invest in an electric boiler (E-boiler) instead of relying on fossil-fuel-based heating. DR earnings would help cover the upfront investment, improving the ROI and making the transition to cleaner energy sources more affordable.

A case study from 2021 comparing heat production costs demonstrates how businesses can use cost-effective electric solutions like E-boilers to replace fossil fuels, reinvesting DR revenues into sustainability efforts while achieving both environmental and financial benefits.



Note: Values of costs & flexibility revenue are "realistic data" based on extrapolation of analysis based on real data. In particular, electricity & balancing market prices have been normalised vs. extraordinary year 2022 (for BM price, used 60% of 2022 real prices). Flexibility revenue generalised across a sample of programs. Actual revenues can differ per country & program

Fuel price per MWh | Natural gas 55EUR, electricity 100EUR. For a new installation project and for 6,000h of heat supply per year / Source: Agora Industrie, Sympower analysis

Enhanced Consumption Insight and Efficiency through Market Volatility

Participating in DR often means using advanced metering and monitoring technologies. **These tools offer valuable insights into consumption patterns, helping businesses pinpoint opportunities to optimise energy use and cut costs.** By analysing this data, companies can adjust their energy consumption in response to market price signals, **boosting operational efficiency and unlocking significant savings on electricity costs.**

In short, Demand Response isn't just about earning revenue. It's about transforming the way businesses manage their energy. It allows companies across industries to create new income streams, improve efficiency and strengthen the ROI on decarbonisation investments. By actively supporting grid stability and reducing reliance on carbon-intense infrastructure, businesses play a crucial role in driving the energy transition. This commitment to sustainable just cut emissions, it also strengthens relationships with stakeholders and gives companies a competitive edge.

2. Benefits for Society

2.
Benefits for Society

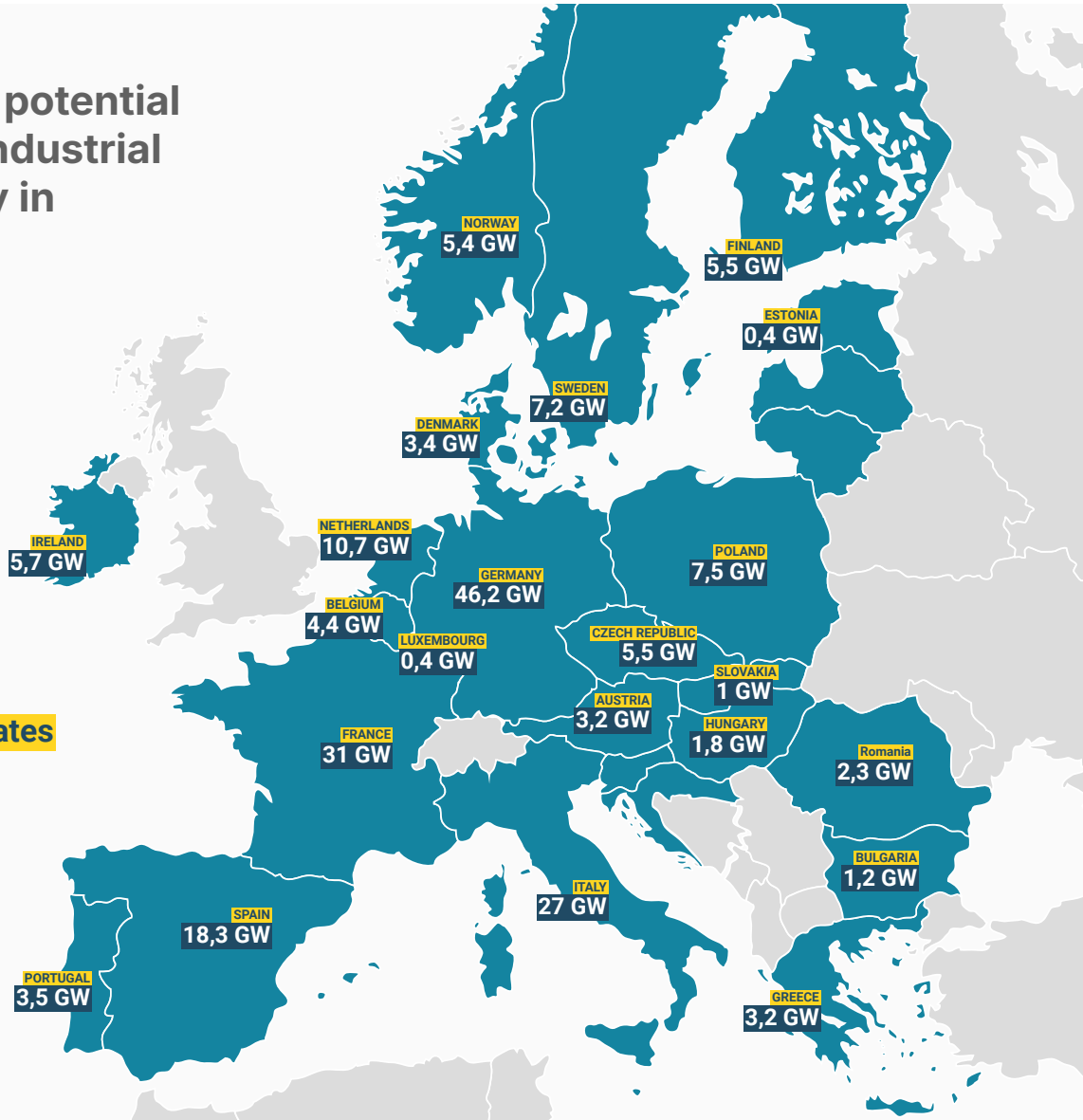
By making the energy system more efficient, reliable, and sustainable, DR delivers major benefits to society. It helps cut costs, boost supply flexibility, maximise existing infrastructure, and increase energy independence. Here's how:

Increased Supply of Flexible Capacity

As fossil-fulled power plants phase out, the need for new flexible resources to keep the grid stable is growing fast. **DR steps in as a crucial solution, increasing the supply of flexible capacity and reducing reliance on traditional gas peakers for balancing supply and demand.**

The graph below shows the huge untapped potential of commercial and industrial DSF across Europe, highlighting how DR can play a key role in addressing challenges in different countries.

Sizing of GW of potential Commercial & Industrial DSF per country in Europe (GW):



Grand Total for 21 EU member states

195 GW

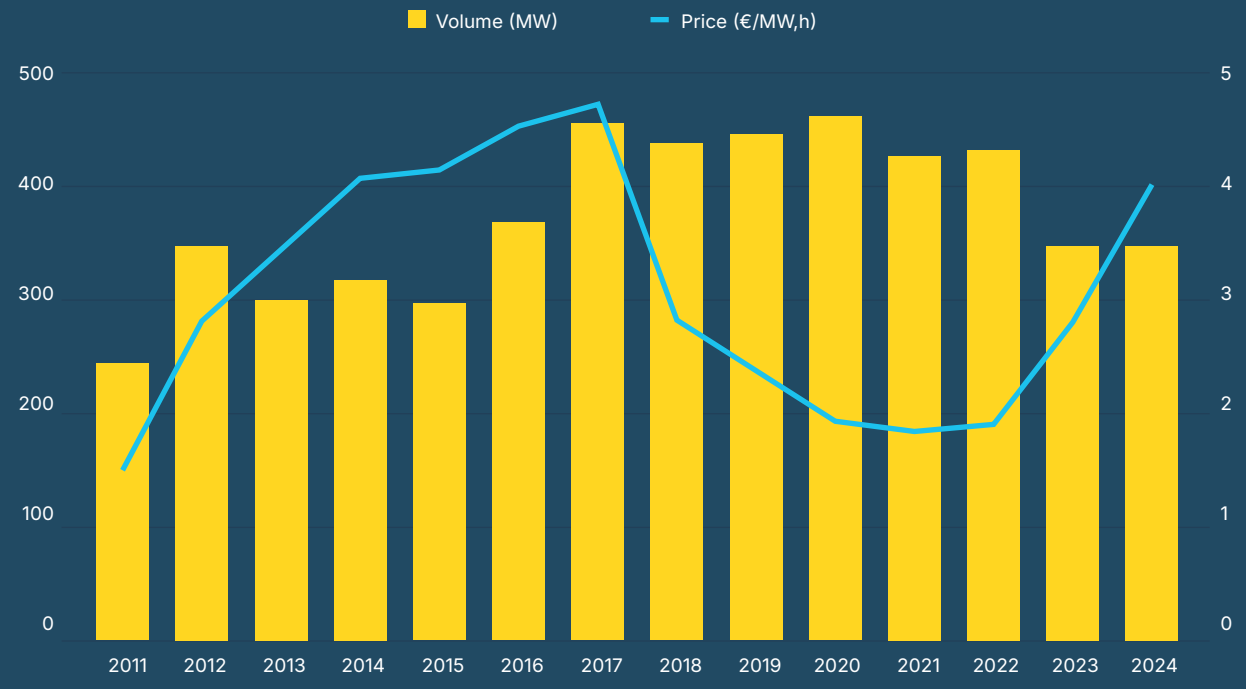
Cost Reduction

One of the biggest advantages of DR is its ability to reduce the costs across the energy system. Since DR bids tend to be around 35% lower than the market average, it helps cut costs of balancing the grid. A 1% increase in DR participation can reduce flexible capacity prices by an average of 2.7% in balancing markets (based on a study on Great Britain and The Netherlands from MDPI). This results in cheaper energy for consumers, easing the financial pressure from households and businesses alike.

CASE STUDY

Evolution of Primary Reserve in Finland

In 2016, independent demand response aggregation was introduced in Finland. As shown in the graph below, in the years thereafter, the FCR-D Up yearly market contract price started trending downwards. The most significant price drop was in 2018, when Sympower went live with an additional 160MW of new capacity, expanding market supply and competition. While quantifying direct cost savings from independent aggregation in the specific FCR-D Up market is challenging due to data limitations, it is evident that their participation has enhanced competition and led to lower prices. The introduction of Demand Response contributes to added supply, allowing for more reserves, which ultimately helps drive prices down by increasing competition.



*This is the accepted volume. While offered volumes would provide the most direct measure, there is a strong correlation between offered and accepted volumes due to market dynamics. As a result, the accepted volumes shown here still offer valuable insight and allow us to draw conclusions about increased supply and market trends.

Beyond this, **DR helps smooths electricity shortfalls and surpluses** by adjusting consumption based on price signals. When enough participants do this at scale, it leads to lower electricity prices overall.

Security of Supply

For network operators, DR is a crucial tool for network operators to ensure a constant energy supply. **By tapping into flexible resources, system operators can quickly balance unexpected shifts in supply and demand,** preventing blackouts and disruptions.

A recent example from Sweden, shown in the graph below, highlights how distributed flexibility played a critical role in avoiding a major outage. This approach not only **strengthens grid resilience but also reduces the reliance on traditional, carbon-intensive backup power sources.**

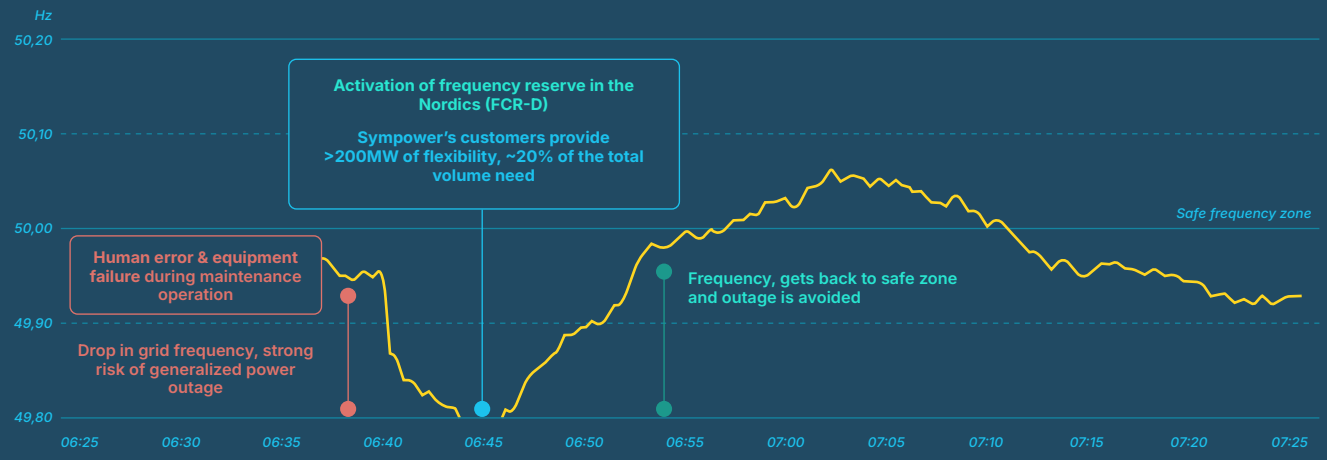
CASE STUDY

During a recent disturbance in the Nordic synchronous area, FCR-D up reserve, which is designed to handle disturbances of up to 1,450 MW, was activated. This reserve is distributed across the Nordic TSOs, with 567 MW allocated to Sweden (SE FCR-D up). However, when the disturbance occurred, the total volume of production that was disconnected was slightly higher than 2,130 MW.

At the time of the disturbance, there was 1,450 MW of FCR-D up and 600 MW of FCR-N available across the Nordic synchronous area. The disturbance caused a drop in frequency, triggering Emergency Power Control (EPC) on several HVDC connections, contributing 600 MW through EPC activated on underfrequency. In addition, the disturbance reserve was automatically activated, with all available units for underfrequency start being engaged, contributing around 500 MW. Furthermore, 200 MW of the disturbance reserve was manually activated, resulting in a total contribution of 700 MW from the disturbance reserve.

This event highlights that despite the FCR-D up reserve being designed for disturbances up to 1,450 MW, the incident exceeded this reference fault size. Therefore, in addition to the FCR-D up, other reserves, such as EPC and disturbance reserves, were activated to stabilize the grid. It is likely that the entire available 1,450 MW of FCR-D up was used during the disturbance. Sympower's contribution of 200 MW, shared between our Finland and Sweden portfolios, accounted for approximately 14.5% of the total available reserve (200/1,450 MW). This demonstrates the critical role that flexible demand resources play in complementing traditional reserves, ensuring grid stability even during significant disturbances.

Frequency on Swedish Electricity Grid
April 26th 2023, in Hz, 06:25 am to 7:25 am



Source: Svenka Kraftnat

Efficient Use of Existing Infrastructure

Demand Response makes smarter use of the infrastructure we already have, reducing the need for costly new grid connections and large-scale investments. This brings several key benefits:

- **Avoiding expensive upgrades:** less need for costly transmission and distribution system developments.
- **Reducing reliance on raw materials:** less demand for resources like copper, which helps to minimise environmental damage and human rights concerns linked to resource extraction.
- **Keeping energy prices in check:** lower grid cysts mean savings for all consumers.
- **Easing grid congestion:** by offering flexible capacity, DR helps optimise existing infrastructure at both Distribution System Operator (DSO) and Transmission System Operator (TSO) levels.

At the European level, demand-side flexibility could save between €11.1 billion and €29 billion annually in grid infrastructure investments. That's a significant reduction in congestion and peak demand, covering between 27% to 80% of the forecasted investment needs.*

Higher Energy Independence

Reducing reliance on imported fossil fuels and rare metals is a crucial societal benefit of Demand Response. By supporting the shift to renewables, DR helps to:

- Lower geopolitical risks by reducing dependence on raw materials from unstable or politically corrupt states.
- Cut natural gas consumption, reducing reliance on costly third-party imports and strengthening national energy security.
- Minimise the need for new infrastructure, as smarter energy management reduces the pressure to upgrade power grids and transmission networks.

This increased energy independence enhances national security and contributes to a more stable and resilient energy system.

By leveraging Demand Response, societies can transition more smoothly to renewable energy, improve energy security, and foster economic and environmental sustainability.

** Source: Study by DNV and Smart En – Demand-side flexibility: Quantification of benefits in the EU, Note: The study covers demand-side flexibility deployment, which is broader than DR, encompassing additional flexibility options beyond just DR programs.*

3.
Benefits for the Environment

3.
Benefits for the Environment

Demand Response plays a vital role in the fight against climate change, helping to accelerate the transition to a cleaner energy system.

Enabling Renewables and Supporting Their Economic Viability

Wind and solar power are inherently variable, meaning the grid needs flexibility to accommodate them without replying on fossil fuel for stability. This is where DR is essential. By dynamically adjusting energy consumption in real time, DR ensures that renewables can be used to their full potential. It helps by:

- **Increasing the grid's ability to handle more renewables without disruption**
- Enhancing system reliability by reducing demand when renewable generation is low
- Accelerating the shift away from fossil fuels by ensuring demand matches renewable supply.

In Balancing Markets, DR directly supports more renewables by:

- Insuring against forecast errors – if wind or solar output is lower than expected, DR adjusts consumption in response to TSO signals.
- Mitigating reduced grid inertia – as renewable energy generators have less inertia than thermal plants, DR in FFR or FCR helps stabilise the grid.

DR also improves the financial viability of renewables by tackling negative electricity prices, which occur when renewable energy generation exceeds demand. By shifting consumption to these times, DR stabilises prices, making investments in renewables more attractive, encouraging further renewable energy expansion.

Figuring out how much DR is needed is complex. Studies suggest that in grids with 40-50% renewable energy DR can provide 10-15% of peak demand flexibility, making it a key enabler of renewable integration without sacrificing grid stability. (Source: IRENA).

In summary, DR not only manages the variability of renewables, but also optimises the grid, while reducing the need for fossil fuels for backup generation. This makes it essential for a sustainable and resilient energy system.

The Cleanest Grid Balancing Technology

Demand Response is one of the most sustainable and efficient ways to balance the grid, offering a cleaner, smarter alternative to traditional energy resources. By making the most of existing flexibility, **DR reduces the need for fossil fuel plants** and helps build a more resilient, low-carbon energy system.

Less reliance on fossil fuel plants: DR reduces the need for backup fossil fuel power, especially in the upward reserve market (which provides additional power during peak demand or outages). Many backup plants operate suboptimally, wasting fuel and increasing emissions. By replacing their role, DR not only cuts greenhouse gases but also weakens their business case, accelerating their closure.

Works seamlessly with BESS: DR and BESS work tandem to maximise flexibility. While BESS stores surplus energy for later use, DR actively adjusts demand in real time. By combining assets used for DR – such as commercial & industrial assets – with battery storage, the overall flexibility and efficiency of the energy system becomes more capable of responding to supply and demand imbalances. This results in a reduced need for longer-duration BESS with higher environmental costs, enhancing the grid's overall flexibility.

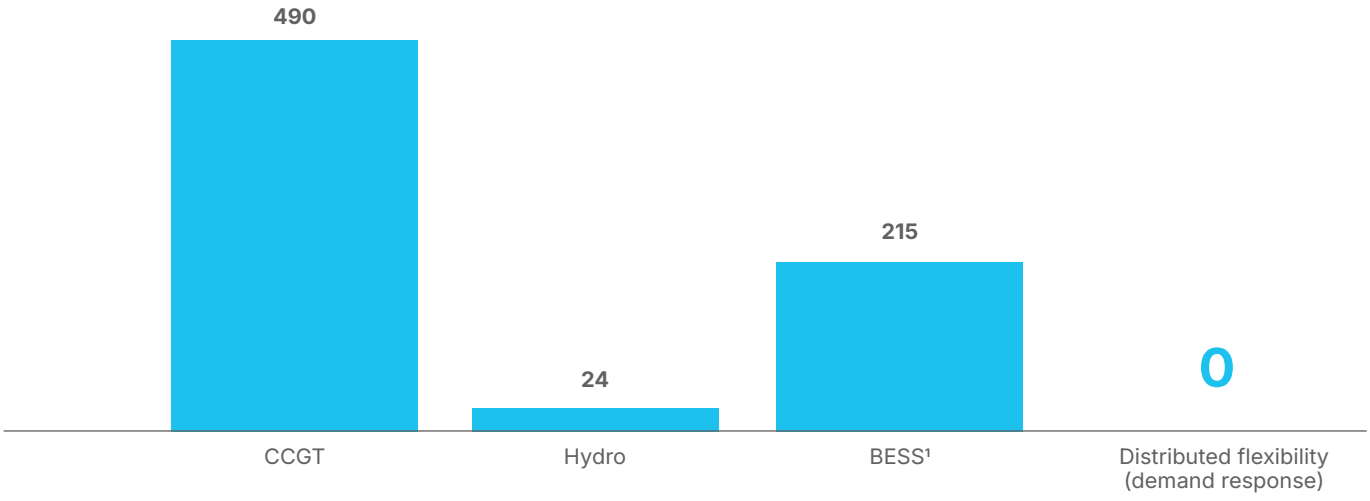
DR plays a key role in cutting greenhouse gas (GHG) emissions in two ways:

- **Directly:** DR activates without generating any emissions. By displacing fossil fuel-based power plants – like peaker plants – to provide grid balancing services, DR keeps the grid stable without burning fossil fuels. This is especially important for regions like Continental Europe, where fossil fuels still play a large role in grid balancing.
- **Indirectly:** DR frees up generation assets – such as hydro and nuclear plants – that would otherwise be used for balancing services. This allows them to be used in wholesale markets, replacing carbon-intensive generation, helping to reduce overall emissions. In the Nordics, where hydroelectric power is a key part of the energy mix, DR helps to maximise the use of these renewable resources and minimise the need for fossil fuels. By enhancing the efficiency of demand-side resources, DR makes the entire energy system more sustainable and resilient.

The graph below illustrates how DR outperforms other balancing technologies in terms of emissions, making it one of the cleanest options for grid balancing.

GHG emissions of technologies used in grid balancing

Emission factors for Finland, 2021, tons CO_2eq/MWh



Source:Fingrid

Conclusion

Demand response is a game-changer within the energy sector, offering benefits for customers, society, and the environment. It creates new revenue streams for commercial and industrial customers, enhances grid efficiency and resilience, and reduces dependence on energy imports which benefits society as a whole. When paired with Battery Energy Storage Systems, the benefits multiply, adding even more flexibility and stability to the energy system. This makes them a critical asset in balancing and enhancing the sustainability of the system. Together, DR and BESS pave the way for a more flexible, and sustainable energy future that is built on a sustainable, smarter and cost-effective solutions.

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Study by DNV and Smart En – Demand-side flexibility: Quantification of benefits in the EU

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