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SMART ENERGY EUROPE

SMARTEN MAP 2024

Wholesale Electricity Markets

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- A free solution to save energy, manage consumption and lower electricity bills

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- Accelerate the integration of intermittent renewable power generation and electrification of usages
- Optimise grid reliability
- Enhance energy security

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smartEn is the European business association for digital and decentralised energy solutions. Our members include innovators in services and technology for energy and data management, finance, and research. By taking an integrated perspective on the interaction of demand and supply, our mission is to promote system efficiency, encourage innovation and diversity, empower energy consumers, and drive the decarbonisation of the energy sector.

For further information please visit **www.smarten.eu**

The smartEn Map Wholesale Markets, January 2025

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Disclaimer: Please note that all historical figures provided in this report are valid at the time of publication. When estimates are provided, they are based on a combination of different sources.

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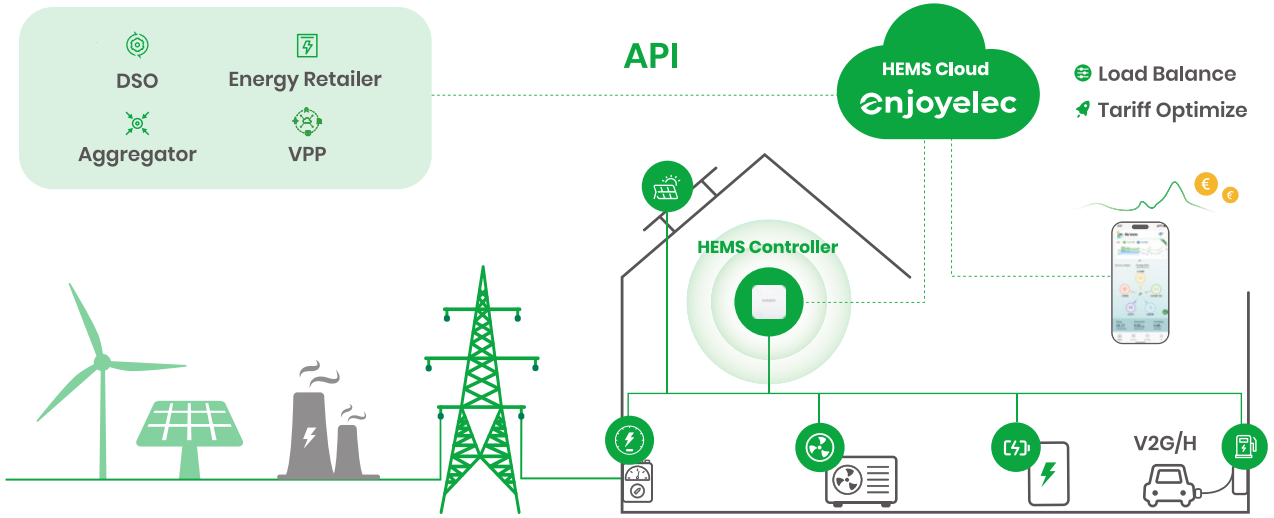

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- Smart Heating
- Battery Optimization
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We also thank all smartEn Members for their invaluable contributions and feedback.

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Tackling grid congestions and unlocking demand-side flexibility are key challenges of the energy transition.

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EPEX SPOT is the leading power spot exchange in Europe, empowering communities to achieve a competitive and climate-neutral Europe. Our wholesale market solutions offer a full range of products to trade across the entire value chain of electricity. We are committed to unlocking the full potential of demand-response for the power system.

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Introduction

Michael Villa
Executive Director, smartEn

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Securing affordable energy is a strategic priority for the European Union.

Reducing both wholesale energy prices and the energy bill for consumers is a prerequisite for industrial competitiveness and an inclusive clean energy transition.

Active consumers hold the key to support the achievement of this strategic objective, although most of the time they are still perceived as passive players that should only benefit from reduced prices that the system would offer them.

For instance, consumers can reduce their retail electricity bills and save money by:

- adopting energy efficiency and saving measures,
- flexibly adjusting their consumption when electricity is cheap,
- engaging in energy communities and energy sharing mechanisms,
- or subscribe to PPAs, notably for large industrial players.

Consumers can also have a crucial role in reducing energy prices for all.

This is where more efforts should be dedicated, as the systemic advantage of allowing active consumers to bid (directly or indirectly with the support of market players) into wholesale electricity markets cannot be missed. By allowing a large amount of demand-side assets to participate into day-ahead and intra-day prices, the wholesale price formation would increase in stability and affordability.

Although allowed since the 2019 Electricity Market Design, it is still impossible or very limited across Europe.

This Map wants to put a spotlight on this barrier which is hindering flexibility business models, revenues for active consumers, and benefits for all.

Before engaging into revisions of EU regulatory frameworks and modifications of the EU market design to ensure affordable energy for households, companies and industries, we encourage once again all relevant decision-makers to implement existing rules to enable consumers to react to price signals and participate in wholesale electricity markets to reduce both energy costs and prices.

This is not a technical detail. This is a strategic priority for the security and competitiveness of the European Union.

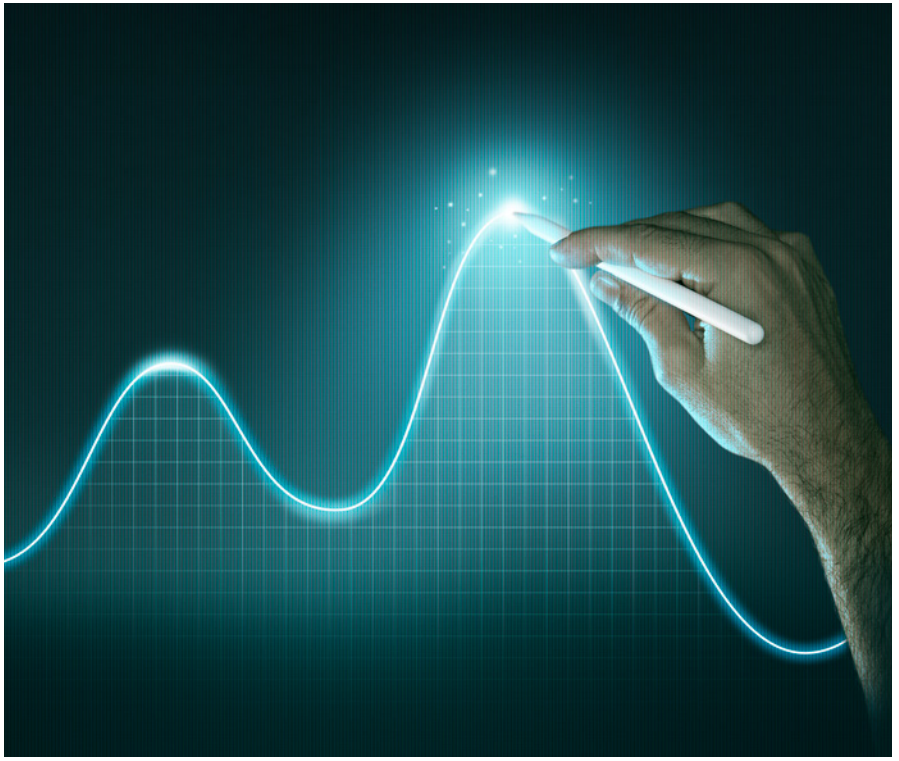
Demand-Side Flexibility in wholesale electricity markets

Demand-Side Flexibility plays an integral role in the energy system of the future. It supports the grid by alleviating congestion at all voltage levels, it facilitates the integration of variable renewables, and it opens up new revenue streams and reductions of energy costs for consumers of all kinds - industrial, commercial and residential ones. One of the main ways to unlock all these benefits comes from participation in wholesale electricity markets which can play a crucial role in reducing consumers' energy bills through implicit participation (e.g., dynamic price contracts) or explicit participation. When talking about such markets, this report is considering only spot markets i.e., Intraday and Day-Ahead markets (i.e. no futures or balancing markets).

smartEn and DNV calculated the potential benefits that demand-side flexibility could bring to the system in 2030. Over €300 billion in indirect annual benefits to people, communities, and businesses would result from reductions in energy prices as a whole, generation capacity costs, investment needs for grid infrastructure, system balancing costs, and carbon emissions. With full market access for distributed flexible resources the energy system would face €4.6 billion savings due to lower costs to generate electricity, it would avoid curtailing 15.5 TWh (61%) of renewable energy, and 37.5 million tonnes would be saved in annual GHG emissions, exceeding the "55% by 2030" target set by the European Commission.

Traditionally, in wholesale electricity markets generators would sell their production, and suppliers, traders, or large energy consumers would purchase said production to either sell to their clients or consume it themselves, in both cases meeting the demand. The price is established where demand and supply meet. Trading occurs on platforms set up by the Nominated Electricity Market Operator (NEMO) in each Member State. For Day-Ahead markets, prices are set one day before delivery through a pan-European auction mechanism. In the Intraday market, trading is organised on a continuous basis until close to delivery, i.e. a trade is executed as soon as two submitted orders match. In addition, three pan-European intraday auctions have been introduced in June 2024 by NEMOs and TSOs, taking place at 3pm D-1, 10pm D-1 and 10am delivery day.

Prices in wholesale markets are volatile, very much dependent on external factors, like energy production, energy consumption, geo-political events, global pandemics and macroeconomic events, or just simply how and when the wind blows and the sun shines. This allows demand-side resources to take advantage of their flexibility and fast reaction time, taking off electricity when it is cheap, or selling it when prices are high. Through this continuous action, DSF helps to soften the peaks and troughs of the wholesale markets, benefiting all consumers, whether they are active participants themselves or not.



There are several ways that DSF can access wholesale markets to grasp these benefits.

Explicit trading

An explicit activation by consumers (or a third party managing their assets) implies direct action taken to increase or reduce the consumption of an asset (e.g., an EV battery or an aluminium smelter). These actions are voluntary and trading this in the DA and ID markets constitute a commitment by the consumer. Explicit trading in wholesale markets can be done in the following ways:

EXPLICIT PARTICIPATION THROUGH DIRECT TRADING

HOW

Placing bids in different wholesale markets to procure electricity or selling demand capacity.

WHO

Direct trading is usually performed by large energy consumers, or on their behalf by optimisers, that have a sufficiently large demand and capacity that it becomes technically viable (reaching the minimum bid size) and profitable to directly trade in wholesale markets. This is not an activity performed by smaller commercial or residential consumers, not only for technical reasons but it is also a highly complex activity that also implies significant risks.

WHY

Trading in this way allows to receive an optimal price in wholesale markets, and can lead to an increase in competitivity.

BEST PRACTICES

France (demand decrease only), Great Britain.

EXPLICIT PARTICIPATION THROUGH (INDEPENDENT) AGGREGATION

HOW

In cases where the individual assets cannot reach by themselves the minimum capacity to trade, an aggregator (this can be a supplier, an aggregator related to the consumers' supplier, or an independent aggregator) can pool a series of assets together, and manage them, based on their customer's needs

WHO

This type of participation is best suited for smaller consumers or those that have smaller assets. For this option to be fully viable, independent aggregators should be able to participate in wholesale markets.

WHY

This avenue is particularly interesting for consumers that simply do not have the capacity to trade directly themselves but who want to benefit from lower wholesale prices, or direct payments from their aggregators in exchange of them managing their demand.

BEST PRACTICES

France (demand decrease only), Great Britain.

Implicit participation

Implicit participation is driven by price signals received by consumers from their suppliers. Based on this received information the consumer can (or not) adapt its consumption. Implicit participation does not signify a commitment to adapt consumption by the consumer. As with explicit participation there are different avenues available:

DYNAMIC PRICE CONTRACTS BASED ON WHOLESALE PRICES

HOW

The energy component of the retail contract[1] that consumers receive reflects the variable prices of wholesale markets. These types of contracts can have a variable time granularity, but most of them stay within hourly blocks with some cases of 30-minute blocks. Consumers need to have access to smart meters (or sub-meters for individual assets) that can provide these price signals in the appropriate time frame. For these dynamic price contracts to be effective, the energy component of the retail contract needs to have a significant impact in the final price for the consumer, and not be diluted by a large percentage of network tariffs, levies and taxes. For the purposes of this report, we estimate that contracts where the energy component is more than 50% of the final price, are providing a strong enough signal to the consumer.

WHO

This type of retail contract is highly beneficial for consumers that have different flexible assets whose activity can easily be shifted throughout the day depending on the wholesale prices (e.g., electric vehicles).

WHY

Consumers with these contracts can benefit from more information that allows them to take the best decisions with regards to their energy consumption, taking off the grid when prices are low and injecting when they are high. Dynamic electricity price contracts do however imply a certain risk related to the volatility of wholesale electricity and can expose consumers to high price spikes. A good understanding of these risks is necessary to avoid surprises.

BEST PRACTICES

Denmark, Latvia, Norway and Spain.

FIXED PRICE CONTRACTS COMBINED WITH OPTIMIZATION BY THE SUPPLIER

HOW

A supplier offers a fixed price to the consumer that is lower than a regular fixed price contract. The consumer does not receive directly a price signal based on wholesale prices. However, they agree for the supplier to manage their consumption, based on wholesale prices.

WHO

This type of contract is suitable for consumers that do not want to think too much about when and how they consume and would rather automatise the optimization process. As before, the more flexible assets the consumer has the more beneficial this type of energy contract can be.

WHY

Consumers receive a lower price compared to a fixed price contract and are not exposed to the variability of wholesale markets. The rewards are lower, but so is the risk.

BEST PRACTICES

Great Britain, Germany.

1 · In most countries the retail tariff is composed of the energy component that reflects the actual cost of the electricity, network tariffs that cover the costs of transport and distribution of electricity, and taxes and levies that might be applied to electricity.

Recommendations

As reflected by this report, access of Demand-Side Flexibility to wholesale markets is still at an infant stage. The main reasons are the lack of appropriate regulatory frameworks that allow market participants to trade in wholesale markets or for suppliers to provide consumers with price signals that reflect them. Luckily the framework that is required to enact these regulatory changes is already set by the Electricity Market Directive and Regulation from 2019 that was complemented more recently. The following recommendations are a checklist of barriers to remove to allow market participants open and non-discriminatory access, and in particular, to allow DSF to unlock its full potential.

1

Independent aggregator framework

Probably the main limitation for the participation of Demand-Side Flexibility in wholesale markets is the lack of an appropriate independent aggregator framework that recognizes in national law these actors and allows them to independently (from any supplier) trade in wholesale (and other) markets. As long as this framework is not available, the explicit flexibility business models will not be viable. The aggregator framework should cover aspects like the terms & conditions for engaging with consumers, suppliers and markets, rules for settlement, and baseline methodologies among others. The responsibility for the establishment of this framework lies with the National Regulatory Agency or from the Energy Ministry that can delegate it, and stems from Article 17 of the Electricity Market Directive.

2

Advance the roll-out of smart meters and allow the use of sub-meters

Smart meters are an integral part for dynamic price contracts (and dynamic network tariffs) to be viable, and also play an important role in the viability of DR services at large. Smart meter roll out was required to be completed by December 2020 according to the 2019 Electricity Market Design. However many countries like Germany, and Greece have been continuously postponing their deployment[2]. Other countries like Czechia and Hungary, only reach less than 10% of market penetration. Alternatively, dedicated measurement devices, should be allowed for explicit participation in wholesale markets, in cases where the smart meter is not deployed or where the dedicated measurement provides better information for the measurement of explicit DR (e.g., when it can isolate the activity of a specific flexible asset like an electric vehicle). Member States should allow suppliers offering (dynamic) energy contracts for specific assets to use sub-meters, to be deployed by market players, ensuring adequate billing and reliability of energy data.

3

Allow multiple service providers per connection point

With increasing electrification, consumers could have different service providers sell electricity and/or manage their assets. This is already the case in some countries where dedicated contracts exist for electric vehicles, separate from the rest of the household's supply. To enable this, consumers should be able to contract different service providers behind their main connection point. To settle consumption and or different DR activations, consumers will need access to sub-meters or dedicated measurement devices, as seen in the next recommendation.

4

Develop price/energy contracts comparison tools

Many consumers are not aware of the benefits of dynamic electricity tariffs, and how they could benefit from a tariff linked to wholesale prices. Furthermore, the research required to gather this information is many times too costly for consumers, in particular small consumers. To that extent the Electricity Market Directive Article 14 requires Member States to introduce at least one comparison tool, free of charge that includes offers for dynamic electricity price contracts. This tool has been developed in only a few countries, and good examples for it are Austria, Denmark and the Netherlands. In countries that have not yet implemented it, the Member State is responsible to do so, and can delegate it to their NRA or a private company.

2 · ACER-CEER 2024 Market Monitoring Report on Energy Retail.

Recommendations

5

Reduction of market gate closure times

Following the Electricity Market Directive, from 1 January 2026, the intraday cross-zonal gate closure time shall not be more than 30 minutes ahead of real time. Short gate closure times are well suited for demand assets, as flexibility service providers have more visibility on the availability of the asset closer to the point of delivery. That way they can also leverage their fast reaction times that are a competitive advantage over other technologies. Trading should be allowed as close to real time as possible and at least up to the intraday cross-zonal gate closure time. To implement this, NRAs should work together with NEMOs in reducing gate closure times. Good practices on this matter can be found in Austria, Central Western Europe region and Finland.

6

Reduce minimum bid sizes

Minimum bid sizes can limit the types of assets that can trade in wholesale markets. High bid sizes (e.g., 1 MW) will require managing very large pools of assets, that might de facto exclude smaller distributed energy resources from accessing the markets, as can be seen in Italy. To prevent this the minimum bid size should be 100 kW or lower for all markets.

7

Increased transparency

There is currently very little transparency on the amounts of DSF and the providing technologies being traded and activated in wholesale markets. The availability of this information could bring light to the potential benefits and lower energy prices that DSF can bring to wholesale markets. The same transparency as to what generating technology is setting the marginal price should be extended to distributed resources. National Regulators should collect this information and make it publicly available.

8

Cost-reflective network tariffs and, taxes and levies

Consumers' energy bill includes more than just the price to procure electricity in wholesale markets. In many European countries, the part of the final bill corresponding to network tariffs and taxes is more than 50%. In some cases, like Hungary, this percentage is 73%. With such big parts of the energy bill being fixed, price signals are blunted, and consumers barely see any benefits from their dynamic tariffs. Hence network tariffs should also be dynamic, and cost-reflective (i.e., reflecting the costs of using the transport and distribution grid at precise times during the day). While both signals reflect different physical realities, i.e., wholesale prices reflect the availability of energy and network tariffs the capacity of the network, they will together, give the best possible information to consumers. The amount of fixed taxes and levies should also be reduced, and either billed separately or in cases of some levies (like support mechanisms for RES) not included in the energy bill to avoid further distorting the price signals.

Recommendations

9

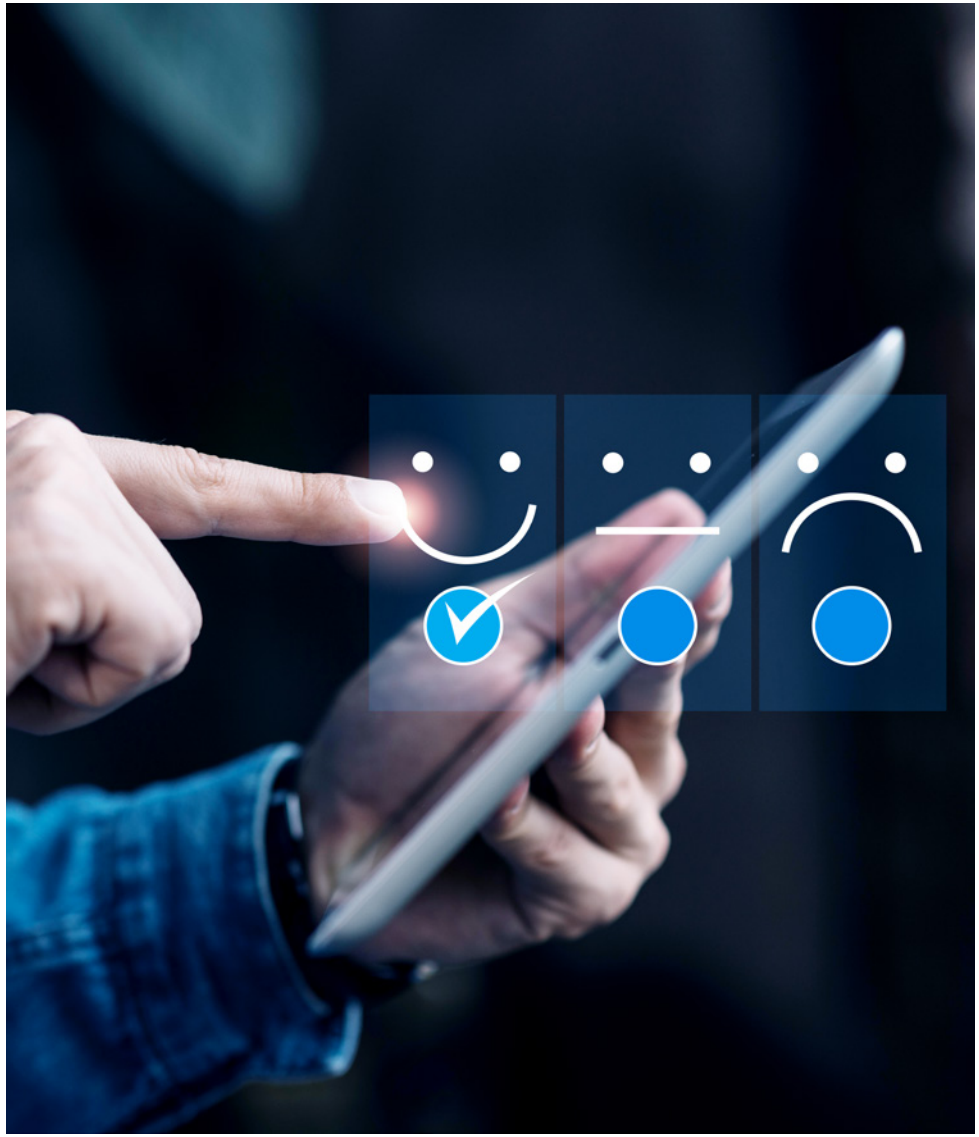
Avoid distortion of incentives through different support mechanisms

Member States might introduce specific incentives and support mechanisms for different consumer sectors or technologies. For example, in Germany, industrial consumers will have a reduced price if their consumption stays above a certain threshold continuously. If they go below that threshold, they will pay higher prices. While such an incentive was geared in the past to incentivise stable electricity consumption in line with large conventional power plant production, it is outdated today and it completely disincentivizes them from consuming in a smart and flexible way, as it prevents them from reducing their demand to avoid losing out on lower costs. To avoid such counterproductive incentives, any support scheme should consider the possibility of consumers behaving in a flexible way.

10

Allow and facilitate value stacking

Demand-Side Flexibility can be used in different markets depending on where it is more useful, at local level for DSOs, at balancing and capacity markets for TSOs, or in wholesale markets. Markets at different levels should allow for sufficient coordination that bids not used in one market could be easily bundled and transferred to the next market if desired. Linked to this, no market should exclude in their requirements the participation of the same capacity in other markets. Splitting a single aggregated unit should also be permitted (for instance a 100kW service could bid 50kW in one market, and 50kW into another). Of course, the same capacity should only be activated at any given moment in one market at a time.



Access to wholesale market and prices

Assessing wholesale market participation for DSF as a whole is a complex matter that risks leaving out the nuances of each country in view of providing a comparable grading. This is particularly evident by the fact that consumers can access wholesale market prices through two distinct, but complementary, avenues. Explicit and implicit flexibility. For this reason, this map summarising wholesale market access should be considered carefully, and countries that are better placed can still have significant barriers for consumers to access wholesale prices. This is in particular in cases like France, where the explicit access is very developed, but consumers have no access to dynamic prices. Two distinctive features inform a successful country, the existence of an independent aggregator framework that clearly defines roles and responsibilities to trade in wholesale markets, and the availability of dynamic price contracts that reflect wholesale prices. In addition, a crucial aspect is the availability of smart meters that allow consumers to receive the appropriate price signals and allow suppliers and independent aggregators to record activity and settle their responsibilities. Countries that stand out overall are Great Britain, as the only one where both explicit and implicit access to wholesale markets is well advanced. Other high performers are France with regards to explicit access (while weak on implicit access) and Spain, where the roles reverse, with a well-developed dynamic price contract but no participation of independent aggregators in wholesale markets. Hence we recommend that this map is assessed together with the other criteria to provide a more nuanced picture.

Access to wholesale market and prices

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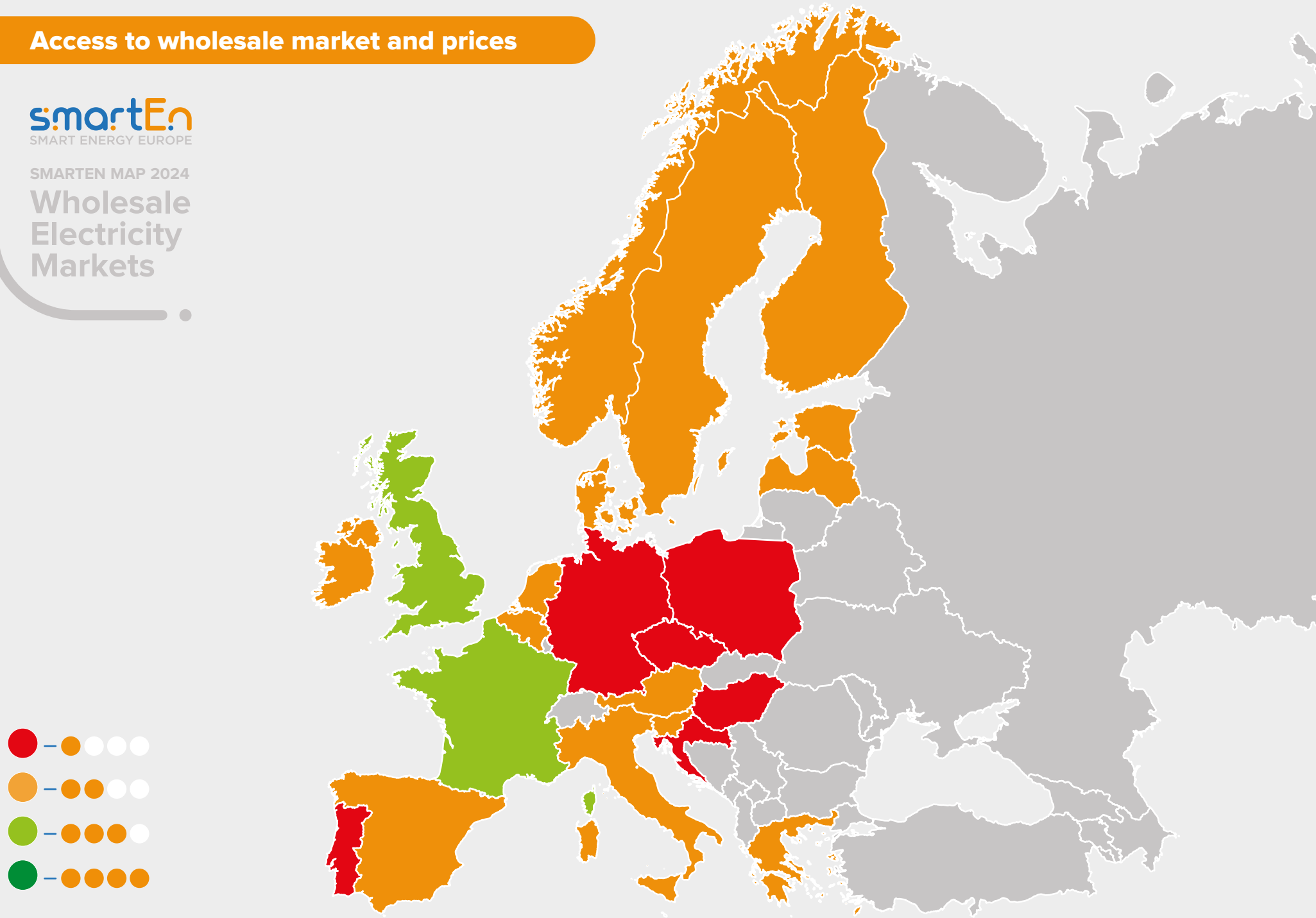
Wholesale Electricity Markets



Explicit participation in wholesale markets

Participation of Demand-Side Flexibility in European wholesale electricity markets is almost exclusively reduced to implicit DSF through dynamic electricity price contracts. Explicit participation, i.e., through direct trading of demand assets or through an aggregator, is only possible in Belgium, France, Great Britain, and Greece. The main reason being the lack of an independent aggregator framework that would formally recognise them as a balance responsible party, and would define the terms and conditions (e.g., settlement and interactions with suppliers) for their participation. Barring this crucial aspect, no market party active in any MS expressed any concerns over technical requirements (e.g., bid sizes or measurement requirements) or administrative requirements (e.g., red tape, collaterals etc.) that were too burdensome or disproportionate towards demand-side resources. This of course, is heavily dependent on the existence of an aggregator framework, and their formalization could also introduce a whole host of technical and administrative barriers if not done properly. Most countries use a 100 kW minimum bid size that is widely accepted as reasonable for DSF. Gate closure times can also incentivize the use of demand-side resources in wholesale markets. Markets with a gate closure time close to real time, or with short lead times are more conducive for smaller variable assets like EVs and heat pumps. In the Intraday market, countries that stand out are Finland, with its gate closure at the moment of delivery, or countries with 5-minute lead times like Austria, France or the Netherlands (among others) The Day-Ahead market saw the highest volume of flexibility activation by independent aggregators. But this was only because, at the time of writing, the French NEBEF mechanism was the sole framework enabling activations by independent aggregators on wholesale markets. NEBEF uses trading on DA timeframe as a norm. Trading on DA timeframe allows a higher participation of some DR profiles, particularly industrial ones. Adapting production schedules may not be feasible if the activation notice is received too close to the delivery time. Activation through the Day-Ahead market enables the participation of these profiles, which are also major energy consumers.

Explicit participation in wholesale markets

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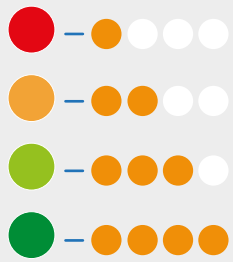
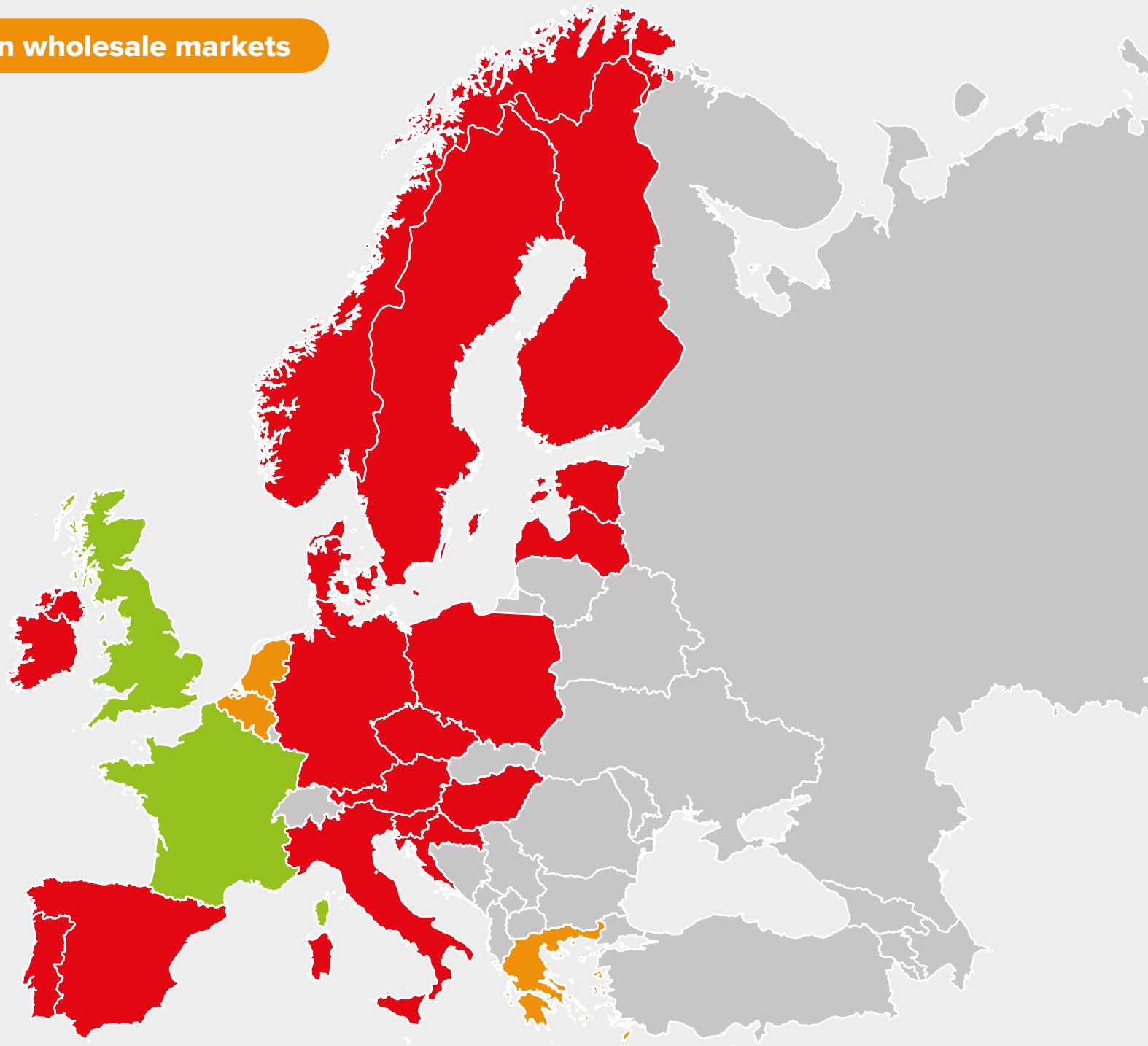
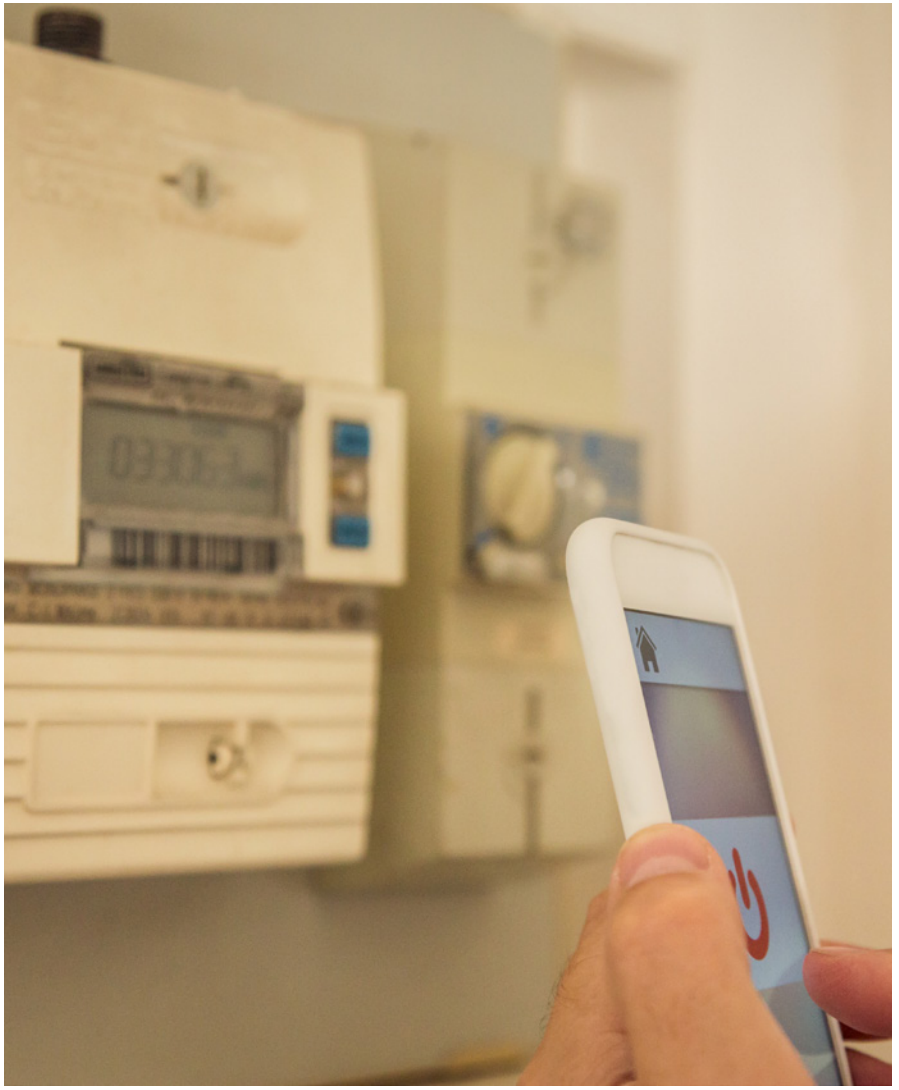




Implicit participation in wholesale markets

The other avenue for consumers to benefit from the variability of wholesale prices is through implicit participation, be it through a dynamic tariff or through a fixed tariff in which the supplier does the trading in wholesale markets. This usually results in a lower fixed tariff for the consumer, compared to other fixed tariffs. The offer of dynamic electricity price tariffs varies wildly by country, but most Member States have at least one offering. Countries that stand out are Norway (with 93% of residential supply contracts being dynamic), Denmark (69%), Finland (30%) and Latvia which stands out for 52% of its commercial customers contracts being dynamic. We have observed that the more varied the technology stock of the country is, i.e., the more electric vehicles, heat pumps etc., that consumers own, the higher the number of dynamic pricing offerings are available.

However, access to these tariffs is quite uneven not only between European countries but within the countries itself. Smart meters are an integral part to be able to access dynamic electricity price tariffs and the roll-out of such devices has been slow or continuously delayed in numerous countries. An alternative to the use of smart meters would be a service-provider-issued sub-meter, but these are not yet available or accepted in many countries.



Implicit participation in wholesale markets

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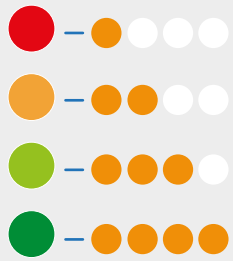
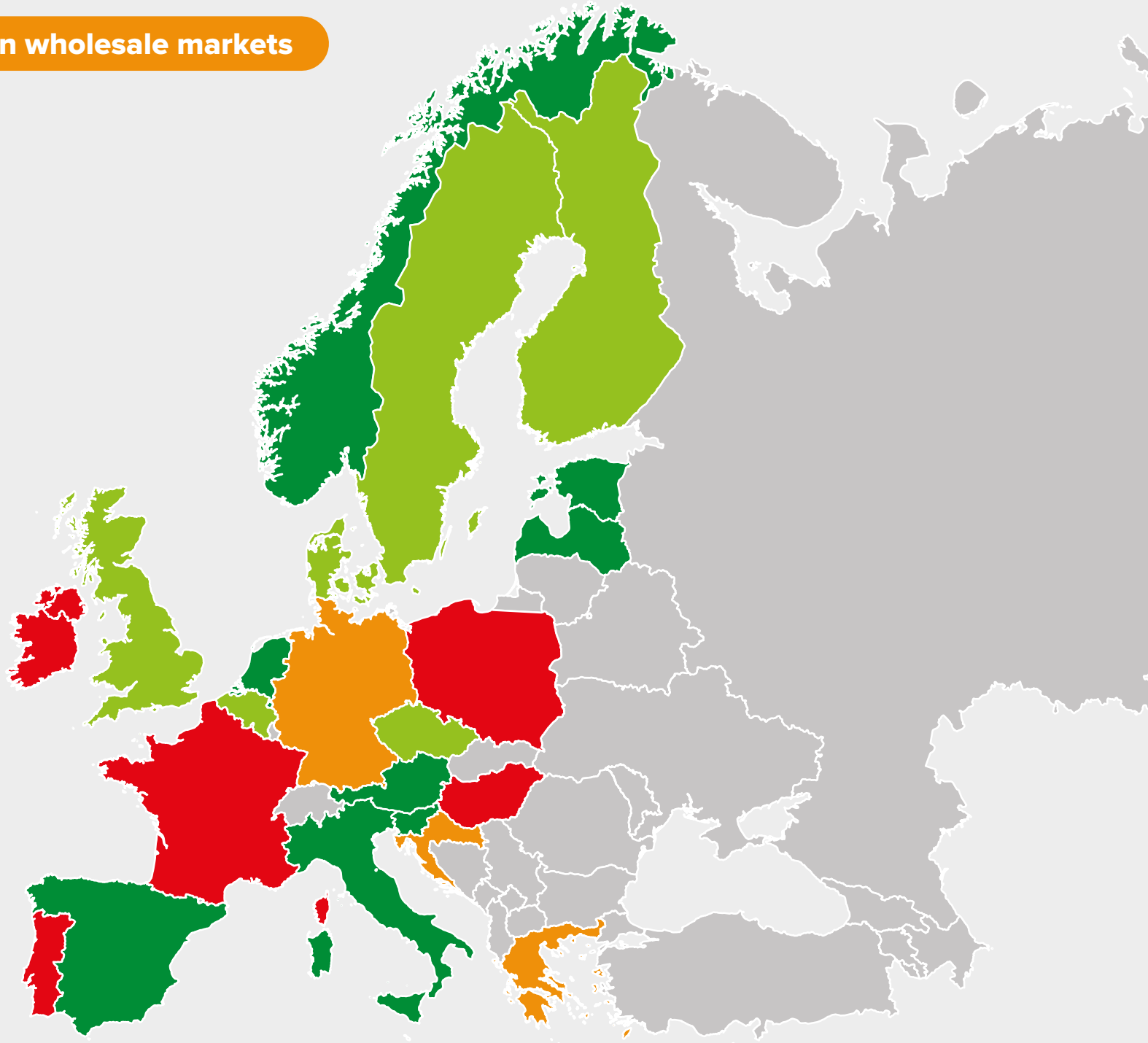




Market Maturity

Wholesale markets are at an infant stage with regards to participation of DSF, and again it is very much linked to the existence of a framework that allows demand-side aggregation to participate. This crucial factor will define the grading of this category. However, in general we have not observed any limitations on paper that prevent any technologies, including Demand Response and storage from bidding into the wholesale market.

Furthermore, a generalised lack of transparency prevented us to gather information of the volumes of electricity traded and the assets providing it. This seriously limits the assessment of flexible resources participating as well as complicates the viability to assess the potential benefits to participate in the market. The one case that stands out is France, that stands out on transparency and availability of data. In 2022, last year with records at the time of writing, 519,9 GWh of DR were activated in wholesale markets, from a total 2 100 TWh traded all wholesale markets.

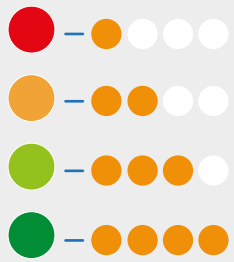
Implicit participation is easier to assess, with more data available with regards to the number or percentages of dynamic tariffs subscribed in each MS, as well as the available offers. Markets with the highest proportion of consumers subscribing to dynamic tariffs include Norway and Denmark, with market share of 93% and 69% respectively. Overall the deciding factors for high numbers of offerings and participation is the penetration of smart meters that facilitate their use, and the countries that stand out in addition have the highest deployments of DERs like heat pumps and electric vehicles that enable suppliers to offer tailored retail tariffs to consumers that benefit from being exposed to wholesale market prices. A particular case is Germany, which has the lowest smart meter penetration in the EU, however one of the largest numbers of dynamic tariffs and services offered (34 different types of contracts). This potential remains untapped, as most consumers move towards self-consumption.

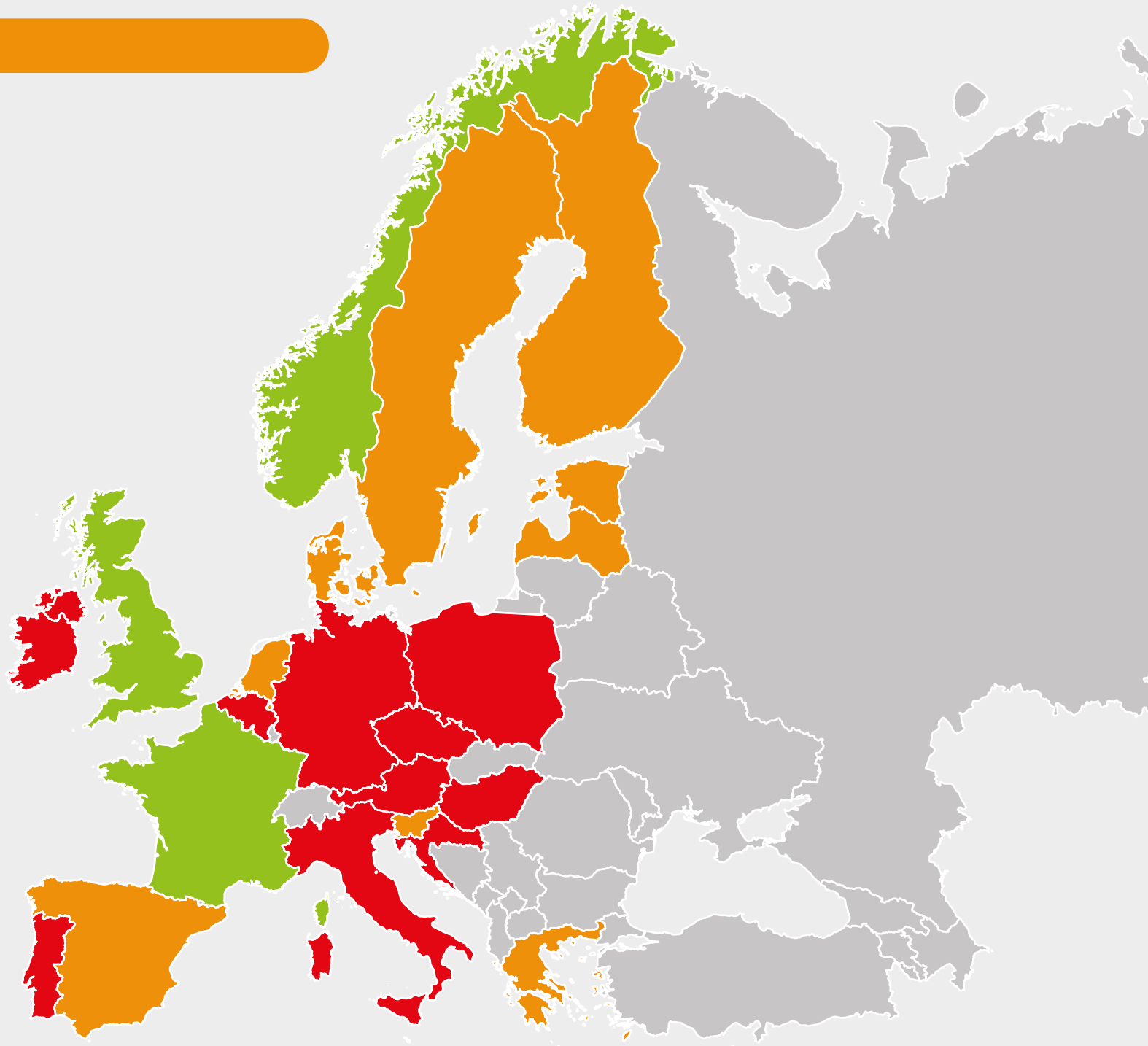
Market Maturity

smartEn
SMART ENERGY EUROPE

SMARTEN MAP 2024

Wholesale Electricity Markets



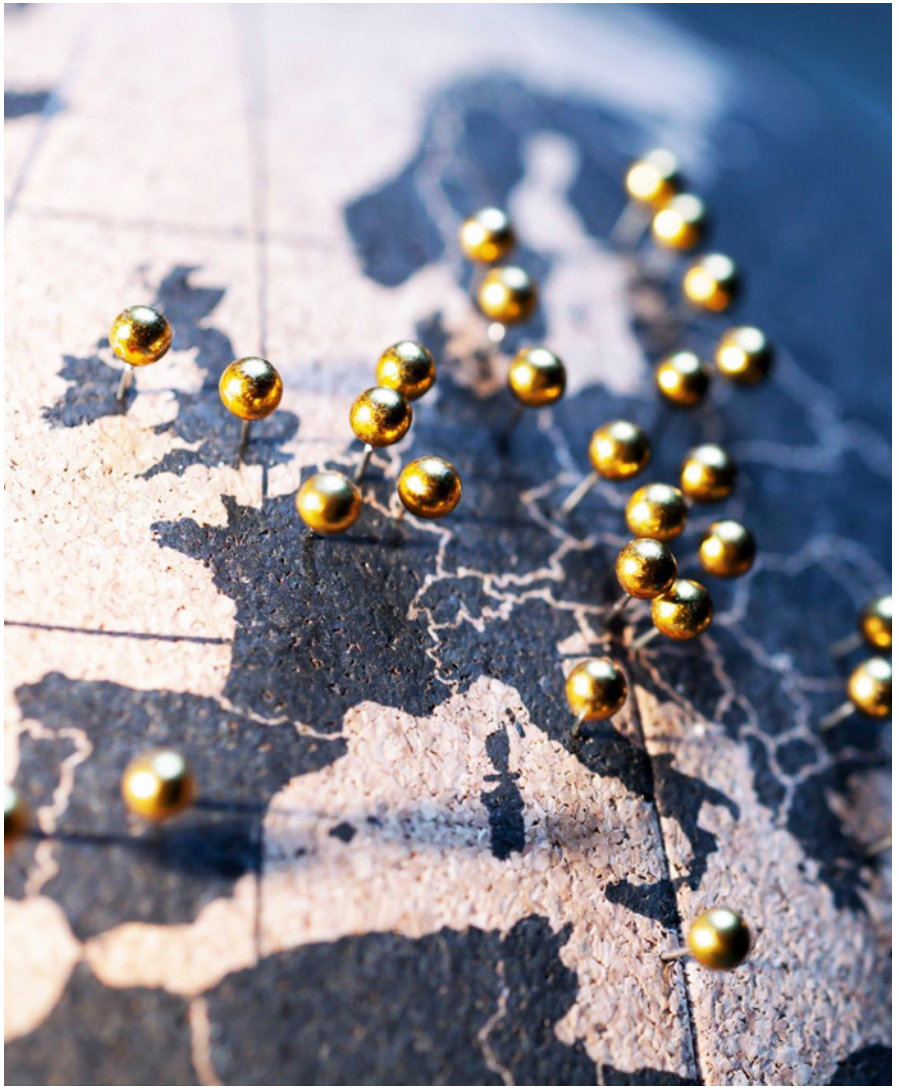


Market Outlook

The main defining factor to assess the future potential of a market is related to the timelines to implement a legal frameworks that allow demand-side aggregation to access wholesale markets in Member States. With that in mind, some countries are close to their introduction, which could mean access between 2025 and 2026. Countries to look out for include France and Great Britain. Other countries are looking at long roads ahead of them, with continuously pushed deadlines, for example Spain does not expect to have an aggregator framework before 2026, and in some cases like Austria and Poland there is no deadline in view. This is a clear step back, and those countries should be considered with hesitation with regards to their viability for business models that require wholesale market participation in the short and medium term.

With regards to smart meter deployment roadmaps, a key aspect for the use of dynamic tariffs, Ireland are currently deploying them and should be finished by 2025. Other countries, like Germany continue delaying their installation until 2027 at the earliest. For those countries, the extent to which dedicated measurement devices will be allowed as alternatives will be critical for the development of business models considering explicit or implicit DR.

Another factor to consider over the medium term is the new network code for Demand Response that is under development at the time of writing by ACER. While the entry into force, in the best-case scenario, would not be until 2026, many of the provisions defined in it will provide significant requirements for Member States that if timely implemented will quickly facilitate market access to distributed energy resources.

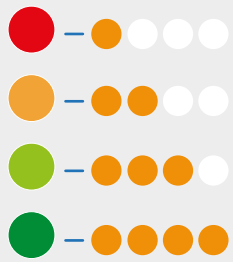


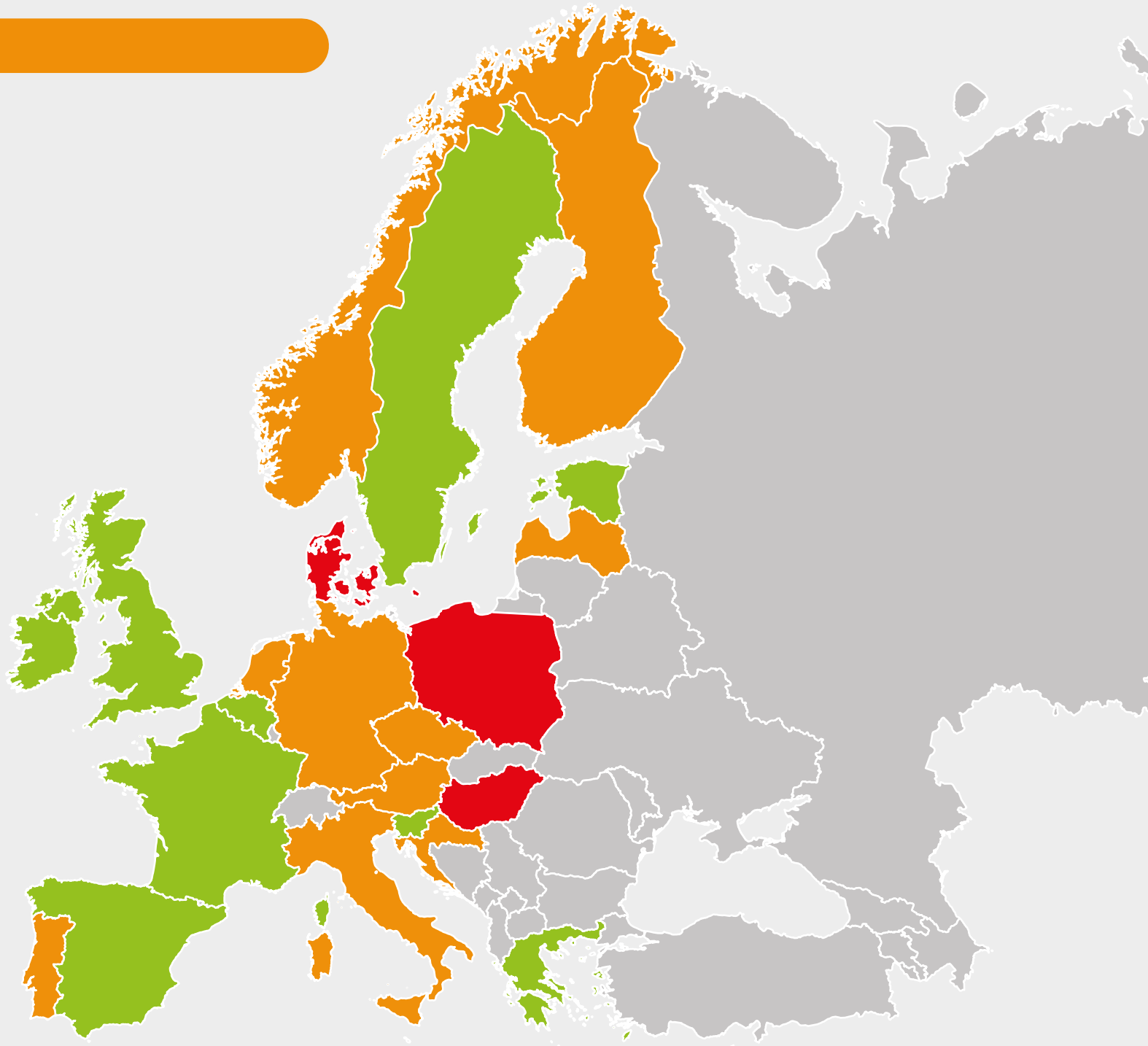
Market Outlook

smartEn
SMART ENERGY EUROPE

SMARTEN MAP 2024

Wholesale Electricity Markets





AUSTRIA

The Austrian wholesale markets are at the time of writing only accessible to electricity suppliers and large energy consumers. Independent aggregators are currently unable to valorise their customers' flexibility through direct trading on the Day-Ahead and Intraday markets. However, consumers have access to wholesale prices through hourly dynamic electricity contracts, thanks to the widespread rollout of smart meters and the availability of dynamic energy price retail contracts. In 2023, 6% of households and 4% of businesses that subscribed to an hourly dynamic electricity contract indexed on wholesale prices.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Access to the wholesale market for independent aggregators is not possible due to the lack of a framework covering their participation in the Day-Ahead and Intraday markets. Other actors can trade, like large energy consumers, and the design of wholesale products—such as minimum bid size, granularity, and lead time before the closure of continuous ID trading—is not seen by participants as a barrier for DER participation.

Putting aside the fact that independent aggregators cannot access wholesale markets, the administrative requirements for trading are well-defined and do not pose significant barriers for new market entrants. Accessing the Austrian wholesale market as a trader involves several obligations. Before beginning activities, the candidate must be part of a balance group, either by obtaining a license as a BRP or by affiliating with an existing BRP and registering as an electricity trader. Licensing conditions for becoming a BRP vary depending on provincial legislation. The process takes an average of 45 working days and involves registration with three entities:

- The Austrian imbalance settlement responsible (APCS), which requires providing collateral and necessary documentation;
- The TSO APG, which mandates the installation of an IT system for schedule transmission;
- The regulator E-Control, which requires certain documentation.

Market participants seeking affiliation with an existing BRP must sign a bilateral contract with the chosen BRP based on general terms and conditions. In both scenarios, the market participant must obtain an ACER code for REMIT compliance and adhere to reporting and publishing obligations once its wholesale market activities commence.

The participation of DERs in wholesale markets is facilitated by the granularity of products and the gate closure times in the continuous ID market.

Three market operators are active in the country: EXAA, EPEX Spot, and Nord Pool. The minimum bid size in Austria is set at 100 kW. The DA market is based on 1-hour products, while the ID market is based on 15-minute products. Traders can place buy or sell orders on the continuous ID market with five minutes lead time.

IMPLICIT ACCESS TO WHOLESALE PRICES

Austrian households and businesses can easily access wholesale prices through dynamic electricity contracts, thanks to a wide variety of contracts and an almost total coverage of smart meters in the country Moreover, in 2023 the share of energy component of the total electricity bill exceeded 50%, leading to significant potential benefits from price variations for customers subscribing to a dynamic contract.

Austrian law requires electricity suppliers with more than 50 000 customers to offer dynamic contracts to customers. As of 2024, four dynamic contract offerings were available on the market. The Austrian regulator, E-control, has developed an online comparison tool that allows residential and small commercial consumers to compare different electricity contracts. However, for hourly dynamic offers, the tool only displays the suppliers' mark-ups, rather than the energy prices based on historical data, which may create confusion for consumers. Austrian households and businesses are able subscribe to dynamic contract thanks to an advanced rollout of smart meters. In 2023, 80% of households had a smart meter installed, enabling the reading of consumption data every 15 minutes.

FINANCIAL INCENTIVES

Due to the lack of aggregators trading in wholesale markets, the main incentive for Austrian consumers lies with dynamic tariffs. The share of the energy procurement cost in the total electricity bill is high enough to provide clear price signals and incentivise consumers to subscribe to a dynamic electricity tariff. The energy component of a consumer electricity bill reached 53% in 2023. This share, together with a sufficient price volatility, can be considered high enough to incentivise consumers to change their behaviour and drive investment in DERs. The national regulator, E-Control advises that to truly benefit from hourly dynamic pricing, consumers should become active consumers, for example through investing in DERs and home energy management systems.

At the time of writing, there are no financial incentives associated with explicit participation of DSF in Austrian wholesale markets is not possible due to barriers to access the market stemming from the lack of a lack of legal basis and technical framework.

MARKET MATURITY

While DR activation in wholesale markets is not possible in Austria, subscription to dynamic electricity contracts is gradually increasing. In 2023, 6% of households and 4% of businesses that subscribed to a dynamic retail contract indexed on wholesale prices[3]. While this is still a low number, these rates place Austria in the average range of European countries studied as part of this research.

MARKET OUTLOOK

The country is at time of writing revising its framework for independent aggregator. However, an implementation roadmap has not been defined yet, but there are high expectations that it will be developed in the short term The adoption of DERs like, EVs and heat pumps, and the development of dynamic tariffs also creates high expectations for many consumers adopting these tariffs in the coming years.

3 · ACER, CEER. 2024. Energy retail - Active consumer participation is key to driving the energy transition: how can it happen? 2024 Market Monitoring Report. P.27-28.

BELGIUM

Belgium is one of the few European countries to establish a dedicated framework for independent aggregator participation in wholesale markets, known as the “DA/ID Flexibility Service.” However, certain flaws in the supplier compensation mechanism, restrictions to contracting customers connected to the low-voltage network, and the economic relevance of other markets have prevented the service from being activated. As for implicit access to wholesale prices, the limited rollout of smart meters restricts electricity end-users from subscribing to dynamic retail offers.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Currently, all market participants, including demand through independent aggregators,are in theory to access the Belgian wholesale markets due to the establishment of a specific framework for independent aggregators. In practice, independent aggregators are severely limited by technical requirements and economic incentives that prevent them from participating in wholesale markets. Crucially, the aggregator framework prevents the participation of customers connected to the low-voltage network.

Belgian law allows access to wholesale markets to all market participants. Aggregators managing supply-side units (e.g. CHP units, batteries) can access DA and ID markets. The Belgian TSO ELIA created a contract specific to the valorisation of DR in wholesale markets called “DA/ID flexibility service”. The service went live on July 1st 2021. It enables a Flexibility Service Provider (FSP) to trade with the demand turn up/down of a single or an aggregated pool of customers. However, FSPs cannot yet engage customers connected to the low voltage level without the agreement of their electricity suppliers, directly contravening the Electricity Market Directive of 2019.

Administrative requirements to participate in the DA/ID flexibility service are readily available on the ELIA website. The FSP candidate must first be, or sign an agreement with, an existing BRP that will bid in wholesale markets on its behalf. FSPs can engage with customers who have a positive yearly average net offtake and are equipped with a boundary meter or sub/meter capable of providing data at a minimum granularity of 15 minutes. The FSP then signs a contract with a delivery point and sends a notification to the delivery point’s supplier. The supplier has one month to respond to the request. The agreement should specify that the supplier agrees to the service, and the compensation price for the supplier to cover the purchase of energy that will not be consumed by its customers. If the two parties cannot agree on a price, a fallback methodology called “Transfer of Energy” applies. However, the framework for the Transfer of Energy does not apply

to customers connected to the low-voltage network. If no agreement between BRPs can be reached, an independent aggregator cannot contract customers connected to the low-voltage network.

Once the customer engagement process is finalised, the BRP of the FSP can place bids in the DA or ID market. Once accepted, the BRP sends a nomination notice to ELIA, initiating the activation process. The FSP instructs the delivery point to reduce or increase their energy offtake. The volume delivered through activation is calculated by comparing the delivery point's consumption with a baseline. Only one baselining methodology is applied, called the High X of Y methodology. ELIA also notifies the BRP of the delivery point's supplier to prevent any counterbalancing actions. During an activation of the DA/ID Flexibility Service, for each quarter-hour of the activation period, delivery points contributing to the activation cannot be part of the pool of delivery points active in the balancing markets.

ELIA then adjusts the FSP's BRP perimeter by adding the activated volume and adjusts the supplier's BRP by removing the volume. The supplier is then compensated by the FSP for revenue losses, either at an agreed price or a default price set by the Transfer of Energy methodology, which considers the previous year's energy price (Y-1) for compensation.

While access to wholesale markets is still in the early stages for DERs, market participants have noted that significant flexibility volumes are being deviated from participating in wholesale markets in favour of other markets to take advantage of more profitable imbalance prices. Adjusting generation or consumption patterns to reduce system imbalances is authorized in Belgium. Recent spikes in imbalance prices (both negative and positive) have created viable business cases, allowing suppliers to use flexibility to cover their imbalances. Moreover, the Belgian TSO provides near-real-time imbalance prices and forecasting services, enabling market participants to access the information they need.

Belgium's wholesale market products are designed in a way that enables the participation of DERs. The minimum bid size is 100 kW. DA trading is based on 1-hour products, while ID trading allows for electricity trading in 15-minute products with up to five minutes before delivery.

IMPLICIT ACCESS TO WHOLESALE PRICES

Access to wholesale prices through dynamic contracts is allowed in Belgium but only available in the Flanders region and hindered by the limited rollout of smart meters.

Since 2022, every electricity retailer with more than 200 000 customers must propose to its customers owning a smart meter, a dynamic electricity contract based on spot prices. In 2024, nine suppliers offer a dynamic electricity contract to their customers (SME or residential customers) exclusively in the Flemish region. Five of these offers allow an automation of DERs , such as EV charging or heat pump operation during low-priced hours[4]. Moreover, the rollout of smart meters is still uneven across the country with only 32% of households having a smart meter installed in 2023. The low rollout creates barriers for consumers willing to subscribe to dynamic contracts. The Flemish region has a more advanced rollout than the Wallonia and Brussels region. The different Belgian regional energy regulators created online tools that enable consumers (residential and businesses) to compare different electricity suppliers offers.

FINANCIAL INCENTIVES

While their market penetration is still at an infant stage, the main financial incentive in Belgium remains with dynamic energy price contracts. Since the explicit DR service has not yet been activated, we cannot assess the financial opportunities it represents. However, market participants have noted that potential remuneration may fall short compared to other commercial opportunities, such as balancing and imbalance management.

With regards to the benefit of dynamic contract, the share of energy procurement costs for residential consumers reached 57% of the total electricity bill in 2023. This high share, if exposed to wholesale prices, could lead to significant price differentiation throughout the day, incentivising consumer responsiveness, and drive investment in DERs. LCP Delta[5] highlighted 23% savings can be achieved by a Belgian household owning a heat pump and an electric vehicle if they switch from a static to an hourly dynamic electricity retail contract and adopt flexible consumption behaviour based on the lowest-cost hours.

4 · Data coming from the Regulatory Assistance Project.
5 · LCP Delta. 2023. Assessment of consumer risks and benefits of heat pumps with and without dynamic price contracts.

MARKET MATURITY

While the groundwork is being laid for DR to access wholesale markets and price signals both through explicit and implicit mechanisms, the market for it is still at an early stage. The framework for DA/ID flexibility service has not been activated yet due to flaws in its design and less than 1% of customers subscribed to a dynamic tariff. Although ELIA has developed a framework for DR participation in wholesale markets, no market participants have opted to enter the market through the DA/ID Flexibility Service. Market participants interviewed, explain that the compensation mechanism, combined with the costs of metering system installation creates a business case that is insufficiently attractive.

Currently, the maturity of implicit access to wholesale prices is extremely low. As of September 2023, only 1 830 customers (both businesses and consumers) in Belgium have subscribed to a dynamic contract, exclusively in the Flemish region. This number seems especially low, taking into consideration that the share of energy procurement costs for residential consumers reached 57% of the total electricity bill in 2023. This high share, if exposed to wholesale prices, could lead to significant price differentiation throughout the day, incentivising consumer responsiveness.

MARKET OUTLOOK

Belgium is a promising market, where at the time of writing, there are ongoing reviews of the regulatory framework that will allow higher participation of demand in wholesale markets. ELIA is reviewing its framework for the Transfer of Energy (the fallback methodology for valuing DR when the aggregator's BRP and the supplier's BRP cannot agree on a price). This will simplify the process of contracting customers connected at the low voltage level. Additionally, the country will allow multiple BRPs to operate on the same access point. This new framework aims to enhance the participation of low voltage assets and customers and is expected to be finalised by the end of 2025.

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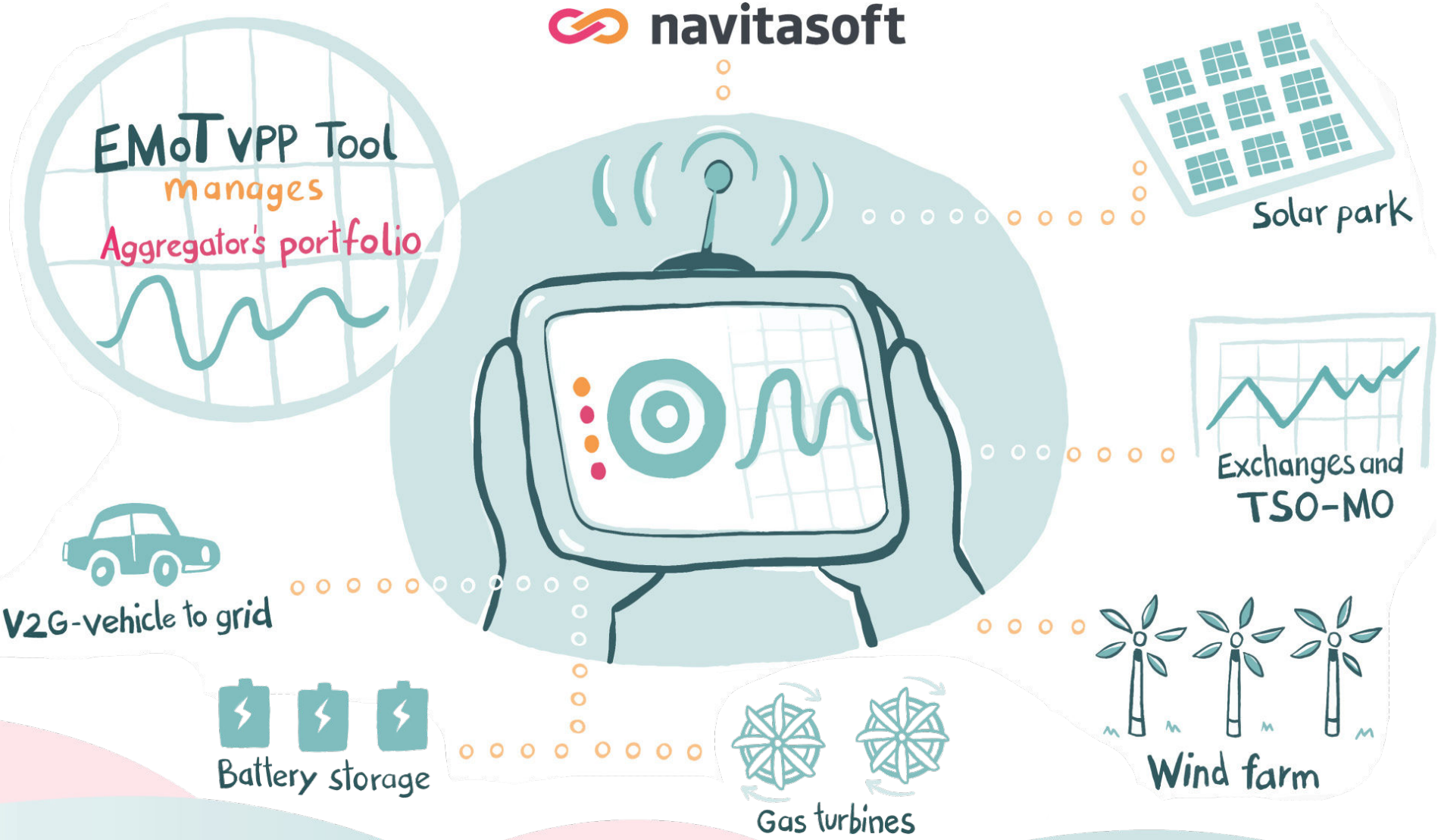

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CROATIA

While the country recognises the right of independent aggregators to access wholesale markets, there is at the time of writing no regulatory framework enabling the participation of DR in wholesale markets, leaving these only for electricity suppliers and large energy consumers. Aggregators managing generation assets can access Day-Ahead and Intraday markets. This might change in the near term as the country is in the process of revising its framework for independent aggregators to enable participation of demand-side assets in wholesale markets. Regarding dynamic pricing contracts, the low rollout of smart meters remains a significant barrier for consumers to access them.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

At the time of writing, Croatia has not developed an independent aggregator framework that would allow a widespread access of DERs to wholesale markets.

Access of explicit and implicit flexibility to wholesale market is currently extremely limited. Various actors including suppliers, independent aggregators, and large energy consumers, have on peper the right to access DA and ID markets. However, without specific framework that covers DA and ID markets, independent aggregators are de facto excluded from these markets.

On the administrative side, participation in the wholesale market requires a trading, supply, and/or production license issued by the Croatian Energy Regulatory Agency (HERA) and an Energy Identification Code issued by HOPS, the TSO. Once these are obtained, participants must register with the Croatian NEMO, CROPEX. Participants are also required to provide collateral, the amount of which varies depending on the type of actor and the size of their portfolio. The amount of the collateral is considered a significant barrier for the participation of smaller actors. Every market participant must either be a BRP or delegate this task to an existing BRP.

Croatian wholesale product designs align with European requirements regarding the minimum bid size. At the exception of DR, the country does not impose limitation to the participation of other DERs (solar PV, batteries). CROPEX, the designated NEMO active on the country, proposes DA products with one-hour granularity and ID products on 15-minute granularity. The minimum bid size of both market is 100 kW. Trades on continuous ID market can occur up to 30 minutes before delivery. The gate closure time of continuous ID trades should be shortened to strengthen DERs participation.

IMPLICIT ACCESS TO WHOLESALE PRICES

While electricity suppliers are required to offer dynamic tariffs to their

customers, the low rollout of smart meters acts as a barrier for consumers wishing to subscribe to these contracts.

Following the Electricity Market Directive, electricity suppliers are offering dynamic contracts to their customers. However, the low rollout of smart meters prevents consumers from subscribing to these contracts. In 2022 only 19% of households had access to a smart meter.

FINANCIAL INCENTIVES

The only financial benefits for consumers in Croatia are through dynamic electricity price contracts due to the lack of explicit wholesale participation. In 2023, 48% of a Croatian household's electricity bill was composed of energy procurement costs. While just below the 50% threshold considered significant in this study, this share can still present substantial price variations for consumers, encouraging more flexible consumption patterns. Croatian consumers are eligible for dynamic contracts, enabling them to adapt their consumption to wholesale price fluctuations.

MARKET MATURITY

Both the market for explicit and implicit flexibility is very immature for DERs. Currently, there is a lack of official statistics available regarding the subscription rates for dynamic electricity contracts in Croatia. Moreover, in absence of a framework for independent aggregators, no volume of DR was exchanged in the markets.

Around 30 participants take part of the Croation wholesale market. Some aggregators (less than five) are registered as participants in the Croatian wholesale markets. These aggregators are managing supply-side units.

MARKET OUTLOOK

Croatia is currently reviewing its framework for independent aggregators. A new Energy Act is expected to enable the participation of energy communities and independent aggregators in wholesale market. The act is expected to take affect at the beginning of 2025. Moreover, the implementation of new electricity products with a timeframe of 15-minute is expected by the second quarter of 2025.

CZECHIA

The Czech wholesale market currently imposes significant restrictions on the explicit valorisation of DER flexibility. Czech regulation lack a framework for independent aggregators, allowing only electricity suppliers and large energy consumers access to wholesale markets. Hourly dynamic electricity contracts are limited to residential customers, but the low smart meter rollout restricts customer participation.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Access to wholesale market is currently not possible for independent aggregators in Czechia. However, the country is, at the time of writing, developing its framework for independent aggregators.

Czech wholesale markets are open to suppliers and large energy consumers. The development of an independent aggregator status is still under development in Czechia. The amendment to the electricity law that establishes the figure of independent aggregators passed the Parliament in December 2024 but full implementation is delayed to H2 2026 (most likely H1 2027).

Except for the fact that independent aggregators' access to DA and ID markets is not covered by the existing framework, market participants did otherwise not identify any barriers arising from the administrative requirements to access wholesale markets. The requirements include, a trading licence issued by the Czech regulator (ERU), demonstrating adherence to EU and national regulation (REMIT), the completion of an Agreement on Settlement of Imbalance to ensure adequate risk management, and registration with the Czech wholesale market operator (OTE) and TSO to have access to infrastructure and market platforms.

If allowed to access the market, the product design would be conducive to the participation of DERs, such as batteries or CHP units. The minimum bid size in Czech wholesale markets is 100 kW. The DA market is based on a one-hour product, while the ID continuous market has offered 15-minute products since July 2024. Trading on the ID continuous market can occur up to five minutes before delivery.

IMPLICIT ACCESS TO WHOLESALE PRICES

While Czech suppliers are offering dynamic electricity contracts, their adoption is very limited due to the low rollout of smart meters.

In 2023, only 3% of Czech households had a smart meter installed. We were unable to retrieve an official statement explaining when the rollout of smart meters will be completed.

FINANCIAL INCENTIVES

Given the right framework, consumers could significantly benefit from subscribing to dynamic electricity contracts and from explicit access to wholesale markets. In 2023, the share of energy component of a household electricity bill accounted for 59%, which presents a substantial opportunity to shift consumption to lower-cost periods and stimulate investments in DERs. In addition, the country should establish a public comparison tool to help residential consumers compare various electricity contracts efficiently.

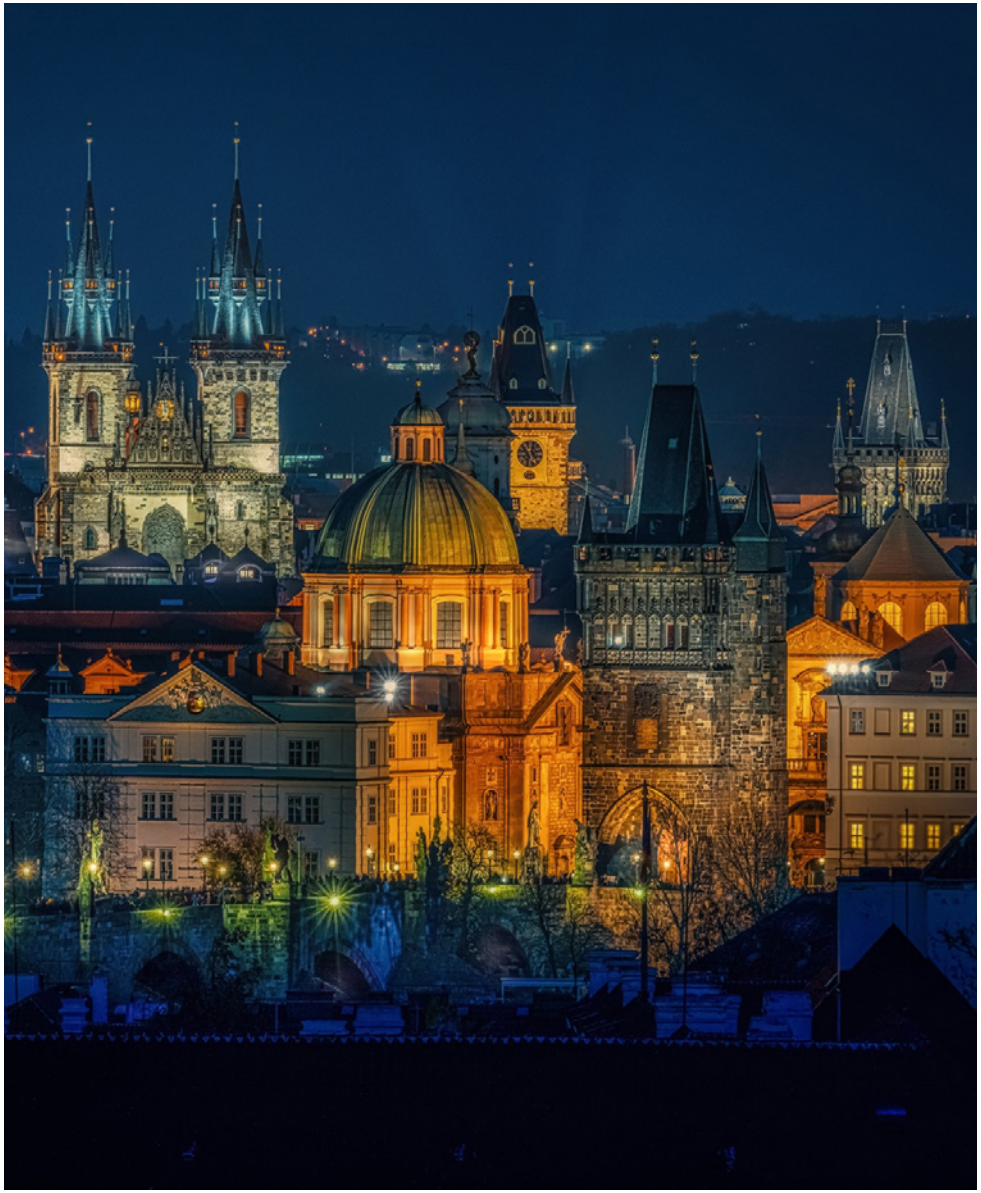
Since there is no framework in place allowing the participation of independent aggregators, it is not possible to assess the financial incentives of explicit participation in wholesale markets.

MARKET MATURITY

Both explicit and implicit flexibility access to wholesale markets and prices are very immature. Although Czech consumers have the right to subscribe to a dynamic retail contract, the limited rollout of smart meters (3%) acts as a barrier. In 2023, less than 1% of Czech consumers subscribed to an hourly dynamic contract. As previously mentioned, explicit participation of independent aggregators is, at the time of writing, not possible.

MARKET OUTLOOK

Reforms leading to the creation of a framework for independent aggregator are ongoing. It should be finalised by 2026. However, market participants are expressing doubts about the current reform, particularly regarding the baseline requirements, and whether it will enable the direct participation of DR in wholesale markets. The country has not officially declared the expected end-date of its smart meter rollout.



DENMARK

At the time of writing, only electricity suppliers and large energy consumers have access to wholesale markets, with no framework allowing independent aggregators to participate. Additionally, the gate closure time for the continuous Intraday market, set at one hour before delivery, can be considered too long to support the participation of DERs in the market. Access to wholesale prices though dynamic electricity contracts is widespread in the country. Residential consumers areenabled by the complete rollout of smart meters and the availability of dynamic electricity tariff offers. While all large electricity consumers are billed by law based on spot prices.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Due to the absence of an independent aggregator framework covering DA and ID market, explicit access for DR to Danish wholesale market is not possible.

While independent aggregators are legally not prevented from participating in wholesale markets, at the time of writing, only suppliers and large energy consumers are actively involved. The current framework for independent aggregators only covers participation in ancillary services and does not cover trades of aggregated demand on wholesale markets. Aggregators can access the Day-Ahead and Intraday markets, but only in the capacity of managing supply-side units such as CHP units or batteries.

Except the limitation for independent aggregators to access wholesale markets, market participants do not consider other trading requirements to be a market access barrier. . To access Danish wholesale markets market actors need to either become a BRP or delegate their balance responsibility. Becoming a BRP requires contacting the Danish TSO, Energinet, providing a collateral of 1 000 000 DKK as a bank guarantee, and signing an Imbalance Settlement Agreement with eSett, the organisation responsible for imbalance settlement services in the Nordic region. Additionally, the candidate must obtain an ACER code for REMIT compliance from the Danish energy regulator, Energistyrelsen. Further technical tests will be conducted by the TSO to ensure the candidate possesses the necessary IT infrastructure to submit resource schedules.

The candidate must then register all generation or consumption units through DataHub, an IT system owned and operated by Energinet that handles data communication between market participants in the electricity market. After completing this step, the BRP needs to register with a wholesale market operator active in the country (Nord Pool or EPEX Spot). This final step involves passing a Know Your Customer (KYC) procedure, undergoing a technical and IT capacity assessment to ensure trading readiness, and providing collateral.

Danish wholesale products design can create a barrier for the participation of DERs outside of DR. Denmark adheres to the wholesale product requirements set by the Nordic region, with a minimum bid size of 100 kW. The DA market is based on one-hour products, while the continuous ID market uses 15-minute products. While aggregators managing supply-side DERs can on wholesale markets, trades on the ID continuous market can occur up to one hour before delivery. As with other Nordic countries, this lead time may be too high to effectively support DER participation in the ID market.

IMPLICIT ACCESS TO WHOLESALE PRICES

Denmark has established an appropriate regulatory and technical framework to enable electricity end-users (households and businesses) to subscribe to dynamic contracts. However, the majority of a household electricity bill consists of network tariffs and taxes, which blurs the price signals from wholesale markets. Wholesale price signals are available to electricity end-users through dynamic retail tariffs. These offers are accessible to both businesses and households. Denmark has a 100% coverage of smart meters, and households are all equipped with smart meters capable of recording consumption data every 15 minutes.

FINANCIAL INCENTIVES

While large energy consumers can benefit from direct trading in wholesale markets, the main financial incentive for Danish consumers lies with the use of dynamic tariffs. However, network tariffs and taxes account for the majority of small- and medium-sized consumers' electricity bill, which reduces the magnitude of price fluctuations for customers subscribing to dynamic electricity tariffs. In 2023, the share of energy procurement costs in the total electricity bill for a Danish residential consumer was 45%. While still relevant, this falls slightly below the threshold of 50%, which we considered as driving significant changes in the total bill and potentially encourage shifts in consumption patterns or investments in DERs. However, high volatily of energy prices, driven in part by the high RES penetration, are significant driver for dynamic electricity price contracts. Since there is no framework in place allowing the participation of independent aggregators, it is not possible to assess the financial incentives of explicit participation in wholesale markets.

MARKET MATURITY

Denmark leads the EU in subscriptions to dynamic electricity contracts, and both large and small electricity consumers can easily access wholesale market price through their contracts. Currently, an hourly settlement of consumption is mandatory for large consumers with a consumption above 100 MWh per year, which cover 50% of the Danish electricity consumption. Moreover, 69%[6] of Danish households subscribed to an hourly dynamic retail contract, the second largest share in the Europe and the first in the EU. Moreover, 19 offers of dynamic contracts linked with an automation of DERs (e.g. automatic charging of EV or heat pump during low-priced hours) were available on Danish market in 2024[7]. No volume of DR was explicitly activated in wholesale markets in Denmark.

MARKET OUTLOOK

No major reform is expected to be implemented in the near future to increase the explicit participation of DERs in the Danish wholesale markets through independent aggregators.

6 · Data coming from Green Power Denmark.
7 · Data coming from Regulatory Assistance Project.

ESTONIA

While participation in Estonian wholesale markets through explicit DR is currently limited for DERs, in particular due to the lack of an aggregator framework, the activity of consumers through implicit price signals is booming, with a high penetration of dynamic electricity tariffs. The country is undergoing a reform process aimed at enabling DR participation in the wholesale market and addressing inefficiencies in balancing markets.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Participation to Estonian wholesale market for independent aggregators is, at the time of writing, not possible in Estonia.

Estonian legislation recognises the right of all actors to access the wholesale market. However, the current regulatory framework restricts DR participation due to unclear provisions on compensation mechanisms and market models. Other supply-side DERs (such as solar PV, batteries and CHP units) can participate in wholesale market.

For distributed generation assets the administrative requirements for participation are considered adequate, requiring a specific prequalification process, involving technical checks and tests, and being or delegating their responsibility to a BRP. Participants delegating the task of BRP must provide a guarantee of €31,955 to ensure the fulfilment of obligations under the balance agreement. Additionally, participants must have the necessary communication tools installed. NordPool, the NEMO active in Estonia, requires collateral to use the platform. However, interviewed market participants do not view the collateral as creating a significant barrier.

Nord Pool and EPEX Spot, the Nominated Electricity Market Operators in Estonia, offer standardized wholesale products for the Nordic and Baltic market areas, including a minimum bid size of 100kW. Both DA and ID products are based on one-hour granularity. The gate closure time for the continuous ID market in Estonia occurs one hour before delivery, at the exception of exchanges to Finland where trades can occur 30 minutes before delivery. A gate closure time of one hour for trading on the continuous ID market can be considered as a constraint for an effective participation of DERs.

IMPLICIT ACCESS TO WHOLESALE PRICES

Estonia has established an appropriate regulatory and technical framework to enable electricity end-users to subscribe to dynamic contracts.

All energy suppliers in Estonia offer dynamic electricity price contracts, enabled by a high price volatility in Day-ahead spot prices and its 99% coverage of smart meters.

FINANCIAL INCENTIVES

The main incentives for consumers come from the use of dynamic electricity price contracts, as the participation through explicit DR in wholesale markets is not possible. Dynamic contracts can offer significant benefits for consumers in Estonia, as the energy component amounts to 50% of the final electricity bill and the high price volatility of the market. This share ensures significant impact on the energy bill and can lead to significant price variations, encouraging consumption during low-priced hours and investments in DERs. In addition, storage is incentivised by the lack of grid tariffs charged when feeding back into the grid (for balancing purposes).

Since the aggregator framework that allows access to balancing markets does notallow the participation of independent aggregators in wholesale markets, it is not possible to assess the financial incentives of those markets.

MARKET MATURITY

Subscriptions to dynamic electricity contracts is widespread in Estonia. While stakeholders have mentioned that dynamic retail tariffs are widespread in Estonia (over 30%), we could not find an official source to corroborate this statement.

Although every technology is legally permitted to access wholesale markets, current regulations are preventing DR from participating. Other DERs, including batteries, can access these markets.

MARKET OUTLOOK

The country is currently revising its framework for independent aggregation. This revision will cover the compensation mechanism with the implementation of a central settlement model and is expected to open access to DA and ID markets. The revision should be finalised by the beginning of 2026.

FINLAND

Finnish wholesale markets are accessible only to electricity suppliers and large energy consumers, with no framework in place to ensure independent aggregator participation. Contrary to other Nordic countries, the gate closure time for the continuous Intraday market is set at the start of the delivery period. This can be considered as an enabler for DER participation. In 2023, 31% of Finnish retail customers subscribed to a dynamic electricity contract - one of the highest rates in Europe.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Due to an absence of framework for independent aggregators covering DA and ID markets, their participation to wholesale markets is at the time of writing not possible. For other actors, administrative requirements are considered transparent and do not create significant barriers for new market entrants. In terms of wholesale product definition, Finland stands out as the country with the shortest lead time before the closure of continuous ID trading (settled at delivery).

The Finnish TSO considers that for the time being implicit DR is sufficient, hence explicit DR participation is reduced to only balancing markets.

Other administrative and technical requirements to access Finnish wholesale markets are well-defined and do not pose significant barriers for market entrants. To participate in the Finnish wholesale electricity market market participants need to register with the Finnish energy regulator, Energiavirasto, to obtain an ACER code for REMIT reporting compliance. The rest of the process is common to all Nordics countries. It requires to obtain or delegate to a third party the status of BRP. To obtain the status of BRP, a market participant must contact eSett, the company managing the Nordic imbalance settlement. The BRP candidate needs to provide eSett a collateral to acquire a valid Imbalance Settlement Agreement. The BRP candidate will then need to request the Finnish TSO, Fingrid, a Balance Agreement which entails requirements such as the responsibility to provide hourly balance, report information to Fingrid.

Market actors not willing to become a BRPcan request to eSett the status of retailer. A retailer is recognised as a market participants that “sells and buys electricity directly from a producer, another retailer or via a Nominated Electricity Market Operator”[8]. The retailer should then sign an agreement with an existing BRP.

8 · eSett. 2024. Nordic Imbalance Settlement Handbook Instructions and Rules for Market Participants. p.3.

Additionally, participants must subscribe to a market operator active in Finland, such as Nord Pool or EPEX Spot. This process includes completing a Know Your Customer (KYC) procedure, undergoing a technical and IT capability assessment to ensure readiness for trading, and providing collateral payments.

Nord Pool and EPEX Spot, the Nominated Electricity Market Operators in Finland, offer standardized wholesale products for the Nordic and Baltic market areas, including a minimum bid size of 100 kW. DA products are based on one-hour granularity, while ID products have a minimum granularity of 15 minutes. Unlike other countries in the market area, the gate closure time for the continuous ID market in Finland is set at delivery for 15-minute contracts and 30 minutes before delivery for 60-minute contracts. As of the time of writing, Finland has the shortest gate closure time for its continuous ID market in the EU.

IMPLICIT ACCESS TO WHOLESALE PRICES

Finland is one of the best-performing countries with regard to access to wholesale prices through dynamic tariffs.

Finnish electricity suppliers with more than 200 000 customers must propose dynamic electricity contract to its customers. Multiple offers are available on the market for households and businesses. Moreover, Finland has completed the rollout of smart meters, providing 100% of its population with access to these devices. As a potential drawback, the share of energy component in the final energy bill is under 50% of the total electricity bill, which could limit the benefits for Finnish households from subscribing to a dynamic contract.

FINANCIAL INCENTIVES

With the absence of aggregators, the main financial incentives in Finland are for consumers subscribing to dynamic electricity price tariffs and large energy consumers directly trading with their demand assets in wholesale markets. While quite extended, the impact of dynamic tariffs on the consumers' final bill is limited by the significant amount of network tariffs and taxes in the bill. Only 42% of the final electricity bill for residential customers corresponded to the energy component.

MARKET MATURITY

While still lagging for explicit access to wholesale markets for demand-side resources, Finland has one of the most advanced markets for implicit access through dynamic electricity price contracts. At the end of 2023, 31% of Finnish retail customers subscribed to a dynamic retail contract where the electricity component of the bill varies every hour and is bound to DA spot price added with a supplier fixed margin.

MARKET OUTLOOK

The Finnish TSO engaged an advanced reform of the independent aggregator framework that would enable their participation in aFRR, mFRR and wholesale markets. The framework for aFRR is expected to be finalised by mid-2025, and for mFRR in 2026. It will clarify the status of independent aggregators and their relationship with other grid stakeholders (e.g., allowing them to contract customers without the agreement of their suppliers). For wholesale market, Fingrid established a working group to discuss DR participation. However, the implementation roadmap has yet to be defined.

FRANCE

France is one of the EU countries with the highest activity of explicit DR in wholesale markets. This is thanks to the implementation of the NEBEF framework, regulatory s framework to ensure DSF access to wholesale markets. This mechanism has allowed the activation of 519,9 GWh of DR from distributed resources in 2022. However, this participation is limited to demand turn-down, and improvements must still be made regarding the structure of wholesale markets (granularity) to ensure substantial participation of DERs. While French consumers have access to smart meters and the country allows hourly dynamic electricity pricing contracts based on wholesale prices, no commercial offerings are currently available on the market.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

France has implemented a framework called NEBEF that ensure independent aggregators access to the wholesale markets. This framework is considered effective by market participants. However, certain reforms are needed to achieve a fully functional market. These include the acceptance of demand turn-up (a reform is at the time of writing underway), the recognition of submetering, improvements to the baselining methodology, and enhancing the coherence of the compensation mechanism for electricity suppliers.

Trades on wholesale markets are currently open to every type of electricity stakeholder considered. The French TSO RTE created a framework enabling its participation of independent aggregators in wholesale markets called NEBEF.

To participate in NEBEF, a standalone site (with a minimum of 100 kW capacity) or an aggregator must obtain certification from RTE, based on technical and financial criteria. Once certified, the aggregator can sign contracts with customers to form a demand response group. Customers don't need their electricity supplier's approval to join a demand response group and even sites without a smart meter can participate. The aggregator can then submit bids to reduce energy use during peak times on the EPEX Spot power market. Currently, only bids to reduce demand (upward bids) are accepted. RTE is currently revising its market rules to allow downward bid (i.e. increasing consumption corresponding to load shifting). After the market clears, the aggregator submits a demand reduction schedule to RTE, specifying the overall energy reduction but not individual sites.

After activation, RTE verifies the energy reduction by analysing data from boundary meter. Through pilot, RTE is currently experimenting verification with sub-metering. Some issues have been raised about RTE's baseline methods, which could be improved for better accuracy.

Finally, a financial transaction occurs between the aggregator and the elec-

tricity supplier. The aggregator compensates the supplier for the energy not consumed and being transferred to the aggregator. Three models coexist, according to the type of the customer: the customer is either billed for the energy not consumed at the retail price (corrected model) or pays a financial compensation to the supplier, through a regulated price, set by the NRA (regulated model), or the aggregator agrees with the supplier on specific conditions. However, the compensation model has flaws: The regulated process relies on the price of future energy products (Y+1 and Q+1), which can sometimes misalign with spot market prices, artificially putting aggregators at a financial advantage or disadvantage.

Administrative requirements are accessible online, and market participants generally consider them not to impose undue barriers to participation in the wholesale market. To participate in NEBEF, a company must first be recognised as a DR operator. This status is granted by the RTE after completing several administrative steps that prove the operator's technical and professional qualifications, including passing prequalification tests.

In addition, the DR operator must either obtain the status of a Balance Responsible Party (BRP) or assign this responsibility to an existing BRP for the volume activated. RTE also requires the operator to provide collateral to cover the compensation owed to electricity suppliers. However, market participants don't see this collateral as a barrier to entering the market.

Trades on wholesale markets are also possible to aggregators managing supply-side units (such as CHP units or batteries. EPEX Spot and Nord Pool are the primary wholesale electricity market platforms active in France, accounting for most of the country's trade. They offer 1-hour products for the DA market and 30-minute products for the ID market. Trades on ID can occur with a five-minute lead time. The minimum bid size for both markets is 100 kW. The granularity of ID products should be revised to 15-minute intervals to enable greater participation of DERs

IMPLICIT ACCESS TO WHOLESALE PRICES

French households are, at the time of writing, not able to subscribe to dynamic electricity contracts. While the rollout of smart meters is almost finalised, no offers are available on the market.

While dynamic contracts are permitted for residential customers, there are currently no such offers available in the market; end-users can only access peak/off-peak retail contracts. However, commercial entities can find hourly dynamic electricity contracts options available in the market. Once dynamic contracts are available to residential customers, households will easily be able to subscribe to these tariffs due to the extensive rollout of smart meters. As of 2023, 94% of French households have smart meters installed, allowing for consumption data to be read every 30 minutes.

FINANCIAL INCENTIVES

Contrary to most countries, the main financial incentive from wholesale markets for French consumers is through explicit participation through the NEBEF framework as there are no dynamic electricity price contracts to benefit from. Figures related to the prices and volume activated are freely accessible on the RTE website. In 2023, 1 MW of flexibility using the NEBEF framework was traded at an average price of €99.76. However, aggregators incur fixed costs (e.g. compensation to the electricity supplier of their client, investment in electricity forecasting system, installation of equipment...) when activating demand response. Therefore, this price does not reflect the final earnings of the demand response participant. Apart from the volume and price of activation of NEBEF, there is currently a lack of official studies analysing the impact of DSF activation on reducing wholesale electricity prices.

Moreover, if available French consumers would benefit from a dynamic electricity contract, as the share of the energy component in a household electricity bill reached 56% in 2023. These tariffs could lead to significant price variations for consumers, allowing them to alter their consumption patterns and drive investment in DERs.

MARKET MATURITY

NEBEF is currently the only framework that allows significant volume of DR to be activated by independent aggregators on wholesale markets in Europe. In 2022, 2 100 TWh of electricity was traded on French wholesale market (including future, DA and ID markets). Activation though NEBEF framework accounted for 519,9 GWh. All technologies have access to the wholesale market either directly or through NEBEF framework.

Although dynamic contracts are permitted for residential customers in France, no such

offers are currently available in the market. End-users can only access a peak/off-peak retail contract, with some variations depending on the time of year. The French TSO, RTE, estimates that 900 MW of flexibility is activated through these contracts[9].

MARKET OUTLOOK

France remains as one of the most interesting markets for explicit DR in the coming years. Some further changes to the NEBEF framework are anticipated, such as the acceptance of downward bids (increased consumption corresponding to load shifting) and the recognition of sub-metering. However, other aspects of the mechanism, that are considered as a shortcoming by some market participants, such as the baselining methodologies used and the supplier compensation mechanism could still see room for improvement.

9 · RTE. 2024. Bilan Electrique 2023. p.162.

“It’s the best energy flexibility platform.”

– You in 2025

FEVER

Energy companies, EV manufacturers, data centres, and power producers use Fever's platform to run virtual power plants, integrating a wide range of energy assets.

GERMANY

The direct participation of DR in the German wholesale market through independent aggregators is currently not possible. And while consumers could on paper have access to dynamic electricity price tariffs, the very low deployment of smart meters, and the constant delay in their roll-out, are severely hindering their use. Unusually, Germany boasts one of the highest offerings in different types of dynamic tariffs and services, very tailored to individual types of consumers and technologies. These tariffs have a very low utilisation. For industrial actors, network tariff design prevents them from adjusting their schedules in response to wholesale price variations, out of fear of losing the financial advantages of their energy intensive consumer status.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Direct participation of independent aggregators in Germany is not possible due to the absence of a framework covering DA and ID markets. However, the design of its wholesale products (granularity, lead time before the closure of continuous ID market) are enabling the participation of supply-side DERs such as batteries or solar PV.

Access to wholesale markets in Germany is, on paper, legally open to suppliers, independent aggregators and large energy consumers. However, the country has not implemented a framework that establishes the rules and responsibilities for direct participation of DR via independent aggregators in the wholesale market. Aggregators' roles are instead limited to managing supply-side DERs (batteries, solar PV). Market parties judge administrative requirements to be adequate. Participants need to provide a collateral as insurance, while the amount depends on the participant, none assessed them as too stringent or limiting.

Three NEMOs are active in the country: EPEX Spot, Nord Pool and EXXA. They propose DA products are based on 1-hour granularity, while ID products are based on 15-minute granularity. The minimum bid size in both markets stands at 100 kW. Trades can occur in the continuous ID market with a lead time of five minutes. These wholesale product features are considered among the most supportive for the participation of DERs in the wholesale market in Europe.

IMPLICIT ACCESS TO WHOLESALE PRICES

While dynamic contracts are allowed and available in Germany, the limited rollout of smart meters have constrained consumers' ability to subscribe to these offers.

Electricity suppliers with more than 100 000 customers are legally obliged to offer a dynamic contract option to customers owning a smart meter. Starting 1.1.2025 all Electricity suppliers have to offer dynamic contracts to customers with a smart meter. Electricity suppliers need to inform the customers about the costs, advantages and disadvantages of a dynamic contract. Germany is a unique case, with the highest number of services and dynamic tariffs available to consumers in the EU, mostly services tailored to different DERs like EVs, while having the lowest numbers in subscribers. However, only 1% of German households had a smart meter installed in 2023. The low rollout represents a significant barrier to subscribing to dynamic tariffs, and may be an opportunity for service providers that use their own dedicated measurement devices.

FINANCIAL INCENTIVES

Since dynamic tariffs are not really widespread, the only financial incentive lies in the prices from direct trading (i.e., more favourable prices for large energy consumers) and wholesale optimization some suppliers do for consumers with smart meters. The share of energy procurement costs in residential electricity bills reached 49% in 2023, close to our threshold of 50%. It can be considered high enough to incentivise consumers to change their electricity consumption patterns.

MARKET MATURITY

Both explicit and implicit access to wholesale markets is not mature in Germany. For implicit flexibility, there is a significant discrepancy between industrial customers and small commercial and residential customers. The low rollout of smart meters impede subscription to dynamic contract. In 2023, less than 1% of customers subscribed to these contracts. The low rollout contrast with the wide range of dynamic contracts available. In 2024, 13 different contracts in Germany integrated dynamic pricing with the automation of DERs, such as EV charging or heat pump operation.[10] While industrial customers can easily access retail tariffs based on wholesale prices, network charges applied to German industrial sites create a limiting effect. Industrial sites can receive a 90% discount on network charges if they consume electricity uniformly throughout the day. This design restricts industrial sites from optimising their consumption in response to wholesale electricity prices. This constraint has led to an estimated 10-25% of German electricity being exposed to wholesale price[11].

MARKET OUTLOOK

Germany developed a roadmap for the rollout of smart meters on its territory However, the rollout will not be finalised before 2030. In 2023, the adoption of the bill to restart the digitalisation of the energy transition (GNDEW) redefined the objectives and conditions for the installation of smart meters. The law removed administrative barriers (e.g. prior market analysis) for the deployment of smart meters. For households consuming more than 6 000 kWh per year (or generators over 7kW), the rollout of smart meters will become mandatory from 2025. Objectives state that by 2030, 95% of metering points will be smart meters. Germany has a positive outlook for companies using their own dedicated measurement device, as the high penetration of DERs incentivises the use of dynamic electricity tariffs.

10 · Data coming from the Regulatory Assistance Project.
11 · Hirth L, Khanna TM, Ruhnau O. 2024. How aggregate electricity demand responds to hourly wholesale price fluctuation. Energy Economics. 135. 107652.

GREAT BRITAIN

Great Britain has developed one of Europe's most comprehensive frameworks to allow DR participation in the wholesale market. However, certain requirements related to portfolio size and the division into Grid Supply Point Groups are considered by some as unjustified. Access to wholesale prices through dynamic electricity price contracts is also possible and well-developed in the country.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Great Britain is one of the few European countries to implement a framework allowing the participation of independent aggregators in wholesale markets.

Since November 2024 independent aggregators and consumers can access wholesale markets. Until recently, only suppliers were able to access wholesale markets. However, the November 2024 implementation of P415, an amendment to the Balancing and Settlement Code introduces Virtual Trading Parties, which can form Secondary Balancing Mechanism Units (SBMUs) that can be used to offer demand increases and decreases in wholesale markets, independently of the suppliers of the sites in that SBMU.

Demand-Side Flexibility can trade through different avenues. Either explicitly through activations from aggregators (or individual large energy consumers), empowered by the implementation of P415, or implicitly through dynamic tariffs and time of use tariffs offered by suppliers. While there is no unified single aggregator legal framework, there are various roles defined in various markets, including wholesale, that are somewhat like an independent aggregator and allow access to those. There is a voluntary code of conduct for aggregators.

While DSOs and TSOs are allowed to procure products for congestion management and voltage control in Day Ahead and Intraday markets, these markets are not linked in any way to any local flexibility markets. This would facilitate access to different markets for flexibility providers.

Administrative requirements for participation are within reason, although it remains to be seen whether the accuracy required in operational metering requirements is justified. To participate in wholesale markets through explicit activations, a consumer has to be part of a an aggregated SBMU with a minimum size of 1 MW. Even though the wholesale market is national, each SBMU must be entirely within one of the 14 regions known as a Grid Supply Point Group. The division of the country into Grid Supply Point Groups adds

unnecessary constraints for participants, both financially and administratively. Requiring data submissions for each region complicates data management, and the minimum threshold of 1 MW per region poses a barrier for smaller actors, such as aggregators. We recommend removing this requirement, as it imposes constraints on market participants without providing any added benefit to the system. Measurements of activation can be performed by a smart meter or a sub-meter provided by the aggregator. The TSO currently requires Operational Metering with less than 5 second latency, which might be too taxing for some assets and remains unjustified for a market that is only settled on a 30-minute basis.

Moreover, British wholesale products' design can be considered as conductive to the participation of DERs. The minimum bid size to participate in the British wholesale market is 100 kW. The DA market offers 60- and 30-minute products, while the ID market is based on 30-minute products. Bids in the continuous ID market can be placed up to 15 minutes before delivery.

IMPLICIT ACCESS TO WHOLESALE PRICES

Dynamic contracts are allowed and widely available in Great Britain, and the smart meter roll out is currently being finalised. The share of the energy component in an households electricity bill offers significant incentives to shift consumption to lower-cost times and to invest in DERs.

Multiple offers of dynamic contracts are available on the market for households and businesses. In 2023, Great Britain was in the midst of its smart meter rollout, with 62% of British households having a smart meter installed. Since the deployment of smart meters is not mandatory in Great Britain, it is not possible to provide a definitive end date. However, electricity suppliers have been tasked with ensuring that three-quarters of households are offered a smart meter by the end of 2025.

FINANCIAL INCENTIVES

British consumers are in a unique position, with enough incentives to take advantage of wholesale prices both through explicit and implicit participation. Consumers receive a payment through a dedicated contract with an aggregator or supplier in case of explicit contracts that manage their consumption or can alternatively benefit from lower retail prices if they have a dynamic or ToU tariff. In 2023, energy procurement costs accounted for 65.3% of the total electricity bill for a typical British household[12].

Such a high share provides a significant incentive to shift consumption to lower-cost times and to invest in DERs. Pricing of wholesale markets is uniform for all of GB, however there are currently discussions ongoing whether to move to a zonal market.

With regards to financial incentives for flexibility service providers to participate in wholesale markets, the P415 framework introduces the socialisation of financial compensation to suppliers for the activation of DR services. Under this scheme aggregators do not pay for the financial compensation received by suppliers. However, the corollary is that, although suppliers have to pay compensation when there is a demand increase activation, these funds do not reach the aggregator, making demand increase services only attractive to customers when wholesale prices are negative.

MARKET MATURITY

Great Britain is an overall mature market, with both access through explicit and implicit DR to wholesale prices. The P415 framework only recently became effective in November 2024. Currently, there is a lack of insights into the framework's effectiveness. However, market participants consider the design of the framework favourable for utilisation by independent aggregators. This framework will enable explicit DR from households, commercial, and industrial actors to be added to the list of technologies participating in wholesale markets. This list also includes residential and small-scale solar PV, distributed generation, small-scale battery storage, and utility-scale battery storage.

At the time of writing, there is a lack of official statistics available regarding subscription rates for dynamic electricity contracts in Great Britain. As a result, it is not possible to provide a clear figure on subscriptions to these contracts.

MARKET OUTLOOK

Great Britain remains one of the most interesting European markets for consumers, and some upcoming reforms could improve the framework. Reforms affecting DER participation in wholesale markets could follow the Review of Electricity Market Arrangements (REMA). The process is still in its early stages, with consultations already initiated. Implementation for any relevant decisions made from REMA would be implemented post 2025 for a focus on post-2030 transition to net zero[13].

12 · https://www.ofgem.gov.uk/all-available-charts?fuel_type=1606&programmes=677&sort=created
13 · https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/innovation-link

GREECE

Trading on the Greek wholesale market is open to suppliers, large energy consumers and as of recently, to independent aggregators. In 2024, the country implemented a framework allowing aggregators managing demand response to participate in DA and ID markets. However, flexibility service providers are not yet trading in wholesale markets, having pointed out some design flaws, such as issues with the baselining methodology. Access to wholesale prices through a dynamic electricity contract remains impossible for electricity consumers due to the low rollout of smart meters and the absence of offers on the market.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Greece is one of the few European countries which implemented a framework allowing the participation of independent aggregators in wholesale markets. However, the design of Greek wholesale products' design (granularity and lead time before the closure of continuous ID trades) can be considered as limiting for DERs.

Greek wholesale markets are currently open to a large number of participants including RES and high efficiency CHP producers, aggregators of RES and CHP generating units, demand response aggregators, self-supplying consumers and consumers representing dispatchable loads. However, energy storage is still restricted from accessing the wholesale market at the time of writing due to the absence of a regulatory framework on storage (expected in 2025).

Administrative requirements to access Greek wholesale markets are considered adequate by market parties interviewed. The only limiting factors is the impossibility to couple in a single portfolio demand and generation units. To trade through HEnEX, the Greek wholesale market operator, prospective participants must meet specific administrative requirements, beginning with a request for "Participant Membership." This application process requires having a Balance Responsible Party contract with the TSO or delegating this role to an existing BRP. Applicants must demonstrate that they possess the necessary organisational, operational, and techno-economic infrastructure, along with robust control and security mechanisms for data processing. HEnEX may also require a pre-qualification test to assess the applicant's readiness. Additionally, applicants are required to pay administrative fees, including an initial registration fee and an annual subscription, and provide collateral based on the volume of trades conducted.

HEnEX's wholesale trading rulebook provides comprehensive guidance on DR requirements. A key issue identified is the limited availability of baselining methodologies for accessing the wholesale market, with only the "Average

X/Y" method currently accepted. This restriction hinders the participation of aggregators that specialise in specific asset types.

HEnEX, the Greek wholesale market operator, offers both DA and ID products based on one-hour granularity. Trades on the Continuous ID market can occur up to 60 minutes before delivery. For the ID market, both the large granularity and long lead time can be considered constraints for the participation of DERs.

IMPLICIT ACCESS TO WHOLESALE PRICES

Dynamic tariffs are not available for Greek households at the time of writing. However, some electricity suppliers will have to propose these contracts from January 2025. Once these contracts become available, they could provide significant incentives for consumers, as the share of energy procurement costs in the total electricity bill is among the highest in the EU. However, the low rollout of smart meters still remains a barrier for customers willing to subscribe to these offers.

Greek regulators recognised the legal validity of dynamic electricity contracts indexed to wholesale prices in 2024. However, no commercial offers are available at the time of writing. Electricity suppliers with more than 200,000 customers will be required to offer a dynamic contract to their customers starting in January 2025. This requirement applies to six electricity suppliers in Greece.

However, access to smart meters remains a major limiting factor, as their rollout is extremely low in Greece. In 2023, only 6% of households had a smart meter installed. The rollout of smart meters is expected to be completed by 2030.

FINANCIAL INCENTIVES

It is currently difficult to assess the financial incentives to access directly or indirectly Greek wholesale markets as they opened only recently to DSF and no offer of dynamic contracts are available at the end of 2024. However, once widely available, dynamic contracts could offer significant benefits for Greek consumers, as 63% of the electricity bill is covered by energy procurement costs. This share is one of the highest in Europe. It can result in significant price variations that encourage changes in electricity consumption and drive investments in DERs.

MARKET MATURITY

The Greek framework for independent aggregators covering DA and ID only recently became effective in June 2024. Currently, there is a lack of insights into its effectiveness. However, DR will be able to provide volumes alongside other approved technologies.

MARKET OUTLOOK

Given all the recent changes in wholesale market trading, and expectations for dynamic price contracts to become available at the beginning of 2025, the Greek market could become one of the most interesting markets in Europe. Reforms are still ongoing, and HenEX is currently developing a framework to allow the participation of storage in electricity markets. The framework is expected to be finalised in 2025.

HUNGARY

Access to wholesale markets is currently limited to electricity suppliers. The framework for independent aggregator implemented in Hungary does not cover Day-Ahead and Intraday markets. Hungarian households do not currently have access to wholesale prices through a dynamic electricity contract. However, starting in 2026, electricity suppliers will be allowed to offer these contracts. The low rollout of smart meters may still hinder households from subscribing to these offers.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Hungary has not yet created a framework for independent aggregators allowing their participation in wholesale markets. However, the features of wholesale markets (especially the gate closure of continuous ID market 15 minutes before delivery) can be considered as favourable for the participation of DERs.

According to Hungarian law, all type of actors can access wholesale markets. However, DSF participation of is quite limited and made through suppliers. Hungarian framework for independent aggregator does not cover participation to wholesale markets. Out of the 17 licensed aggregators registered in Hungary, none participated in wholesale trades. At the time of writing, no distributed resources (expect CHP units) can have access to wholesale markets in Hungary. For storage, it is limited to grid-scale BESS.

Hungary allows the participation on wholesale market to market actors without being themselves or being linked to a BRP. However, the participant is responsible for any imbalance caused, which exposes to high financial risks. Technical requirements for being allowed to trade are clearly stated by HUPX, the Hungarian wholesale market operator. It includes a test of the candidate IT system to ensure its ability to perform trades through HUPX.

HUPX proposes hourly products for the DA market and 15-minutes products for the ID. The minimum bid production both markets is 100 kW. Market parties can place bids on the Continuous ID market up to 15 minutes before delivery. These features can be considered as facilitating DERs participation in wholesale markets.

IMPLICIT ACCESS TO WHOLESALE PRICES

Dynamic electricity price contracts are not currently available to electricity consumers. Even if such offers were introduced, the limited rollout of smart meters (at around 9% coverage) would pose a significant barrier

for interested customers. Additionally, the share of the energy component in an electricity bill is among the lowest in the EU, which diminishes consumer incentives to subscribe to these offers.

Access to wholesale market prices through dynamic tariffs is not possible for residential customers. These contracts are not, at the time of writing, recognised by Hungarian law. The country is expected to allow dynamic electricity contracts indexed on wholesale prices in 2026. The rollout of smart meters is at an early stage in Hungary. In 2023, only 9% of Hungarian households had a smart meter installed. We were unable to retrieve an official statement explaining when the rollout of smart meters will be completed.

FINANCIAL INCENTIVES

Assessing the financial incentives for directly or indirectly accessing Hungarian wholesale markets is not possible, as these markets are not open at the time of writing. The introduction of dynamic contracts should be accompanied by a revision of the structure of household electricity bills, as the energy component accounts for only 26% of the total bill—one of the lowest shares in the EU. Adjusting this share and allowing dynamic contracts could offer Hungarian consumers stronger incentives to invest in DERs and shift their consumption to cheaper hours once commercial offers become available.

MARKET MATURITY

No activation of DR either directly on wholesale markets or indirectly through a dynamic tariff occurred in 2024.

MARKET OUTLOOK

Hungary is engaging reforms to allow residential customers to receive price signal from wholesale market through a dynamic contract from 2026. For the explicit participation of independent aggregators, no further reforms are foreseen.

IRELAND

In Ireland, independent aggregators face significant challenges in accessing wholesale markets, primarily due to the lack of remuneration for the energy they provide and complex technical requirements such as stringent telemetry and capacity thresholds. While Ireland offers Time-of-Use tariffs that can incentivise changes in consumer behaviour, dynamic electricity contracts linked to wholesale prices are not available on Irish market.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

For independent aggregators, access to Irish wholesale markets is currently possible under the conditions of the Capacity Mechanism. However, independent aggregators are only remunerated for their available capacity and not for the energy they deliver in activation.

Suppliers, independent aggregators, and large electricity consumers have the legal right to access both DA and ID markets. However, independent aggregators currently face a significant challenge as they are not paid for the energy they provide to the system. The absence of a well-defined framework for remunerating aggregated demand-side resources creates a barrier to their full and effective participation to wholesale markets.

Technical and administrative requirements create an additional barrier for the participation of DERs (through aggregation) to wholesale market. The registration process for Demand-Side Units (DSUs) is standardised across all electricity markets but involves a complex and demanding procedure. This includes stringent requirements for telemetry, such as providing real-time SCADA signals, and meeting specific capacity thresholds—a minimum portfolio size of 4MW or a maximum capacity of 10 MW per delivery point. These criteria present significant barriers to the participation of DR in the market.

Additionally, the testing requirements are often viewed as discriminatory between different types of assets, particularly between Behind-the-Meter and in-front-of-the-meter assets. For instance, a residential battery's participation in the electricity market is contingent upon its ability to be dispatched for at least two consecutive hours. This minimum dispatch time, however, does not apply to in-front-of-the-meter assets such grid-scale battery storage system.

Two market operators are active in Ireland: Nord Pool and SEMOpx. They provide access to two different markets. Every market has minimum bid size of 100 kW. The DA market with hourly products and the ID market with 30-minute products. Trades can occur on the ID market up to 45 minutes

before delivery. For the ID market, the long lead time and the high granularity can be considered as detrimental for the participation of DERs.

IMPLICIT ACCESS TO WHOLESALE PRICES

Dynamic contracts are not currently available for electricity consumers. Moreover, even if such offers were introduced, not all consumers have access to a smart meter, which would pose a barrier for interested customers.

Access to wholesale prices through a dynamic electricity contract is not possible due to several factors. Firstly, the lack of current offers by electricity suppliers. While hourly dynamic contract based on spot prices are allowed in Ireland, no supplier made this offer available to households and businesses.

Energy consumers, on the other hand, can subscribe to ToU tariffs. The regulated Smart Pay Time of Use Tariff (SST) divides the day into three distinct time-bands: Peak (5 pm to 7 pm), Day (8 am to 5 pm and 7 pm to 11 pm), and Night (11 pm to 8 am). These time-bands allow consumers to adjust their energy consumption patterns in response to different pricing levels throughout the day, potentially leading to cost savings and more efficient energy use.

In 2023, 69% of Irish households had a smart meter installed. If offers were available, a significant share of Irish households would not have the technical ability to subscribe to a dynamic contract. Ireland plans to finalise its rollout of smart meters by the end of 2025.

FINANCIAL INCENTIVES

At the time of writing, there are no financial incentives for DSF to participate in the Irish wholesale markets, beyond the obligations placed on them by the Irish Capacity Market. The absence of a compensation model, combined with strict technical requirements, creates a significant barrier to their engagement.

On the other hand, the benefits of Time-of-Use (ToU) tariffs are notable. It is estimated that a residential customer who shifts 7% of their electricity use from the Peak period to the Night period could reduce their annual bill from €1,052 to €982. This highlights the potential savings for consumers who adjust their energy consumption patterns in response to ToU pricing.

Once dynamic contracts are available, significant incentive could be obtained for consumers able to manage their loads. On average, the energy component of the Irish electricity bill amounts to 57% of the total costs. It can represent in significant price variations that encourage changes in electricity consumption and drive investments in DERs.

MARKET MATURITY

No volume of DR took part explicitly (apart from the obligation of the Capacity Market) in wholesale markets or received implicitly price signal from through a dynamic contract.

MARKET OUTLOOK

The country is currently revising its rules on energy payments, with the new measures expected to be decided by the end of 2024. While this revision aims to remove the primary barrier to the participation of DSF in the wholesale market, further review of the technical and administrative requirements will be necessary. It is required to ensure a level playing field between DERs and other assets, promoting fair and equal access to the market for all participants. Moreover, Ireland will finalise its rollout of smart meters in 2025.

ITALY

Italian wholesale markets are open to suppliers and large energy consumers. Independent aggregators are unable to explicitly valorise their customers' flexibility in the Day-Ahead and Intraday markets due to the lack of a specific framework. For the implicit access to wholesale prices, the country has completed its smart meter rollout, and subscriptions to dynamic electricity contracts are increasing.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Participation in Italian wholesale markets is hindered by the absence of a framework for independent aggregators covering DA and ID markets. Additionally, the country should revise its wholesale product design, as the current structure can act as a barrier to the participation of DERs due to factors such as minimum bid size, granularity, and the lead time for the closure of continuous ID trading.

In Italy, suppliers and large electricity consumers can have direct access to DA and ID markets if they hold the status of dispatching user. Large consumers and energy communities may access the market indirectly through a supplier. However, independent aggregators are currently not allowed to participate explicitly in DA and ID markets.

Requirements to enter wholesale market are considered as appropriate for new entrants (at the exception of independent aggregators) and the level financial guarantees needed as fair. A market party willing to participate in wholesale market needs to follow an administrative process that include:

- **Registration:** Market parties must register to the market operator, GME.
- **Technical and professional competence test:** the test should demonstrate the adequate technical and professional skills in market operation and IT systems.
- **Dispatching contracts:** Candidates must sign a dispatching contract for all generation and consumption units with the TSO, Terna. The dispatch contract also links the unit to a market-authorised entity called a dispatching user. Dispatch user status can be obtained independently (by meeting administrative, technical, and economic requirements) or delegated to an existing dispatch user. Currently, there is a distinction between production units, which must be linked to a dispatch user in injection mode, and consumption units, which require a dispatch user in withdrawal mode. Batteries have a special status that allows the withdrawal of electricity to be treated as negative injection, thus only requiring a dispatch user in injection mode.

- **Financial guarantees:** Market parties must pay several fees to GME (an access fee, a yearly fixed fee, a variable fee) an provide a collateral.
- **Transmission and Distribution Contracts:** Market party must sign contracts for transmission and distribution services with relevant DSOs.
- **Regulatory Compliance:** The adhesion to GME regulations and ARERA directives, ensuring transparency and market rules compliance is required.

GME, the Italian wholesale market operator, offers products on an hourly basis for both Day-Ahead and Intraday markets. The minimum bid size in the Italian wholesale market is 1 MW, which sets Italy apart from the other countries covered by this publication, as it has not implemented a minimum bid size of 100 kW. The gate closure time for continuous Intraday trading is one hour before delivery. These factors (minimum bid size, granularity, and lead time in the continuous ID market) restrict the participation of DERs in the Italian wholesale market.

IMPLICIT ACCESS TO WHOLESALE PRICES

Italy has implemented a comprehensive regulatory and technical framework to allow electricity end-users to subscribe for dynamic contracts. Italy was one of the first European countries to finalise its rollout of smart meters.

Implicit access to wholesale prices is possible in Italy. Dynamic pricing has been available and mandatory for Italian residential customers since 2010. Initially, dynamic pricing was offered as a Time-of-Use tariff with separate Day and Night periods. Over time, additional options have been introduced, including fully dynamic contracts that vary hourly based on the PUN (Prezzo Unico Nazionale), which is the single national price calculated as the weighted average of prices across Italy's seven bidding zones. This evolution in pricing offers consumers more opportunities to align their energy usage with market conditions and potentially reduce costs. Italy was one of the first European country to finalise its rollout of smart meters. In 2024, the smart meter penetration reached 100%.

FINANCIAL INCENTIVES

While explicit access to wholesale markets cannot be assessed, implicit access to wholesale prices through a dynamic tariff can offer significant financial benefits.

Italian consumers who subscribe to a dynamic contract can experience significant price variations, as the energy component makes up 66% of their electricity bill—the highest share in the EU. Moreover, LCP Delta[14] highlighted that an Italian household can achieve savings of up to 12% on their electricity costs by owning a heat pump and an electric vehicle, switching from a static to an hourly dynamic electricity retail contract, and adopting flexible consumption behaviour based on the lowest-cost hours.

MARKET MATURITY

While implicit access to wholesale prices through a dynamic tariff is increasing in Italy, explicit access is still not possible for independent aggregators. 33.2% of households have a variable-price contract (where the price changes over time according to the terms of the contract), which includes 3.3% on dynamic contracts where the energy price is indexed to the hourly PUN. This trend is higher for non-household actors, with 68.3% subscribing to a variable-price contract, including 8.7% on dynamic contracts.

MARKET OUTLOOK

Since 2017, 40 BSPs have participated in the UVAM pilot program, which was aimed at testing the participation of DERs (including in aggregate form) - such as smaller generation assets (<1MW), consumers and batteries - in the ancillary services, redispatching and local flexibility markets.

The new Italian regulation, the Testo Integrato del Dispacciamento Elettrico (TIDE), effective from the 1st of January 2025, incorporates the experience gained through the UVAM pilot program into the general dispatching framework. In addition, TIDE introduces two key parties in the regulatory framework: the BRP and the BSP. Any resources participating in the energy and ancillary services markets must define their BRP and BSP (which may also coincide).

Looking ahead, the GME (Gestore dei Mercati Energetici) is expected to reduce product granularity to 15-minute intervals by 2025. This change is a positive development for future participation of DERs into wholesale market. However, further reform should be implemented to ensure a level of playing field between DERs, including DR, in Italian wholesale market.

14 · LCP Delta. 2023. Assessment of consumer risks and benefits of heat pumps with and without dynamic price contracts.

LATVIA

Access to wholesale markets for independent aggregators is currently impeded by the lack of technical regulations. At present, only electricity suppliers and large energy consumers can trade in the Day-Ahead and Intraday markets. Implicit access to wholesale prices is common in the country, with 15% of households and 52% of businesses subscribing to a dynamic electricity contract with hourly pricing indexed to wholesale prices.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Due to a missing technical regulation in the Latvian framework, independent aggregators cannot access wholesale markets. Moreover, the country should revise its wholesale product design (specifically granularity and lead time before the closure of continuous ID trades) to facilitate the participation of DERs in wholesale markets.

While the legislation recognises that every actor, including independent aggregators, have access wholesale market, only electricity suppliers and large energy consumers are able to trade on Latvian wholesale markets. The technical framework needed to ensure the participation of independent aggregator in DA and ID markets is currently missing. All other DERs can be active in Latvian wholesale markets through managing supply-side units (CHPs units, batteries).

To trade in the Latvian electricity market, a market participant must complete the following steps:

- Register as a company in Latvia or within the EU.
- Be listed in the electricity trader registry managed by the Latvian regulator, PUC.
- Obtain an energy identification code and conclude a system use agreement with the TSO, AST.
- Either become a Balance Responsible Party (BRP) or delegate this responsibility to an existing BRP.
- Register with a market operator active in the country.

Two wholesale market operators are active in the country: EPEX Spot, and Nord Pool. The minimum bid size in Latvia is set at 100 kW. Both DA and

ID markets are based on 1-hour products. Traders can place buy or sell orders on the continuous ID market up to one hour before delivery. The long lead time can be considered as a constraint for the participation of DERs in the wholesale markets.

IMPLICIT ACCESS TO WHOLESALE PRICES

Latvia has established an appropriate regulatory and technical framework to enable electricity end-users to subscribe to dynamic contracts. Latvian electricity suppliers offer dynamic contracts to their customers (households and businesses), and commercial offers are available on the market. Moreover, the rollout of smart meters in Latvia is almost finalised. In 2023, 90% of households have a smart meter installed, enabling the reading of consumption data every 60 minutes.

FINANCIAL INCENTIVES

Limited access to wholesale markets for independent aggregators impedes any estimation of the financial benefits. However, subscribing to a dynamic electricity contract can be an attractive prospect. For a Latvian household, 59% of the electricity bill consists of the energy procurement costs. This high share allows consumers to receive significant price variation though the day and shift their consumption to lower-priced hours.

MARKET MATURITY

Latvia is one of the European countries with the most developed market for dynamic retail contracts. In 2023, 15% of households and 52% of businesses subscribed to a dynamic contract with hourly pricing indexed to the wholesale price. The absence of framework for independent aggregators in DA and ID market hampers the participation of DR to wholesale markets.

MARKET OUTLOOK

While the Energy Market Law recognises the status of aggregator, specific requirements for independent aggregators and currently missing. Amendment needed to the Energy Market Law have already been drafted. Moreover, secondary legislation is needed to clarify roles, responsibilities with regards to actors and technical requirements (baseline and compensation mechanisms). The framework for DR services is currently being elaborated.

THE NETHERLANDS

Participation to Dutch wholesale markets remains inaccessible for independent aggregators as the framework for independent aggregation do not cover DA and ID markets. However, the design of wholesale products, including one of the shortest lead time before the closure of continuous ID market facilitates DER participation. Dynamic electricity contracts are available in the Netherlands, supported by a 90% smart meter rollout.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Independent aggregators cannot access Dutch wholesale markets due to an aggregator framework that does not cover activities in the DA and ID markets, except for the innovative GOPACS platform. However, the design of wholesale products (such as minimum bid size, granularity, and lead time before the closure of continuous ID trading) can be considered favourable for the participation of DERs (such as batteries or CHP units).

The Netherlands legally allows every type of actors to access wholesale market. However, the country did not implement a framework allowing independent aggregators to trade wholesale markets. Hence, aggregators can only be managing supply-side units (CHPs, batteries).

The Netherlands developed a specific platform for congestion management linked to wholesale markets called GOPACS. GOPACS is a cooperation between market operators and certain SOs (TSO and DSOs) linking congestion management products to wholesale bidding. Market parties (such as energy suppliers, congestion service providers, and large consumers) place bids or orders via a partner market operator platform. The order is processed by GOPACS only if a delivery location data is provided.

Large producers or consumers gain access to wholesale markets by requesting a physical connection to the transmission network from the TSO, TenneT, and either becoming a BRP or delegating the task to an existing one. To become a BRP, they must pass prequalification tests administered by TenneT. Market operators require collateral, with the amount varying based on the volume traded and the direction of trading (buyers need to provide higher collateral to cover purchasing invoices).

Dutch wholesale products' design can be considered as facilitating the participation of DERs. The minimum bid size to participate in the wholesale market is 100 kW. Trades on DA are based on one-hour products while ID trades are based on 15-minute, 30-minutes, and one-hour products. Offers

and bids can be placed on the continuous ID market with a five-minute lead time before delivery.

IMPLICIT ACCESS TO WHOLESALE PRICES

Implicit access to wholesale prices through a dynamic electricity contract is possible in the Netherlands thanks to the availability of commercial offers and the extensive rollout of smart meters.

Dutch households and businesses can access wholesale price signal by subscribing to dynamic retail contracts based on DA prices. Energy suppliers are able to tailor a commercial offer to large electricity consumer without the approval of the Dutch regulator ACM. DSF can participate to wholesale market directly or indirectly through a supplier offer. Moreover, The Netherlands almost finalised its rollout of smart meters. In 2023, 90% of Dutch residential customers were equipped with a smart meter.

FINANCIAL INCENTIVES

The main financial incentive from wholesale markets for Dutch consumers comes from subscribing to a dynamic electricity tariff. The energy component represents 56% of a typical Dutch electricity bill, offering a significant incentive to shift consumption to lower-cost times and drive investments in DERs. Consumers owning a storage battery can also benefit from wholesale prices, but due to the lack of aggregator participation, this is only the case for utility scale batteries.

As the Netherlands has not yet implemented a framework to allow independent aggregators access to wholesale markets, we cannot provide clear numbers on the potential benefits.

MARKET MATURITY

While the explicit DR market is underdeveloped for aggregators, dynamic electricity contracts have gained interest from businesses and households in the Netherlands. In 2023, 4% of households and 9% of non-household customers subscribed to these offers. The Netherland has a wide range of dynamic contracts available. In 2024, 16 different contracts were coupling dynamic pricing with an automation of DERs, such as charging of EV or heat pump)[15]. On the other hand, no flexibility has been offered or activated by an independent aggregator on wholesale markets. However, in 2023, exchanges through GOPACS for congestion management product accounted for 261,54 GWh of electricity: 130,77 GWh of downward volume to alleviate congestion and 130,77 GWh of upward activations to balance the grid[16].

MARKET OUTLOOK

The Dutch market remains an interesting prospect due to the small but important changes required to allow access to wholesale markets for demand-side resources and due to the large customer-based of dynamic price contracts. The development of BESS (residential and grid-scale) projects is currently constrained by high connection costs. The Dutch regulator announced a reform of connection costs for battery systems, applying under specific conditions. We expect a higher participation of BESS in the coming years.

15 · Data coming from the Regulatory Assistance Project.
16 · https://app.gopacs.eu/public/clearedbuckets

NORWAY

Norway is the European country with the highest uptake of dynamic electricity contracts. In 2023, 93% of the population subscribed to an hourly dynamic contract. Trading on the Norwegian wholesale market is currently limited to suppliers and large energy consumers, as no framework has been implemented to ensure the participation of independent aggregators. Similar to other Nordic countries, the gate closure time for the continuous Intraday market, set at one hour before delivery, may be too restrictive to support DERs participation.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

In 2024 independent aggregators do not have access to the Norwegian wholesale market due to the lack of a framework for independent aggregators covering DA and ID markets. Moreover, the design of Norwegian wholesale products can create difficulties for DERs to participate, due to factors such as granularity and the lead time before the closure of continuous ID trades.

Norway wholesale markets are open to suppliers and large energy consumers. Independent aggregators cannot participate as the status is not recognised by Norwegian law. Aggregators managing supply-side units (such as solar PV or batteries) can access wholesale markets without restrictions.

Accessing Norwegian wholesale markets requires first requesting a trading license from the Norwegian regulator, NVE. The rest of the process is common to all Nordic countries. It involves obtaining or delegating the status of BRP. To obtain BRP status, a market participant should contact eSett, the company managing Nordic imbalance settlement. The BRP candidate must provide eSett with collateral to acquire a valid Imbalance Settlement Agreement. The BRP candidate will then need to request a Balance Agreement from the Norwegian TSO, Statnett SF, which entails requirements such as the responsibility to provide hourly balance and report information to Statnett SF.

For candidate not willing to become a BRP, they should request eSett the status of Retailer. A Retail is recognised as a market participants that “sells and buys electricity directly from a producer, another retailer or via a Nominated Electricity Market Operator”. The retailer should then sign an agreement with an existing BRP. The final step is the registry by a wholesale market operator. As any other country, it requires to pass through a KYC procedure, a technical and IT capacity assessment to ensure the readiness for trading, and paying fees related to the subscription and use of the platform. As of other Nordic countries, these requirements are considered as appropriate by market participants.

EPEX Spot and Nord Pool are the two designated NEMO in Norway. DA products features follow the requirements on the Nordic and Baltic market areas, namely a minimum bid size of 100 kW and one-hour granularity. However, Norway remains the only Nordic country offering only 1-hour products on the ID continuous market. Trades can take place on the ID continuous market up to one hour before delivery. This product granularity and lead time may be too high to effectively support DER participation in the ID market.

IMPLICIT ACCESS TO WHOLESALE PRICES

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Norway has established an appropriate regulatory and technical framework to enable electricity end-users to subscribe to dynamic contracts.

Consumers can have indirect access to wholesale price through dynamic tariff. Commercial offers are widespread for every type of consumers (industrial, commercial and residential). Moreover, 99 % households have a smart meter installed by DSOs that enable the reading of consumption data every 60 minutes.

FINANCIAL INCENTIVES

Norway is one of Europe's countries with the highest adoption of distributed energy resources; for example, 82.4% of new vehicles sold in the country were electric vehicles. This controllable load enables Norwegian consumers to grasp the benefits from dynamic electricity contracts. Moreover, the energy component represented 51% of a typical Norwegian electricity bill in 2023[17], offering a significant incentive to shift consumption to lower-cost times and drive investments in DERs.

MARKET MATURITY

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Norway is the European country with the largest share of electricity end-user subscribing to a dynamic retail contract. It is 93% of the population that subscribed to a dynamic contract indexed on wholesale prices. Moreover, Norway has a wide range of dynamic contracts available. In 2024, 20 different contracts were coupling dynamic pricing with an automation of DERs, such as charging of EV or heat pump)[18].

With regard to direct access to wholesale markets, apart from demand response (DR) managed by independent aggregators, other technologies do not face barriers to accessing the wholesale market.

MARKET OUTLOOK

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Apart from the development of R&D projects, market participants did not highlight any particular legislative changes that would affect DER participation in wholesale markets. The country remains interesting for any market actor interested in offering dynamic offers, due to the high penetration of DERs and smart metering devices.

17 · https://www.ssb.no/en/energi-og-industri/energi/statistikk/elektrisitetspriser/article-for-electricity-prices/electricity-prices-fell-in-the-second-quarter
18 · Data coming from the Regulatory Assistance Project.

POLAND

Independent aggregators are not yet able to access Polish wholesale markets. The status of independent aggregators was only recognised in 2023, and further reforms are needed to ensure their framework can cover Day-ahead and Intraday markets. While dynamic electricity contracts have recently become available to Polish consumers, the low rollout of smart meters remains a significant barrier for those interested in subscribing to these dynamic contracts.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

While Polish law permits independent aggregators to access all electricity markets, the absence of a framework covering wholesale markets excludes them from actuall participating. Moreover, certain features of Polish wholesale products, such as the one-hour lead time before the closure of continuous ID trading, can be considered limiting factors for the participation of DERs.

Poland revised its Energy Law in 2023 creating a legal status for independent aggregators and allowing their participation in electricity markets. However, a framework is still required to enable independent aggregators to access wholesale market. Other actors considered in the scope of this study such as suppliers and large energy consumers can participate in the DA and ID markets.

Participation in Polish wholesale market is conditioned to the granting of a trading or producer licence by URE, the Polish regulator. Other requirements are specific to the relevant market operators but include becoming a BRP or delegating the task to an existing one, as well as providing collateral to use the platform. Market parties consider these requirements to be appropriate for market entrants.

Polish wholesale markets are managed by three designated NEMO: TGE, NordPool, and EPEX Spot. The minimum bid allowed on the Polish DA and ID markets is 100 kW. The DA market operates with one-hour products, while the ID market uses products with 15-minute granularity. ID trades can take place up to one hour before delivery, which can be considered as constrained for the participation of DERs.

IMPLICIT ACCESS TO WHOLESALE PRICES

Poland recently allowed electricity suppliers to offer dynamic contracts to their customers, effective August 2024. several commercial offers are

available on the market. However, the low rollout of smart meters poses a high constraint for consumers interested in subscribing to dynamic contracts. Additionally, the share of energy in the total electricity bill is among the lowest in the EU, which reduces consumer incentives to adopt such offers once available.

Poland revised its Energy Law in 2023 to enable electricity suppliers to offer dynamic contracts to their customers. This requirement took effect in August 2024 and several offers are available on the market.

The ability to subscribe to a dynamic electricity contract is hindered by the low roll-out of smart meters. In 2023, only 27% of Polish households were equipped with a smart meter. Poland's smart meter rollout plan aims to achieve 80% penetration at the residential level by 2028.

FINANCIAL INCENTIVES

There are, at the time of writing, limited incentives to benefit from Polish wholesale prices through dynamic tariffs or explicit trading. Even with a higher roll out of smart meters, consumers are disincentivised due to the structure of the electricity bills. For example, on an average household electricity bill theenergy component represents only 26% of the total bill—one of the lowest shares in the EU. A higher share could provide Polish consumers, once commercial offers of dynamic contracts become available, with stronger incentives to invest in DERs and shift their consumption to cheaper hours.

MARKET MATURITY

Explicit participation of independent aggregators in wholesale markets is not possible at the time of writing. Moreover, subscriptions to dynamic tariffs remain quite low, as these offers have only been available for a few months. No dynamic tariff offers the option to automate DERs (such as charging of EV or heat pump operation during low-priced hours[19].

MARKET OUTLOOK

No pending reform are expected to increase the explicit participation of DERs in wholesale markets. However

he 2023 reform of the Energy Law and Balancing rule will enable and higher participation of DSR in balancing markets.

19 · Data coming from The Regulation Assistance Project.

PORTUGAL

While every market actor is entitled to access the Portuguese wholesale market, additional technical regulations are needed to ensure the participation of independent aggregators. Moreover, access to dynamic tariffs is hindered by the absence of commercial offers from electricity suppliers.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Independent aggregators managing generation assets are legally entitled to access Portuguese wholesale markets, ill-defined technical requirements such as baselining, settlement, and supplier compensation act as barriers to market entry.

Any entity willing to access Portuguese wholesale market needs to register as a “market agent” with the TSO, REN. This rule applies to all electricity markets (future, DA, ID and system services). Every market actor can register, including suppliers, independent aggregators, industrial consumers and energy communities. In 2023, Portugal undertook reforms to improve self-consumptions access to wholesale market through an independent aggregator. However, the current framework does not cover the technical requirements ensuring the participation of DR in wholesale markets (e.g. baselining, settlement, compensation of suppliers). Aggregators active in the country manage supply-side units such as small-scale solar PV, distributed batteries, and other distributed generation.

Administrative requirements to access wholesale markets include the assignment to a CRIA (Individual Agent Record Code) by the Portuguese regulator, ERSE. Generation, independent storage, and energy supply activities also require prior licensing from the Directorate-General for Energy and Geology (government authority). The market participant must then put in place a self-billing fiscal system, constitute a collateral (equivalent to the average value for a period of 90 days of imbalance and grid tariffs) and cover economic obligations to demonstrate (tests are required) the capacity to exchange information with the computer systems of the liquidation procedures (financial, technical and operational ability).

While the country recognises the status of independent aggregators, the current framework creates limitations. A major element stands on the obligation of all units integrated in an aggregator portfolio to belong to the same BRP. Moreover, technical requirements governing the aggregation of

low voltage customers (e.g. prequalification, requalification, baseline methodology and settlement) is acting as a barrier.

For actors other than independent aggregators, trading on Portuguese wholesale markets is conducted through the OMIE platform, the designated NEMO for Portugal and Spain. The ID and DA markets both offer a single product called Energy Hourly Contracts. The minimum bid size stands at 100 kW. The granularity of these products is currently one hour but is expected to be adjusted to 15 minutes by 2025. Additionally, trades on the continuous ID market can occur up to one hour before delivery. This long lead time can be considered detrimental to the participation of DERs.

IMPLICIT ACCESS TO WHOLESALE PRICES

Portuguese consumers do not currently have implicit access to wholesale prices through dynamic tariffs, as no commercial offers are available on the market. However, once these offers become available, the extensive rollout of smart meters and the high proportion of energy costs in domestic electricity bills are likely to encourage consumers to subscribe and benefit from these tariffs.

Portuguese law allows electricity suppliers to offer dynamic electricity contract their customers. However, no electricity suppliers currently offer a dynamic retail contract based on wholesale prices for residential and commercial customers. Instead, available tariff options include three regulated choices: a flat tariff, a bi-hourly tariff with two periods (off-peak and peak hours), and a tri-hourly tariff with three periods (peak, mid-peak, and off-peak hours). Portugal is in the final stage of its smart meters' roll-out. In 2023, 86% of households had a smart meter installed enabling the collecting consumption-data every 15 minutes.

FINANCIAL INCENTIVES

There are currently no financial incentives for consumers stemming from wholesale market participation, neither implicitly nor explicitly. While dynamic contracts are not yet available, Portuguese consumers who can shift their loads to cheaper hours could benefit from these offers. In 2023, the energy procurement costs represented 50% of a Portuguese household electricity bill, which can lead to significant price variation. This variation could drive changes in consumption patterns and encourage investment in DERs.

MARKET MATURITY

Both explicit participation of independent aggregators and implicit access to wholesale prices though dynamic contracts are not possible in Portugal. However, aggregators managing supply-side units have been active on wholesale markets. In 2023, 7.6% of the electricity sold in the DA market was generated by DERs, including CHPs units.

MARKET OUTLOOK

Officials recognise that technical requirements (e.g.,. prequalification, requalification, baseline methodology and settlement) need to be updated to create a level of playing field between DR and other technologies. By early 2025, the Portuguese regulator announced the launch of pilot projects aiming at identifying barriers faced by for aggregation of small residential/commercial consumers (and other distributed energy resources). A promotional campaign should support regulatory updates to raise awareness among low-voltage consumers about the economic advantages to engage in DR programme. The introduction of dynamic tariffs, when it occurs, should also open up the door to plenty of possibilities for Portuguese consumers, with one of the most advanced smart meter stocks in Europe.

SLOVENIA

There are no explicit legal limitations for any market participant to enter wholesale markets. In practice, however, the regulator needs to implement further technical regulations to ensure independent aggregators participation in Day-Ahead and Intraday markets. Currently, aggregators active in Slovenia also act as electricity suppliers. Access to wholesale prices is a common practice for large energy consumers, but the small consumer segment is still not mature.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Independent aggregators are entitled to access wholesale markets. However, all of the aggregators active in the country also operate as electricity suppliers. Stakeholders have mentioned that the current framework for independent aggregators needs to be revised to ensure their effective participation in wholesale markets.

Access to wholesale market in Slovenia is possible for every type of actors (suppliers, aggregators, large energy consumers and energy communities). However, energy communities' participation in wholesale markets is at an infant stage. While independent aggregators are allowed to participate in wholesale market, only aggregators linked to a supplier are active in Slovenia. The country is currently revising independent aggregator framework and compensation models to electricity suppliers. Aggregators managing supply-side units (such as residential solar PV and batteries) do not face barriers to access Slovenian wholesale markets.

Any entity trading on Slovenian wholesale markets needs to be a BRP or it needs to delegate this balancing responsibility to a BRP (called "being part of the balancing scheme"). Member of a Balance scheme can either be a trader (with closed contracts) or a supplier responsible for supplying electricity to consumers and for purchasing electricity from producers (with open contracts).

Being active on the Slovenian power exchange platform, BSP South Pool, entails the payment of certain fees (a membership fee, market participation annual fee, technical fee and transaction fees). While it can represent a significant barrier for new entrants with low liquidity (e.g. energy communities), it is not considered as a barrier for existing players.

The BSP South Pool Energy Exchange facilitates trading in several types of wholesale products: DA products with one-hour granularity and ID products with either one-hour or 15-minute granularity. The minimum bid size on both markets is 100 kW. Trades on the continuous ID market can occur up to

one hour before delivery. This last feature can creates difficulties for DERs to access continuous ID market.

IMPLICIT ACCESS TO WHOLESALE PRICES

Slovenia implemented a comprehensive regulatory and technical framework enabling electricity end-users (households and businesses) to subscribe to dynamic contracts.

Dynamic electricity contracts are recognised under Slovenian law, and electricity suppliers with more than 100 000 customers have been required to offer such contracts to their customers since 2022. Suppliers are also obligated to inform their customers about the opportunities, costs, and risks associated with dynamic contracts. Additionally, Slovenia has nearly completed its rollout of smart meters. By 2023, 95% of households were equipped with smart meters, enabling access to consumption data in 15-minute intervals. As a result, almost all customers now have the technical capability to subscribe to a dynamic electricity contract.

FINANCIAL INCENTIVES

No information on the financial incentive for explicit participation could be retrieved. However, benefits for residential customer subscribing to a dynamic electricity price contract are consequent. In 2023, the energy component made up 52% of a Slovenian household electricity bill. This share allows for significant price variation, providing consumers with clear price signals, enabling them to adapt their consumption, and potentially driving investment in DERs.

Moreover, a study by the Slovenian energy agency[20] highlighted that from January to May 2024, customers using the dynamic contract could see their monthly electricity bills drop by 18.26% in January (the month with the smallest savings) and by 43.35% in April (the month with the largest savings) compared to the regular fixed contract[21].

MARKET MATURITY

A review of the framework for independent aggregators will be necessary to ensure their effective participation in wholesale markets. Six aggregators are active in Slovenia; however, none hold the status of independent aggregators, as they are all also active as electricity suppliers. In 2023, aggregators accounted for 49,5 GWh of electricity traded on the ID market and 15,6 GWh on the DA market[22]. However, these volumes are not only covered by DR but by all DERs managed by an aggregator. The Slovenian energy agency[23] stated that, out of the total volume activated by aggregators across all markets in Slovenia (including balancing), 1.69% came from DR.

Slovenian electricity suppliers propose dynamic contract offers to every type of end-users. While subscribing to such contracts is a common practice among large businesses, similar offers have only been available to residential and small business customers since 2022. The adoption rate among residential customers remains low. The total amount of energy purchases through dynamic electricity price contracts[24] accounted for 2,83 TWh in 2023[25].

MARKET OUTLOOK

Slovenia's DER goals are set in the National Energy and Climate Plan in relation to decarbonization and renewable energy. The regulatory environment for the Integration of DER in Slovenian wholesale market is already set-up. The market operator Borzen is, at the time of writing conducting a public consultation founded on a cost benefit analysis to identify the optimal independent aggregator framework and compensation models for Slovenia.

20 · Ibid, p.147.
21 · In 2024, regular retail fixed contracts for small customers are price capped by the Government for 90% of consumption, remaining 10% of consumption can be charged by market price.
22 · Ibid, p.190.
23 · Ibid.
24 · Contracts with large consumers, small businesses and households.
25 · Agencija za energijo - Poročilo o stanju na področju energetike v Sloveniji p.139.

SPAIN

Spanish wholesale markets are accessible only to electricity suppliers and large energy consumers, with no framework in place to ensure independent aggregator participation. However, the first step towards developing this framework was taken by the Ministerio para la Transición Energética y el Reto Demográfico in September 2024, with the release of a draft royal decree aimed at establishing the conditions for aggregation. Nevertheless, past experiences with the slow implementation of the European Electricity Market Directive have tempered market participants' expectations regarding aggregators' access to this market. On the other hand, residential dynamic tariffs are thriving in Spain, with exponential growth in the number of consumers subscribing to the Precio Voluntario para el Pequeño Consumidor (PVPC) tariff[26] and other commercial offerings emerging in recent years.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

In the absence of a framework for independent aggregators, their participation in any electricity market is not possible in Spain. However, the country is currently revising its regulations and aims to develop a framework by March 2025.

Access to wholesale markets in Spain is currently limited to suppliers and large energy consumers, with the main barrier for explicit DSF being the regulatory framework. In September 2024, the Ministerio para la Transición Energética y el Reto Demográfico (MITECO) launched a draft royal decree for consultation to establish the conditions for aggregation. This decree specifically addresses the regulatory framework for aggregators and independent aggregators, the general principles of aggregation, a proposed interim aggregation model, and the rights and obligations of independent aggregators. The final framework is not expected to be implemented until 2025.

Administrative requirements for trading on Spanish wholesale markets are considered clear and do not create undue barriers to market entry. Trading on the Spanish wholesale market requires obtaining market agent status, which can be granted to producers, retailers, direct electricity consumers, and representatives. The process involves several administrative steps. First, the applicant must comply with the Electrical Production Market Activity Rules. Next, they must register as a market agent with Spain's TSO, RED-E, by passing technical, economic, and IT tests. Subsequently, registration as a market agent with the Spanish NEMO, OMIE, is required. The final requirement is either becoming a BRP or delegating this responsibility to an existing BRP.

Once aggregators are allowed access to wholesale markets, more tailored rules will need to be implemented. In addition to the topics addressed in the

26 · The PVPC tariff is a dynamic electricity pricing system in Spain, designed for residential consumers with a contracted power of less than 10 kW. It directly links the price of electricity to the hourly prices of the wholesale electricity market, allowing consumers to pay varying rates depending on the time of day.p.3.

recent consultation by the MITECO, other areas that will need attention include enabling aggregation and portfolio management, establishing technology requirements that are not overly restrictive, and ensuring baseline requirements are accurate and simple.

However, wholesale products design can create difficulties for the participation of DERs. OMIE is the operator of the wholesale electricity market in Spain. The minimum bid size in DA and ID markets stands at 100 kW. Both markets are based on hourly. In the Continuous Intraday market, Buy and Sell orders can be placed up to one hour before delivery. Both features (granularity and lead time before the closure of continuous ID market)which can be considered as limiting DERs participation.

IMPLICIT ACCESS TO WHOLESALE PRICES

Accessing wholesale prices through a dynamic tariff is common in Spain, thanks to the completed rollout of smart meters and the availability of special offers, such as the regulated PVPC contract.

Residential and small commercial consumers can benefit from wholesale prices through a well-developed dynamic tariff (PVPC) where the TSO publishes on a daily basis the hourly wholesale prices for the next day, making it available for those consumers. This tariff also includes a time-of-use component with three different time slots that reflects the network operating costs.

Large energy consumers can also, with some select suppliers, declare their consumption profiles for the upcoming day. This allows the supplier to adjust their positions accordingly and the consumer to receive a more advantageous price.

Subscription to the PVPC and other dynamic electricity contracts is supported by the completed rollout of smart meters. By 2023, 99% of Spanish households had a smart meter installed, enabling the recording of consumption data every 60 minutes.

FINANCIAL INCENTIVES

Financial incentives for consumers are mostly linked to the use of dynamic tariffs. In 2023, the share of energy procurement costs accounted for 54% of the total electricity bill for a Spanish household. This level is high enough to create an incentive for households to change their behaviour and to drive investments in DERs. LCP Delta[27] highlighted that savings of up to 31% on electricity bills can be achieved by a household equipped with a heat pump that switches from a static electricity contract to a PVPC contract and adopts flexible consumption behaviour based on the lowest-cost hours. These savings can increase to 38% if the household also owns an electric vehicle. While no data was available for large energy consumers, interviews with them indicated the financial benefits from sharing in advance their schedule with their supplier.

MARKET MATURITY

A big divide between the maturity of the market can be seen between explicit and implicit offerings. No data is available regarding how many large energy consumers actively trade in wholesale markets, and participation is mostly limited to direct electricity purchase, rather than flexibility trading. Due to the lack of aggregator being able to access the market very few DERs are able to access wholesale markets. An exception are standalone storage batteries that are part of a generation project, that can participate together with their associated generation. With regards to residential consumers, while the total number of EVs, heat pumps, renewable generation assets are broadly available, there is no visibility on how many of those are in households with dynamic tariffs.

With regards to consumers with dynamic tariffs, and according to the Ministry of Energy, 8.5 million consumers adhered to such a tariff at the beginning of 2024[28]. This amounts to one third of all residential consumers and has shown a significant growth in the past years, with 1.25 million customers in 2021.

MARKET OUTLOOK

Access to wholesale markets for DSF will continue to depend on the implementation of the aggregator framework. While the figure of the aggregator is already introduced in Spanish law (Royal Law Decree 23/2020), the implementation and definition of many important aspects as mentioned before are lagging. Red Eléctrica, the Spanish TSO, has presented a roadmap setting the expected implementation of the aggregator framework in March 2025. However, beyond this date there are no details on how and what concretely will be implemented, which many market participants in Spain interpret as further delays to be foreseen.

27 · LCP Delta. 2023. Assessment of consumer risks and benefits of heat pumps with and without dynamic price contracts.
28 · https://www.miteco.gob.es/es/prensa/ultimas-noticias/2023/12/entra-en-vigor-la-nueva-metodologia-de-calculo-de-la-tarifa-regu.html

SWEDEN

Sweden has not implemented framework for independent aggregators covering Day-Ahead and Intraday markets Moreover, the gate closure time for the continuous Intraday market, set at one hour before delivery, may be too long to support DERs participation. The country has a developed market for implicit flexibility, with 14% of electricity end-users (both residential and business) subscribing to a dynamic retail contract.

ACCESS TO WHOLESALE MARKETS

EXPLICIT ACCESS TO WHOLESALE MARKETS

Sweden has not yet implemented a framework for independent aggregators covering wholesale markets. However, discussions are ongoing about introducing a new aggregator framework within the next 5 to 6 years. In the meantime, an interim solution may be tested around 2026-2027, but it is still unclear whether this interim solution will allow independent aggregator participation without being linked to a supplier.

Swedish law recognises that all market actors (including suppliers, large energy consumers, and independent aggregators) should access wholesale markets. However, independent aggregators, while their role is recognised by the energy law, currently cannot directly monetize demand turn-down or turn-up actions in the wholesale market. Activity of aggregators are limited to aggregating supply-side units as batteries as solar PV panels.

Trading on the Swedish wholesale market requires obtaining or delegating Balance Responsible Party (BRP) status. To become a BRP, a market participant should contact eSett, the company managing Nordic imbalance settlement. The BRP candidate must provide eSett with collateral to acquire a valid Imbalance Settlement Agreement. The candidate must then request a Balance Agreement from the Swedish TSO, Svenska kraftnät, which includes requirements such as ensuring hourly balance, reporting information, and paying for services from Svenska kraftnät. This agreement must be renewed annually. Additionally, the candidate should obtain an ACER code for REMIT compliance from the Swedish energy regulator, EI.

For candidates not intending to become a BRP, they may instead request Retailer status from eSett. A retailer is defined as a market participant that "sells and buys electricity directly from a producer, another retailer, or via a Nominated Electricity Market Operator"[29]. The retailer must then enter into an agreement with an existing BRP.

29 · eSett. 2024. Nordic Imbalance Settlement Handbook. Instructions and Rules for Market Participants. p.3.

The final step involves registration with a wholesale market operator. As in other countries, this requires passing a Know Your Customer (KYC) procedure, undergoing a technical and IT capacity assessment to ensure trading readiness, and providing collateral.

These requirements are generally viewed as appropriate by market participants.

Swedish wholesale market operators are Nord Pool and EPEX Spot. The minimum bid size is set at 100 kW. The DA market is based on 1-hour products, while the ID market is based on 15-minute products. Traders can place buy or sell orders on the continuous ID market with a 60-minute lead time. This long window between the ID gate closure time and the delivery can constrained DERs from accessing the continuous ID market.

IMPLICIT ACCESS TO WHOLESALE PRICES

Sweden has established an appropriate regulatory and technical framework to enable electricity end-users to subscribe to dynamic contracts. However, the high share of network tariffs and taxes prevents electricity consumers from fully experiencing price fluctuations linked to wholesale prices.

Dynamic tariffs are recognised by Swedish law, and electricity suppliers with more than 200 000 must offer a dynamic electricity contract as part of their commercial offers. Electricity suppliers must inform the electricity user of the possibilities, costs and risks involved with dynamic contracts.

Moreover, Sweden has completed its rollout of smart meters, and every household and business now has access to these devices. Every customer can decide to subscribe to a dynamic contract.

FINANCIAL INCENTIVES

Sweden consumer receives only limited variation on their electricity bill while subscribing to a dynamic contract. In 2023, energy component of a Swedish household electricity bill was only reaching 34%, one of the lowest rates in the EU. However, high and volatile electricity prices following the Russian invasion of Ukraine led electricity suppliers to increase their risk premiums, resulting in a substantial increase in the cost of fixed-term contracts compared to dynamic contracts.

MARKET MATURITY

The market of dynamic tariffs is relatively well-developed compared to other European countries, with 14% of electricity end-users (both residential and business) subscribed to a dynamic retail contract in 2023 and 54% subscribed to a contract that varies based on the monthly average spot price. Residential customers subscribing to a dynamic electricity contract are often homeowners who have installed DERs, such as rooftop solar panels or battery systems. Moreover, 20 offers of dynamic contracts linked with an automation of DERs (e.g. automatic charging of EV or heat pump during low-priced hours) were available on Swedish market in 2024[30], the highest number in the EU.

As previously mentioned, the country has not yet implemented a framework allowing independent aggregators access to wholesale markets.

MARKET OUTLOOK

The country has reviewed its framework for independent aggregators. However, further reforms are underway to ensure compensation for the supplier following an explicit activation. Additionally, the country recently restructured its electricity market design by differentiating the roles of Balance Responsible Party and Balancing Service Provider (however a BSP still has to be a BRP). The effects of this law remain to be seen in the market.

Discussions related to the establishment of a framework for trading in the Day-Ahead and Intraday markets are ongoing. The Swedish TSO, Svenska Kraftnät, is considering two different aggregation models: the split balance responsibility model and the shared delivery model. However, these reforms are expected to be implemented within four to six years. In the meantime, an interim model, similar to the split balance responsibility model, could be introduced within one to two years before further consolidation. It remains unclear whether this solution will allow independent aggregators to directly access wholesale markets, or if they will have to become or assign a supplier to participate.

30 · Data coming from Regulatory Assistance Project.

List of acronyms

BESS	Battery energy storage system
BRP	Balance Responsible Party
BSP	Balancing Service Provider
CHP	Combined Heat and Power
DA	Day-Ahead
DER	Distributed energy resource
DKK	Danish Krone
DR	Demand Response
DSO	Distribution System Operator
DSR	Demand-Side Resources
EU	European Union
FSP	Flexibility Service Provider
ID	Intraday
IT	Information Technology
KW	Kilowatt
KYC	Know Your Customer
MW	Megawatt
NEMO	Nominated Electricity Market Operator
PUN	Prezzo Unico Nazionale
PV	Photovoltaic
SBMU	Secondary Balancing Mechanism Unit
SME	Small and medium-sized Enterprise
TOU	Time-of-Use
TSO	Transmission System Operator
VPP	Virtual Power Plant

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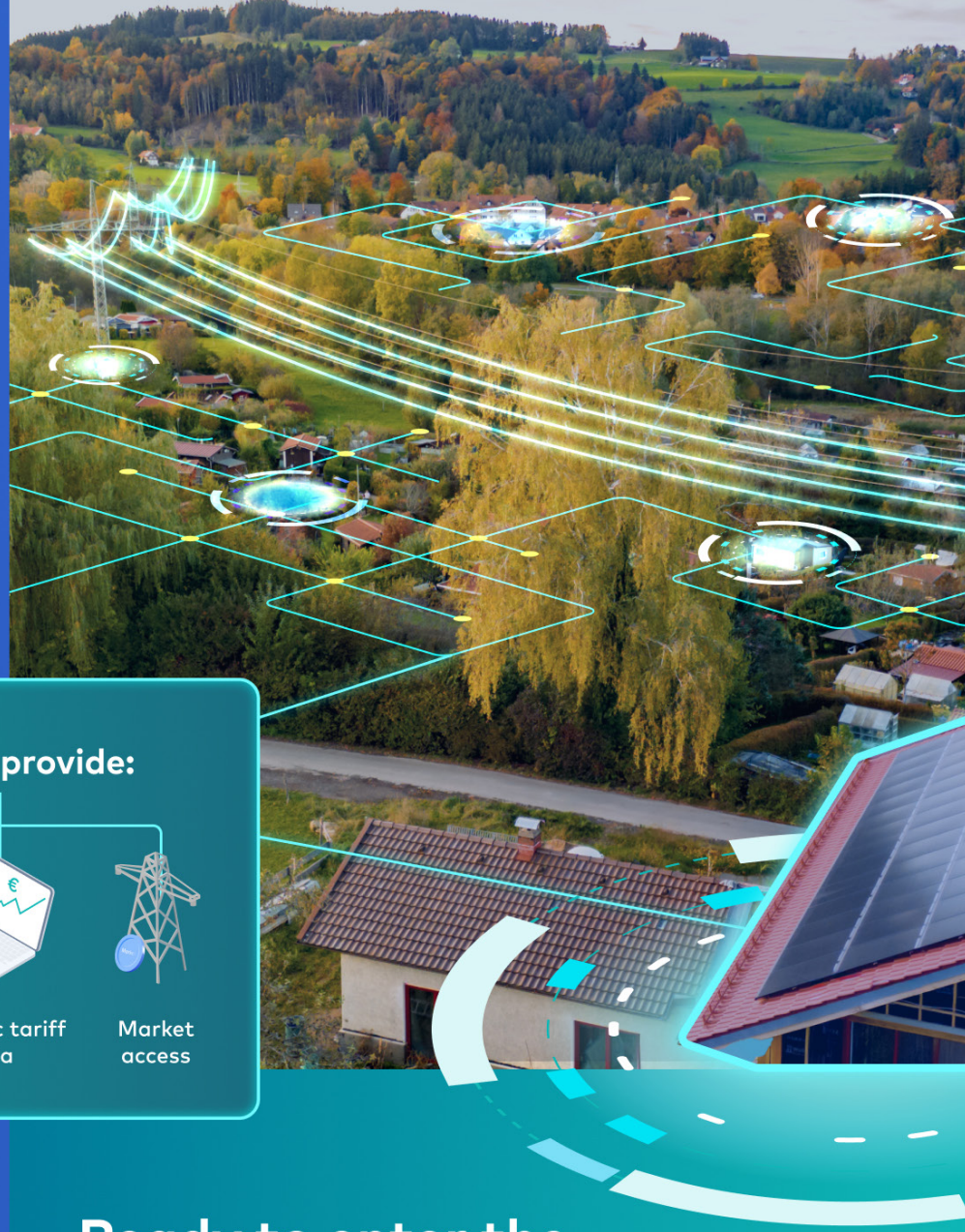

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