March 2024

Industrial demand-side flexibility in France

CURRENT SITUATION AND RECOMMENDATIONS

ALLICE

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ALLICE's mission is to bring together stakeholders to innovate to decarbonise industry. The alliance has 3 major objectives:

- **Bring together all sectoral stakeholders to innovate collectively to decarbonise industry:** industrial operators, solution providers, energy suppliers, thought leaders, engineers, financial players, research laboratories and skills centres, professional federations and organisations, etc. ;

- **Support the development of a range of high-performance** and differentiating decarbonisation solutions in France and internationally,

- **Support industrial players** in accelerating their decarbonisation.

ALLICE is a neutral organisation which facilitates exchanges and works to bring together stakeholders which are currently dispersed, while also taking the sector's financial aspects into account. With a cross-disciplinary approach, ALLICE facilitates technology transfer and the emergence of projects which are enhanced by diverse stakeholders.

Founded in 2018 by CETIAT, in association with CETIM, CTCPA, CTMNC, CTP and Blunomy (formerly Enea Consulting), ALLICE is supported by ADEME. As of 2024, it has more than 120 members and partners and has already produced or committed to more than 40 collective studies with a budget of €2 million (roadmaps and economic studies, comparative studies of decarbonisation solutions, technological state of the art reviews).

Study carried out for ALLICE by the Blunomy team: Florian Deveza, Anatole Rozier-Chabert and Jacques Arbeille.

Blunomy is an independent strategy consultancy specialising in energy and the environmental transition. Since 2007, it has advised and supported more than 200 private companies and public authorities around the world, from the largest energy and industrial companies to start-ups, financial players and investors. With its in-house expertise, Blunomy helps its clients to produce robust transition roadmaps, involve all stakeholders in their value chains, create business coalitions, develop new business models, prove their impact, structure financing and attract capital to scale up.

Blunomy is committed to its pro bono work in developing countries to ensure that the transition leaves no one behind and to create a more decarbonised, circular and inclusive economy.

This document is a summary of the study on "Industrial demand-side flexibility in France", carried out by Blunomy on behalf of ALLICE. The detailed report of the study is available to ALLICE members.

Thanks to the companies and technical centres which contributed to this study:
ADEME, Adisseo, Agregio Solutions, Ahlstrom, Axens, Bonduelle, CETIM, Copacel, CRITT Agro-alimentaire, CTMNC, Energy Pool, Fédération Forge Fonderie, Gerflor, RTE, Setforge, Vynova.

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Part 1

Industrial electricity consumption, a tool to increase the flexibility of the French electricity system

Industrial demand-side flexibility improves the reliability of electricity networks and helps to reduce CO_2 emissions.

The electricity network requires a permanent and "real-time" balance between electricity production and consumption to guarantee a high-quality supply of electricity and avoid the risk of blackouts. When an imbalance occurs, the network operator must react within a few milliseconds and a few seconds to restore the balance between production and consumption.

Demand-side flexibility involves reducing consumers' electricity demand[1] for a defined period in response to an external signal (for example, a request from the network operator or a price signal). As such, demand-side flexibility is one of the solutions for managing network imbalances. Today, particularly in France, there are a variety of mechanisms with different contractual conditions which make it possible to take advantage of demand-side flexibility and to play a role in balancing the electricity network. Increased integration of intermittent renewable energies (which are required for the ecological transition) is creating a growing need to balance the electricity network, thereby encouraging the development of solutions such as industrial demand-side flexibility, which involves adapting the consumption of industrial sites to provide the electricity network with flexibility.

While demand-side flexibility is primarily of **financial benefit to industry and the electricity system** and contributes to the **reliability of the electricity network, it also reduces the carbon content of electricity** by limiting the need to activate peak production resources (gas, coal and oil-fired power stations).

To achieve its targets, France must increase its industrial demand-side flexibility capacity by 17% by 2030 and double it by 2050.

In 2018, France set itself ambitious targets for the development of industrial demand-side flexibility (PPE 2019-2028[2]): 4.5 GW in 2023 (industrial, residential and tertiary contributions), reaching 6.5 GW of contracted capacity by 2028.

In 2021, RTE, the public electricity transmission system operator, drew up four scenarios for growth in industrial demand-side flexibility until 2050 [1]. From 2.7 GW in 2020, **industrial demand-side flexibility could reach 8.4 GW in a high scenario and remain at 2.7 GW in a low scenario.** The 2023-2035 forecast [2] published by RTE in 2023 refines these trajectories with values for 2030. **Figure 1** summarises RTE's possible trajectories for the development of demand-side flexibility within industrial sectors.

1 - Demand-side flexibility using fossil fuels, which involves offsetting reduced consumption with a fossil-fuelled generator, is not considered in this report.

2 - *Programmation Pluriannuelle de l'Énergie*: a multi-year energy plan which sets out how public authorities will manage all forms of energy in mainland France.

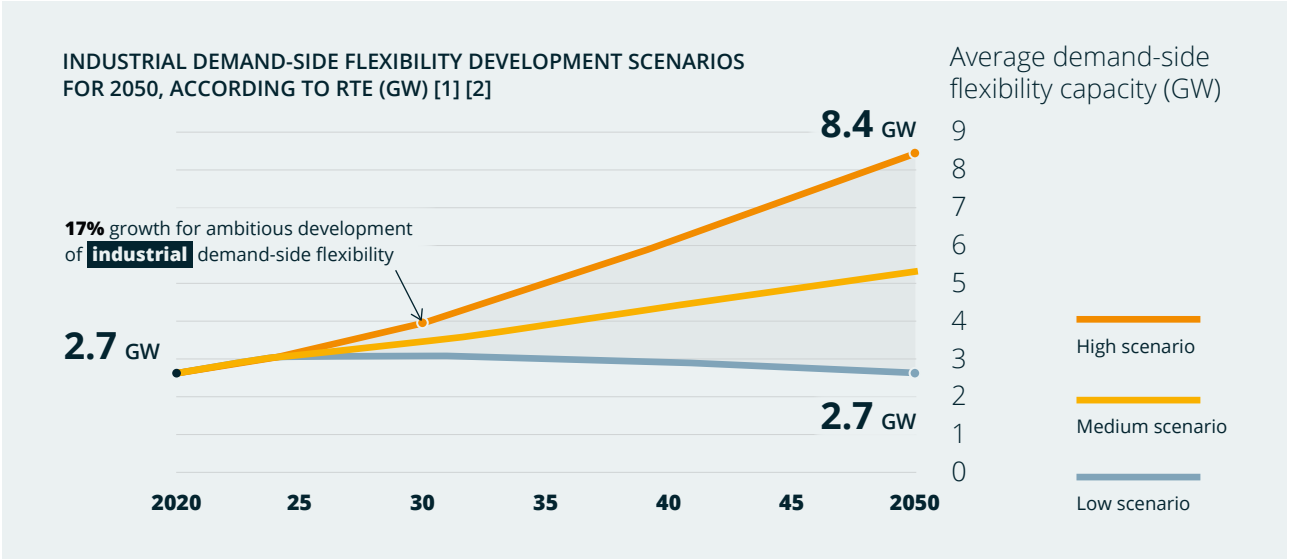


FIGURE 1

RESULTS BELOW THE TRAJECTORY TARGETED BY THE 2019-2028 PPE

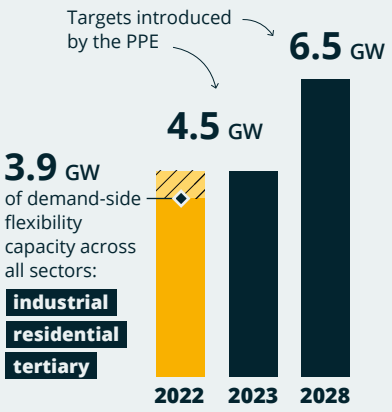


FIGURE 2

However, by 2023, the industry will not quite achieve its targets and a slowdown in the development of industrial demand-side flexibility is predicted.

Demand-side flexibility capacity for all sectors combined is expected to reach 3.9 GW in 2022, 0.6 GW below the PPE's 4.5 GW target.

In terms of industrial demand-side flexibility, the outlook is for a slowdown in the development of capacity. RTE's latest forecasts for industry suggest that annual growth will fall from 3.5% to 2.2% with a capacity in 2030 which will be lower than the initial target set out in the PPE.

In view of current remuneration conditions, there is potential for 3.4 GW of industrial demand-side flexibility, which falls short of the industry's ambitious targets. Electrification could significantly increase this potential.

A study carried out by ADEME in 2017 [3] quantifies the gross potential of demand-side flexibility capacity in the industrial sector. **According to ADEME, in view of the current remuneration conditions of €60/kW/year, just 3.4 GW of industrial demand-side flexibility capacity is accessible for a duration of 30 minutes.** In addition, 1.4 GW requires significant remuneration (at least €100/kW/year) to be utilised effectively. Lastly, the study shows that more than 70% of this potential is concentrated in four industrial sectors: metallurgy, chemicals, mechanical engineering and paper.

TECHNICAL AND ECONOMIC POTENTIAL BY REMUNERATION LEVEL, FOR AN ACTIVATION TIME OF 30 MINUTES [3]

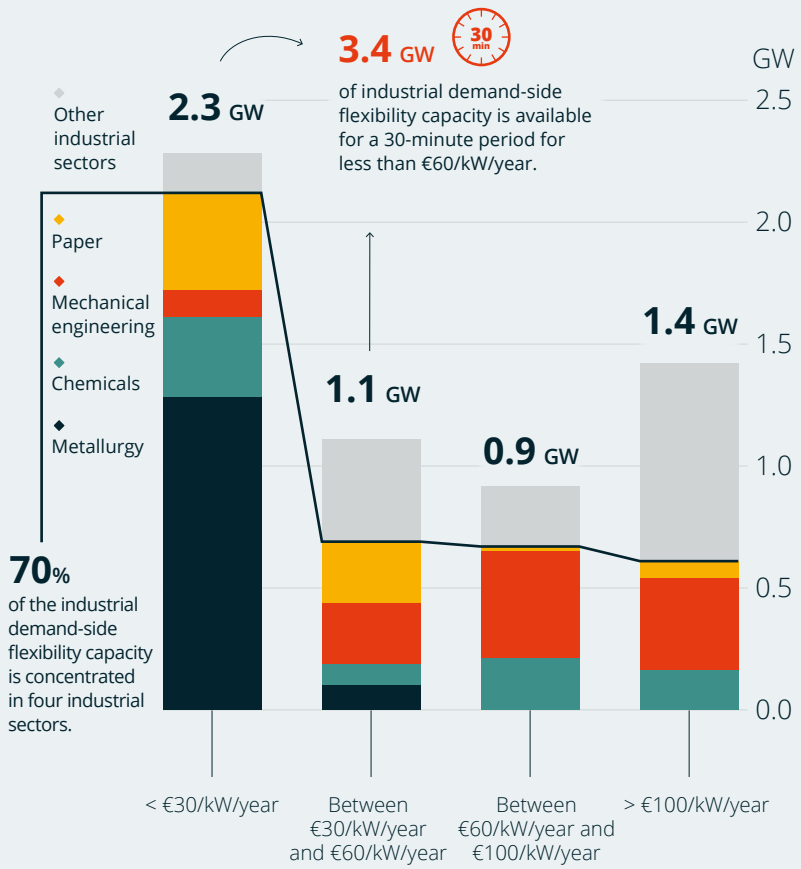
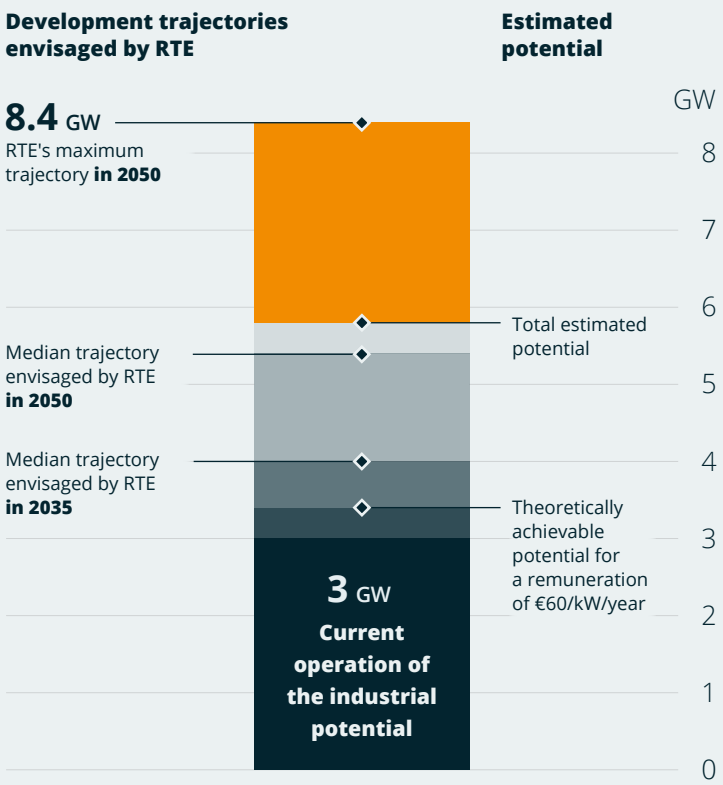


FIGURE 3

PUTTING RTE'S VARIOUS POTENTIAL DEVELOPMENT TRAJECTORIES FOR INDUSTRIAL DEMAND-SIDE FLEXIBILITY INTO PERSPECTIVE [1] [2] [3]



The electrification of thermal processes in industry represents a major source of additional flexibility. Based on the conclusions of ALLICE's PEP 2 study [4], there could be an additional increase in the potential of demand-side flexibility associated with the electrification of thermal processes of between 3 GW and 6 GW, depending on electricity cost scenarios. This estimate shows that electrification could significantly increase industrial flexibility potential, which would be consistent with the trajectories envisaged by RTE.

FIGURE 4

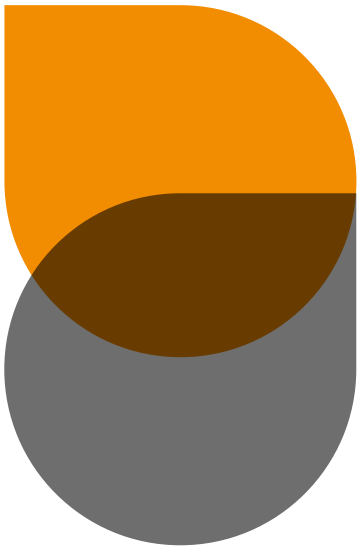
The aim of this study is to identify the barriers preventing the adoption of demand-side flexibility in industry and to make proposals about the development of the industrial demand-side flexibility sector in France.

ALLICE has carried out a study to analyse the discrepancy between planned targets and actual development of the demand-side flexibility sector and to better understand the challenges of increasing demand-side flexibility for processes which are going to be electrified. This document provides a public summary; the full study is available to ALLICE members.

This study's objectives are to:

- Understand the main barriers preventing the adoption of demand-side flexibility solutions on industrial sites,
- Describe the operational implementation of demand-side flexibility,
- Suggest ways in which to achieve demand-side flexibility targets as identified by the PPE and RTE's scenarios.

Part 2



The demand-side flexibility value chain and its operational implementation

The demand-side flexibility operator, more commonly known as the aggregator, is often an essential player in facilitating industrial sites' participation in demand-side flexibility mechanisms.

Industrial sites can either participate in demand-side flexibility mechanisms directly or via an aggregator. In the former case, the industrial site has its own access to RTE's mechanisms, manages its participation strategy and monitors and mitigates the risks of incorrect provision or implementation of demand-side flexibility.

In the latter case, the industrial site relies on a demand-side flexibility operator (also known as an aggregator). These operators are commercial and technical intermediaries with in-depth knowledge of and access to the electricity markets, enabling sites which do not have the necessary resources or skills to participate in demand-side flexibility mechanisms. The demand-side flexibility operator is certified by RTE to carry out demand-side flexibility operations. This means that the site does not have to undergo a certification process, which can be costly in terms of human and financial resources.

FIGURE 5

Process for implementing demand-side flexibility on an industrial site (via an aggregator)

The process of implementing demand-side flexibility on an industrial site can be broken down into four stages. **Figure 6** shows these stages and the key questions for industrial players to ask themselves.

Between 2021 and 2023, ADEME carried out a study entitled *"Experimentations pour favoriser la Décarbonation Industrielle & sa Transition Énergétique"* or EXPEDITE. The third part of this study focuses on demand-side flexibility, driven by ADEME's objective of developing flexible industrial consumption in France. The deliverables of the study include an update to the technical guide "Electricity flexibility in industry" [5], the "Audit Effacement" specifications [6] and a tool for pre-diagnosing the potential for electrical load shedding on industrial sites [7] which enables industrial players to assess their flexibility potential by answering 8 questions.

5 feedback documents detailing real-world experiences were also produced with information from demand-side flexibility audits which were carried out at companies in various sectors: automotive, aeronautics, metallurgy, food processing and chemicals.

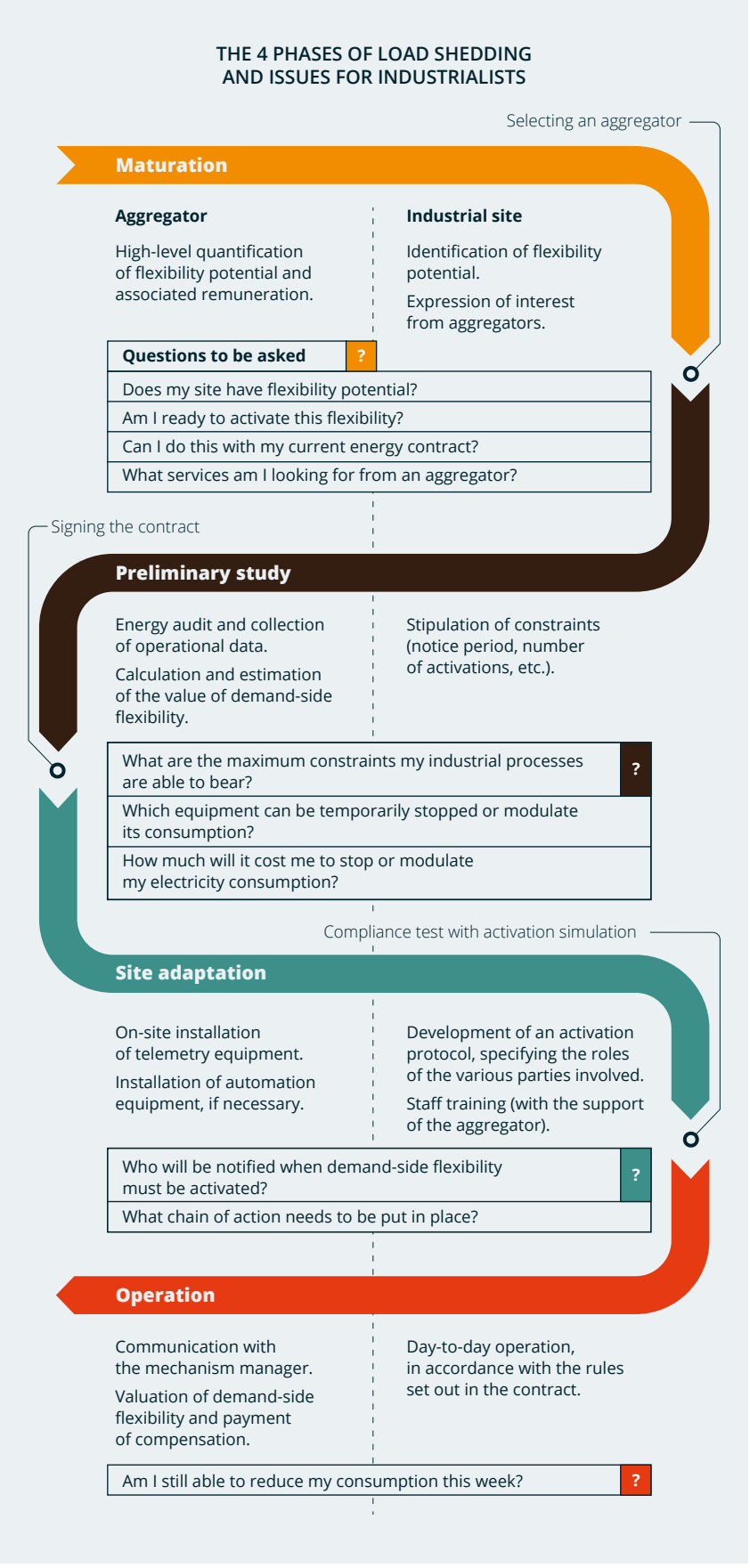


FIGURE 6

Part 3

Technical and economic barriers to be overcome to maximise industrial demand-side flexibility in France

Drawing on interviews with players in the demand-side flexibility market and around fifteen industrial companies, the study shows that current utilisation of flexibility potential varies significantly, depending on the sector of activity, with four types of industrial sector identified:

- **Sector in which flexibility is fully utilised:** metallurgy.
- **Sectors with growing operations in recent years:** paper and mechanical engineering.
- **Sectors in which flexibility is used for specific applications:** chemicals, food processing and non-metallic materials.
- **Sectors with very little potential:** plastics and rubber, textiles and miscellaneous other industries.

The study highlighted six barriers which must be overcome to maximise the adoption of industrial demand-side flexibility in France.

1.

Insufficient financial attractiveness for many players

The levels of remuneration offered by the current mechanisms are not high enough for some industrial players to consider using their flexible capacity to provide services to the electricity system. This is the case for chemical and food manufacturers, two industries with high added-value products.

The mechanisms' terms, particularly the length of the contract, do not align with an industrial company's constraints. The length of the contracts, between one and two years, is considered too short by many of the industrial players interviewed for this study and does not allow them to make investments to increase their flexibility.

While improvements are still needed, progress is possible and has been noted in recent years. The increase in remuneration in recent years (particularly via the AOE or Appel d'Offres Effacement mechanism) is highlighted as the main reason for the acceleration of demand-side flexibility in sectors such as mechanical engineering and paper.

2.

A significant mobilisation of internal resources

The availability of in-house resources to organise demand-side flexibility is also a major barrier which is often mentioned by SMEs (Small and Medium-sized Enterprises). Many of these companies do not have dedicated energy teams and find it difficult to allocate employee time to this issue. Because of a lack of information on the subject, some companies also believe that they are not entitled to access demand-side flexibility mechanisms.

Setting up contracts can be complex. Most small businesses rely on staff with non-legal backgrounds to read and sign contracts. Often carried out by company directors, reviewing a long contract with complex terms can sometimes be an intimidating experience and can even cause a "major mental block".

3.

Major cultural and organisational adaptation for some industrial players

To develop demand-side flexibility on an industrial site, many stakeholders must be convinced, from management teams to production teams. **Initial objections may come from the company's management** for whom switching off will generate a major paradigm shift, seemingly in contradiction with production optimisation.

There may also be other objections from production teams. The staff supervising the operators (supervisors, machine managers, etc.) may be apprehensive about the idea of stopping production; this is unusual for them and can make them uncomfortable.

4.

Constraints imposed by customer contracts affect industrial players' flexibility

For sites operating without intermediate storage or on a just-in-time basis, the additional delivery times likely to be generated by demand-side flexibility may be incompatible with existing customer contracts.

5.

Site size: a barrier to entry

Companies with few demand-side flexibility resources are not attractive to aggregators; as such, they cannot access demand-side flexibility mechanisms.

For aggregators, finding a site, managing the contractual relationship, installing the equipment needed to participate in demand-side flexibility mechanisms and monitoring the site during the contract entail significant costs. In addition, below a certain demand-side flexibility capacity, these costs are too high in relation to the expected income from demand-side flexibility mechanisms to generate a profitable business model for the aggregator. For example, SMEs in the mechanical engineering or agri-food sectors, with many sites with low electrical power consumption, are below the minimum profitability threshold for aggregators (approximately 100 kW of flexible demand).

6.

Overly restrictive mechanisms for certain processes

Many industrial players in various sectors (chemicals, mechanical engineering, food processing, paper) use electricity primarily for motive power and therefore have very little inertia. Implementing demand-side flexibility on these sites amounts to completely stopping equipment and may require the shutdown of other processes in the production chain (which are often thermal and run on fuel). This means longer start-up times (to allow for temperature rises) for the production chain.

Continuous processes encounter technical barriers when demand-side flexibility is implemented.

This type of production is theoretically the most likely to be switched off because of the stability of consumption. However, implementation is complex when the production chain is segmented and intermediate storage facilities must therefore be established to ensure that the loss of one link in the chain does not paralyse the entire chain.

Several other technical barriers were identified during the interviews:

- Batch production processes consume electricity too intermittently to be activated for demand-side flexibility needs,
- Some companies do not have the necessary latitude over their energy consumption (group purchase of energy, use of sub-contractors to operate equipment, etc.),
- Demand-side flexibility is wrongly associated with a strong need for industrial automation of the production chain.

7.

Industrial players are not incorporating demand-side flexibility into their electrification plans

Because of a lack of visibility regarding remuneration, industrial players are unable to consider demand-side flexibility as an additional source of revenue to recoup part of their electrification investments. All the interviewed players said that demand-side flexibility was not considered when they made their investment decisions. If contracting periods were longer, demand-side flexibility mechanisms could be used to promote the electrification of industry by acting in the same way as a subsidy.

Part 4

Methods, tools and recommendations for industrial and demand-side flexibility players

METHODS AND TOOLS FOR INDUSTRIAL PLAYERS

To facilitate the implementation of demand-side flexibility on industrial sites, the study provides information to help industrial players with their decision-making process.

Assessing the financial relevance of demand-side flexibility for industry

For an industrial player, the financial relevance of demand-side flexibility can be assessed by comparing the benefits of demand-side flexibility with the additional costs incurred by its implementation. **Three methods were identified during interviews with industrial players:**

METHODS FOR ASSESSING THE FINANCIAL RELEVANCE OF DEMAND-SIDE FLEXIBILITY

TABLE 1

SITUATION	DECISION-MAKING METHOD
No financial losses are generated by demand-side flexibility and there is no need for investment.	Saving on energy bills is the first factor in the decision. A minimum remuneration threshold must be determined, e.g. €20k/year or 5% of the electricity bill.
No need for investment, but a loss of income due to demand-side flexibility.	An equilibrium cost between remuneration for demand-side flexibility and production losses must be calculated. The remuneration associated with demand-side flexibility is converted into €/h by dividing the annual profit by the contractual demand-side flexibility period. Assumptions may be made about the rate of activation of demand-side flexibility, which may be significantly lower than the contractual conditions. The cost of shutdown is also calculated in €/h and is compared with the profits associated with demand-side flexibility.
Need for investment to implement demand-side flexibility.	The same calculation as above must be carried out, then completed by calculating a return-on-investment time, which is then compared with the company's expectations. The length of the contract can be considered to reduce long-term risks.

RECOMMENDATIONS FOR ACHIEVING THE PPE'S TARGETS AND KEEPING TO RTE'S TRAJECTORIES

The study makes seven recommendations for **demand-side flexibility professionals, both aggregators and electricity system managers, and industrial players to increase the use of industrial demand-side flexibility in France.**

Demand-side flexibility players

RECOMMENDATION 1
Provide systems, mechanisms and offerings for demand-side flexibility with greater long-term visibility, over periods of around 5 years, with a particular focus on industrial players which need to invest to develop new flexibilities.

RECOMMENDATION 2
Maintain an attractive level of remuneration, in line with the value which flexibility brings to the network.

RECOMMENDATION 3
Develop comprehensive energy offerings for energy service providers (including aggregators) to facilitate access to demand-side flexibility mechanisms (energy efficiency, energy digitalisation, electrification, integration of alternative energies, etc.).

Industrial players

RECOMMENDATION 4
Work with industry federations; they can instigate commercial dialogue between aggregators and industrial members interested in flexibility and develop a simplified and standardised contractual model with which to reassure industrial members.

RECOMMENDATION 5
For industrial players which want to adopt demand-side flexibility, ensure in-house support for all stakeholders contributing to the site's flexibility.

RECOMMENDATION 6
Undertake industry-wide efforts to focus on the link between electrification and demand-side flexibility. This could involve the grid operator, industrial federations, equipment manufacturers and aggregators.

RECOMMENDATION 7
Encourage industrial players to make their contracts with customers more flexible.

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