
CORE REFERENCE MODEL FOR DSO PROCUREMENT OF FLEXIBILITY
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smartEn
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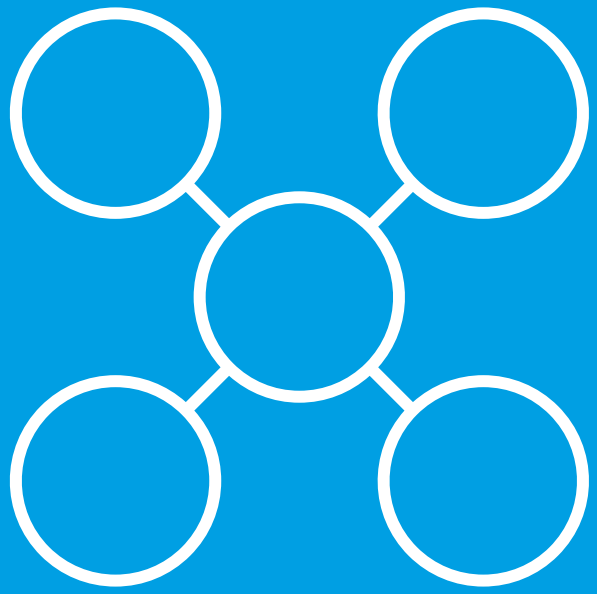
Introduction



The Core Reference Model (CRM) for DSO procurement of flexibility is intended as a blueprint of the ideal market design for flexibility procurement by DSOs.

This paper is smartEn's contribution to specifically address the DSO procurement of flexibility. In the coming months following this publication, smartEn will be releasing a range of other papers with the aim of illustrating the increasingly complex issue of defining a holistic market for local flexibility. We see this as being essential in maximising the take up of the very significant potential offered by local, commercial and residential flexibility assets. Our contributions would aim to improve the existing Electricity Market Design.

Introduction

Why do we need a core reference model for DSO procurement of flexibility?

- This paper aims to support DSOs in the implementation of art. 32 of the EU Electricity Directive which foresees that DSOs shall procure flexibility services in accordance with transparent, non-discriminatory and market-based procedures.

- Progress is very slow: local flexibility procurement by DSOs has not advanced at the same pace as DSF use by TSOs, as highlighted in smartEn/Delta-EE EU Market Monitor for DSF 2021.

- The lack of a European harmonised framework has precipitated the fragmentation of different procurement schemes for local flexibility needs which is reducing competition, liquidity in the markets, and making an inefficient use of the available flexibility.

- Best market designs are to be found in the Netherlands and Great Britain but they are still lacking scale for wide commercial viability.

- This paper does not aim to limit DSF participation to local flexibility markets. Consumers and prosumers should be able to participate in all markets, mechanisms and price-driven schemes to activate their flexibility potential.

What is the core reference model for DSO procurement of flexibility?

- The report provides the ideal features in market design for local flexibility procurement by DSOs.

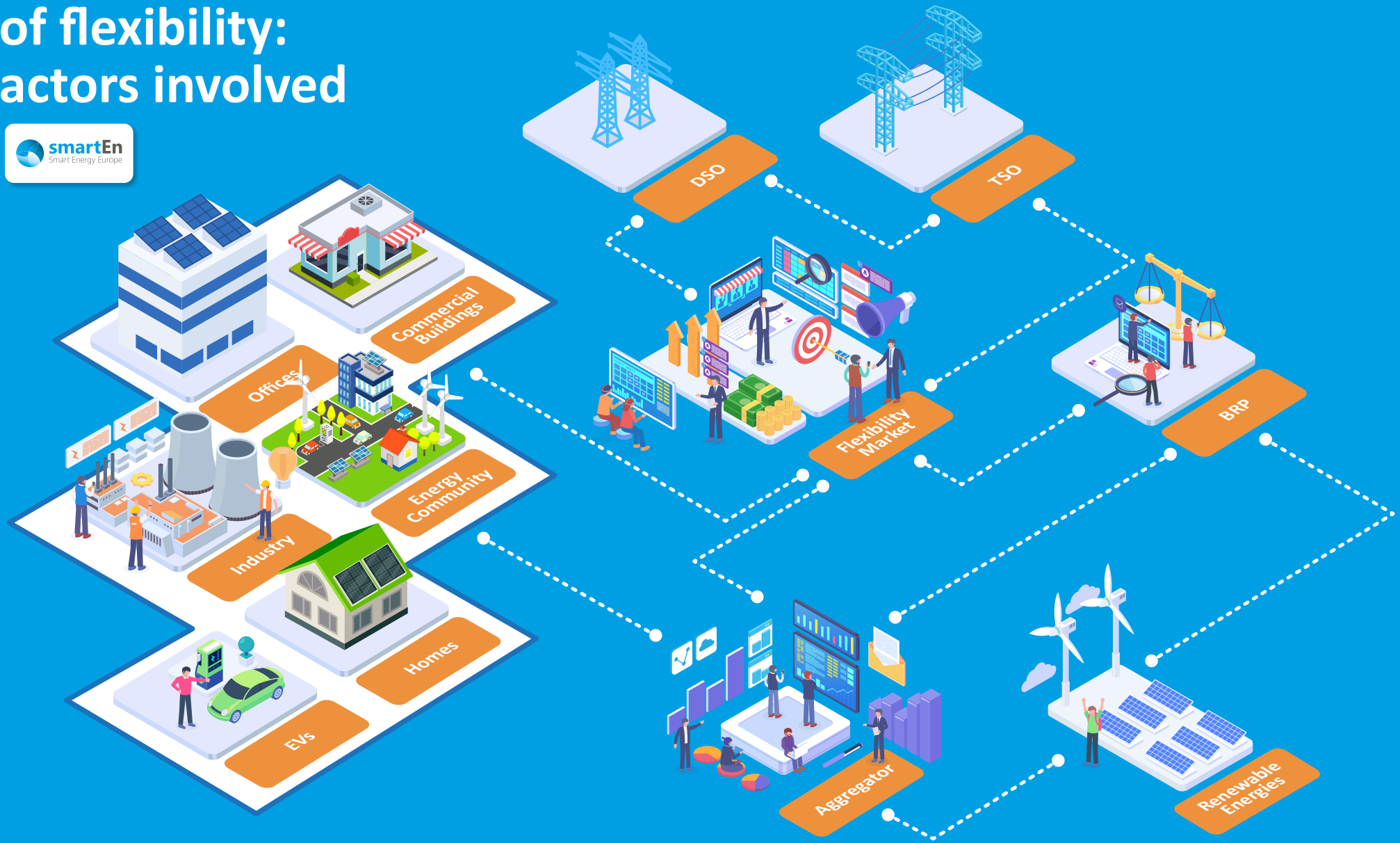
- It can be used as a blueprint against which to compare existing local flexibility markets, or proposed future market designs, and assess their viability for DSF providers to participate in them.

- The proposed model is based on years of experience from smartEn members' in providing DSF in both DSO and TSO markets.

- The report is divided into five sections covering market structures, product design, data sharing, TSO&DSO cooperation, and technical requirements.

- Each section investigates the different features by aiming to to identify the ideal ✅, the second best ~ and the unsatisfactory features ❌.

DSO procurement of flexibility: actors involved



Core Reference Model for DSO procurement of flexibility 1/2

CATEGORY	IDEAL FEATURES
Procurement method	Fully market-based.
Market participants	Multiple sellers (flexibility service providers) and buyers (System operators and other balance responsible parties).
Pooling of resources	Pooling of generation and demand permitted.
Incentive structures for SOs	Mandatory DSF targets in network development plans. TOTEX based approach to valorise investments. Counter-factual scenarios to grid investments that include non-wires alternatives.
Product definitions	System-needs approach.
Trading area	Full DSO area and cross-zonal trading.
Product availability	Grid capacity management, congestion management, redispatching, voltage control.
Timeframe of products	Long term and short term products available.
Types of products	Availability and energy products.

Core Reference Model for DSO procurement of flexibility 2/2

CATEGORY	IDEAL FEATURES
Grid planning	Ten-year network development plan that requires DSO with mandatory consideration of flexibility.
Data sharing	Bi-directional data sharing (DSO/TSO – FSP and TSO – DSO).
Data types	Congested areas. Real-time energy mix. Real-time CO2 content in energy mix.
Flexibility Resources Register – use and process	Flexibility resources register is used to access local flexibility markets and acts as an automatic prequalification. It should be compatible with other markets and facilitate access to wholesale and balancing markets.
Flexibility Resources Register – contents	Identification information (pool or individual depending on product requirements). Deliverable flexibility and constraints. Information required to guarantee prequalification.
TSO – DSO cooperation	Harmonised product design that allows SOs to buy flexibilities from the same market. Prequalification is standardised for different products and markets.
Imbalance settlement	Clear definition about redispatch responsibilities. This may differ per time frame (e.g. BRP before DA gate closure, TSO/DSO after DA gate closure). Other responsibilities to be clearly defined include the BRP allocations and the impact of aggregators in their positions.
Telemetry requirements	Delivery, validation and settlement for all services are allowed based on both the boundary meter (“smart meter”) and sub-meters (embedded meters). Whichever method is used, they shall provide the necessary data quality depending on the product’s requirements. If the main meter or sub-meter is not owned by the DSO it shall be certified by the DSO or NRA.

Core Reference Model for DSO procurement of flexibility

MARKET STRUCTURE

Procurement method

MARKET-BASED

A market-based approach is the preferred structure for local flexibility procurement as it will guarantee neutrality of the DSO, especially for those which are part of integrated utility companies or where unbundling is not fully performed.

HYBRID OPTION

A market-based tendering procedure.

Bilateral agreements, like non-firm connection agreements, in case of significant liquidity problems or market power issues.

BILATERAL AGREEMENTS / NON-FIRM CONNECTION AGREEMENTS

Bilateral agreements can increase the concentration of power with the system operator and can lead to inefficient results, locking in flexibility resources without being able to take into account all market signals and options.

Market participants – buyers and sellers of flexibility

MULTIPLE FLEXIBILITY BUYERS

A fully developed local flexibility market where buyers of flexibility include DSOs and TSOs, in addition of other balance responsible parties (BRPs), like aggregators, but also energy communities or industrial consumers.

TSO-DSO COORDINATION

While DSOs remain the main buyer of flexibility in the local market, TSOs participate in the product design, facilitating the activation of unused orders in the DSO market in the subsequent TSO market (e.g., mFRR or RR).

LACK OF SYSTEM PERSPECTIVE

DSOs are also the only buyer of flexibility in the local flexibility market. Product design is based on the DSOs specific needs, which can harm compatibility and coordination across voltage levels.

GENERATION AND DEMAND

Sellers of flexibility can be any energy resource, both from the generation and demand side. They can join the market individually or through an aggregated pool offered by a flexibility service provider (FSP), usually an aggregator.

TRADITIONAL GENERATION ASSETS

Providers of flexibility remain legacy generation assets that provided the service in the past.

Lack of demand sources might indicate limiting product design or lack of financial incentives.

Incentive structures for DSOs

TOTEX BASED APPROACH

Investment decisions in local grid infrastructure and operation consider both capital and operational expenditures.

This allows DSF to compete on equal terms with traditional grid reinforcement.

CAPEX-BASED APPROACH

Remuneration of regulated DSO activities is based only on the capital expenditure required for grid reinforcement.

Due to the cost structure of DSF services (which rely heavily on operational costs – OPEX), they are at a disadvantage when comparing to traditional investments.

REGULATED INCENTIVES FOR FLEXIBILITY PROCUREMENT

The NRA includes a mandatory requirement of DSF in any regulated activity if cost effective.

Counter-factual scenarios and a CBA are required based on non-wire alternatives, before the deployment of new infrastructure.

NO OTHER INCENTIVES

No specific incentives for DSF procurement by regulated actors.

Core Reference Model for DSO procurement of flexibility

PRODUCT DESIGN

Product design

SYSTEM-NEED PERSPECTIVE DEFINITION

The service-based approach guarantees that system-needs are covered independently of what assets are providing the service. Product definitions do not consider the capabilities of available assets, but only system-needs. Portfolio-based bidding is central to this model. For certain local needs, locational information can be provided to the DSO by the flexibility provider.

ASSET-CLASS BASED PRODUCT DEFINITION

Product design is based on the types of assets providing the service. This can be useful if only a few legacy assets, known to the DSO are available in a region. However, DSF and in particular "hidden" flexibilities will rarely participate. This implies the need to individually register assets, even if a pool is providing the service.

FULL DSO AREA AND CROSS-DSO AREA TRADING

The market area is wider than the single DSO area. In addition to the full DSO area, trading to other DSO areas is possible, leading to efficiency gains from harmonisation.

FULL DSO AREA

The full DSO area is considered for the local flexibility market. Appropriate signals identify needs in specific areas.

CONFINED AREA

Flexibility procurement is confined to a reduced area where the SO identifies a congestion. This reduces the viability for FSPs to enter the market due to reduced profitability.

Product design – types of products and timeframes

VARIED PRODUCTS AVAILABLE WITH SEVERAL BUYERS

A combination of products available for system operators and other BRPs: Grid capacity management, congestion management, redispatching, service restoration and voltage control. Multiple products with similar timeframes are available to accommodate activation times of different technologies.

VARIED PRODUCTS WITH SINGLE BUYER

Varied products that allow stacking of services, but only available to the DSO as a single buyer in the market. This limits an efficient price formation.

LIMITED PRODUCTS AVAILABLE

The market is limited to congestion management for the DSO, limiting the possibility of value stacking.

FULLY MARKET-BASED LONG-TERM (LT) & SHORT-TERM (ST) PRODUCTS

A combination of ST energy products and LT capacity payments with market-based energy prices, that provide system security and investment signals for flexibility providers. Requires high TSO & DSO coordination.

HYBRID SOLUTION

A combination of ST and LT products. LT products in the form of capacity payments with a fixed energy price.

SHORT TERM PRODUCTS

Only short-term energy products.

Product design – settlement and measurement

HARMONISED BASELINE METHODOLOGIES

Harmonised baseline methodologies are followed based on EU-wide guidelines. Different baseline methodologies are available based on the types of assets, consumers and products. Baselines are designed with accuracy, simplicity and integrity in mind.

EACH DSO DESIGNS THEIR BASELINE

Each DSO (or Member State) designs their own baselines, without a common EU methodology.

Monitoring would be required to avoid market fragmentation, reducing mobility for FSPs and lowering liquidity of the market.

NONE OR LIMITING BASELINES DEFINED BY DSOS

No baselining methodology is defined by the NRA or SO. Customers or aggregators have to define their own baselines against which they will be measured. An overly-complicated baseline methodology is imposed for all DSF, regardless of consumer load types.

MULTIPLE MEASUREMENT METHODOLOGIES

A harmonised measurement and settlement method is used based on EU-guidelines. A wide range of sub-metering provided by the manufacturer is allowed as an alternative to the main meter. It has to be compliant with relevant legal criteria and consistent with boundary meter data.

Use of sub-metering is not mandatory, and only provided if beneficial.

ONLY MAIN METER DATA

Only main meter data is used for the measurement and settlement process.

Product design – Telemetry requirements

MINIMISED TELEMETRY AND SETTLEMENT REQUIREMENTS

- Metering and data communication requirements are no more stringent than what is actually needed for operation and justified by a cost-benefit analysis.
- No requirements for real-time telemetry into the system operator's control centre (i.e. SCADA).
- Markets rely on aggregators to manage reliable resource delivery in their own least-cost manner.
- Settlement is done based on the interval data from the existing boundary meter or sub-meter (15 or 30-minute data), unless justified for fast response products.

ACTIVE EFFORT TO REDUCE TELEMETRY REQUIREMENTS

- Telemetry may be required, but if so there is great care to minimise per-site costs by minimising the specifications. Since latency requirements can have a particularly strong cost impact, at least 60 seconds of latency is allowed.
- Data quality and completeness standards are not applied to non-settlement interval data. Where such standards are applied, markets provide participants with an appropriate reconciliation period to perform quality control measures (typically, at least 30 days).

TELEMETRY REQUIREMENTS DESIGNED FOR GENERATORS APPLIED TO DSF

- Requirements that were developed for generators are applied to DSF resources.
- SCADA-style real-time telemetry is required. This adds unnecessary costs for the DSF resource while not really providing added value. DSF assets are not comparable to large, centralised generators which pose a much greater reliability risk and therefore need close monitoring.
- Completeness for all interval data is required and reconciliation period is very short (i.e., 24 hours).

Core Reference Model for DSO procurement of flexibility

DATA SHARING

Data sharing and transparency

TRANSPARENT GRID PLANNING

Grid expansion planning is performed involving all market parties.

The NRA requires mandatory local flexibility procurement in the grid expansion plan when cost effective.

OPAQUE GRID PLANNING

Grid planning is performed without public consultations.

No mandatory inclusion of DSF in the expansion plan.

Conservatory grid-planning with little to no DSF in the ten-year period.

BI-DIRECTIONAL DATA-SHARING

Data sharing is a bi-directional effort by FSPs and DSOs.

In addition to the data required by FSPs, DSOs provide comprehensive congestion and qualitative information on the grid and customer: CO2 emissions, both avoided by activated DSF and in the current energy mix; energy mix composition; access to grid-tie point (GTP) data by FSP.

Data is provided close to real time (where technically possible) and in a standardised format. Information can be included in the FSPs commercial offering.

DATA SHARING ONLY BY FSPS

Data sharing is one-directional from the FSP to the DSO.

The Flexibility Resources Register requires individual asset registration (even where not necessary).

Data sharing and transparency

TOTAL INTEROPERABILITY OF DATA FORMATS

Data formats and cybersecurity requirements follow a common EU guideline, for example by using standards like:

CIM IEC62325 based APIs and interoperability,

ISO27000 family for ICT management, the common criteria approach (ISO/IEC 15048) for the ICT services,

IEC 62443 family for ICT products.

INDIVIDUAL DATA FORMATS

No universal standards are used.

Data formats and cybersecurity requirements might be inconsistent between different markets.

Flexibility Resources Register

SIMPLIFIED AND COMPATIBLE REGISTRATION

The flexibility resources register automatically prequalifies for DSO & TSO products.

It is possible to register a pool of assets unless a reasoned justification is provided by the SO for individual asset registration.

Bi-directional flexibility register: The flexibility register includes flexibility needs by SO and detailed information on congestion.

MULTIPLE REGISTRATIONS REQUIRED

Registration is mandatory for all individual assets beyond the GTP wanting to provide flexibility services.

The registration process is not compatible with other prequalification processes, either for DSO products or TSO products.

Registration has to be performed by the consumer or their representative.

The data format of the flexibility resources register does not follow the EU harmonisation guideline.

Flexibility Resources Register – characteristics and use

STREAMLINED AND SIMPLIFIED INFORMATION

The flexibility resources register is used to facilitate visibility over existing flexibilities (individual or pools) in any given area. It can include the following information:

- Identification information.
- Deliverable flexibility (individual or pool).

The flexibility resources register can not be used to curtail or disconnect any demand resources (without compensation).

UNNECESSARY DATA REGISTRATION

The flexibility resources register is required for all individual assets and includes information like:

- Prequalification information: both processes should be unified in one.
- Contractual information: sharing of unnecessary or too detailed information could create conflicts if unbundling is not complete.
- Settlement-related information: settlement should be harmonised and independent from the register.

FLEXIBILITY RESOURCES REGISTER USED FOR EFFICIENT IDENTIFICATION OF FLEXIBILITIES

The flexibility resources register is used exclusively as a means to identify flexible assets and allow them access to the markets.

The register cannot be used to curtail or disconnect any demand resources (without compensation).

FLEXIBILITY RESOURCES REGISTER IS USED AS A MEANS TO CONTROL AVAILABLE ASSETS INSTEAD OF SURFACING AVAILABLE FLEXIBILITIES

The flexibility resources register is used as a means to control and curtail individual assets by the system operator.

The register fails to identify all flexibility resources in an area due to lack of commercial incentives to register them. The DSO assumes that no flexibilities are available in a specific area.

Core Reference Model for DSO procurement of flexibility

TSO&DSO COORDINATION

TSO & DSO interaction

MULTIPLE BUYERS

Both DSOs and TSOs should have access to the same flexibility in a fair and competitive market in a coordinated manner. This will allow for the proper valuation of flexibility in order to sell it to the best buyer.

COORDINATED SINGLE BUYER

Both DSOs and TSOs coordinate and act as a single buyer of flexibility. This allows for a second-best efficient use of resources, but does not properly valorise the available resources.

SINGLE BUYER

A single buyer of flexibility (DSO) can limit liquidity of the market by reducing prices and expelling competition.

COMPATIBLE PRODUCT DESIGN AND CASCADING BIDS

A single bid into the market can be used in subsequent markets. I.e., if an order is not activated by the DSO for a local congestion issue, the same bid can be used for the next market (in time), e.g. the TSO balancing markets (in particular mFRR and RR).

This requires a cooperation by SOs in the product design, harmonising to the extent possible, product shapes, activation times and ramping requirements.

INDIVIDUAL MARKETS

Individual and non-compatible markets mean additional hurdles for FSPs to bid into different products that might be exclusionary. This reduces their chance of activation and increases the opportunity cost for the flexible asset.

TSO & DSO interaction

COORDINATED GRID ASSESSMENT

DSOs and TSOs coordinate in the assessment of the grid's state of use and congestions.

This would allow for a more efficient use of local flexibilities, and could facilitate the inclusion of congestion signals in the market prices.

INDIVIDUAL GRID ASSESSMENT

DSOs and TSOs assess their grids individually. This can create bottlenecks and congestion issues in the activation of local flexibilities by any of the parties.

Core Reference Model for DSO procurement of flexibility

TECHNICAL REQUIREMENTS

Prequalification requirements and attributes 1/2

	✓	~	✗
MODE OF ACTIVATION	Automatic or manual depending on the service.		Activation mode not adapted to the type of service (e.g., automatic activations for products with long duration).
AVAILABILITY WINDOW	DSF availability windows are based on the type and purpose of the program, the grid characteristics and any other products existing in the market.		DSF required to be available 24/7/365 regardless of the program they participate in.
VALIDITY PERIOD	Settlement periods are tailored to the physical problems needed to be solved. Ideally 15-minute settlement periods if viable.	30-60 minute settlement periods.	4-hour blocks or above.
DURATION OF CONTRACT	Long- and short-term contracts available.		No choice over contract duration.
LOCATIONAL INFORMATION	Prequalification at grid-tie point.		Individual asset prequalification.
RECOVERY TIME	■ The frequency of dispatches reflects system needs- there is a good balance between the cumulative call hour requirements and what the grid actually needs. ■ Limits on dispatch frequency should be justified and specified by the system operator. ■ Recovery times for generation units should not go over 15 minutes and 1 hour for demand units.		■ Unlimited access – DSF asset to be available 24/7/365. ■ The system operator over or under-specifies the grid's needs- too many dispatches, which means no customer participation or too few, which means no value added to the system. ■ No limits on dispatch frequency specified by the system operator.

Prequalification requirements and attributes 1/2

	✓	~	✗
MIN & MAX CAPACITY	■ Minimum capacities should not be over 100 kW ■ Portfolio aggregation is allowed and capacity varies from a few kilowatts to megawatts (there is no limit to portfolio size). ■ De-rating: DSF "owners" decide on the projected availability of their capacity and must be held accountable for any differences between actual and fore-casted availability (de-rating for battery storage is based on actual system model-ling; for DR, the de-rated value includes considerations re historical availability/ performance).	Minimum capacity in different products of no more than 500 kW with aggregation allowed.	■ Aggregation is not allowed and there are minimum and maximum limits to portfolio size imposed by the program rules. ■ De-rating: a constant de-rating factor is applied to different technologies; or a too short historical period (ie. one year) is used as reference to calculate the de-rated value of different technologies; for DR, the de-rated value is based on its duration.
DIRECTION OF ACTIVATION	Up/down asymmetrical bids.	If up & down bids are placed, they have to be symmetric.	Mandatory placing of up and down bids.

Prequalification requirements and attributes 2/2

	✓	~	✗
DIVISIBILITY	Bids can be partially activated, either in terms of power activation or time duration. Divisible bids allow solving of grid constraints with the highest accuracy possible.		Bids are not divisible.
PREPARATION PERIOD	■ System operators provide sufficient advance notice, based on effective prediction of emergency or peak load conditions. ■ Dispatch lead times naturally depend on the purpose of the program – continuous balancing need programs start from 3-minute lead times while infrequent emergency-based reliability programs may entail up to 24 hours of lead time. ■ For demand response, in general, a 2-hour mark represents the point above which most customers will be able to participate and below which most customers start to lose eligibility. However, lower preparation periods should be available depending on the product requirements.		■ System operators do not provide sufficient advance notice, so lead times are short across all programs and many customers start to lose eligibility. ■ Customers incur costs related to enabling sub-minute or sub-second dispatches.

Prequalification requirements and attributes 2/2

	✓	~	✗
RAMPING PERIOD	■ DSF is not required to follow a particular ramp shape and should not be longer than 15 minutes. ■ Ramping period varies based on the type of consumer, load, the geographical location of the electricity market and system operator, etc. Short and real-time programs have a shorter ramp period compared to programs with longer time scales. ■ Remunerated ramping periods.	■ Ramping periods are defined based on the type of asset providing the service. ■ Ramps are not remunerated.	■ Ramps are linked to the product shape and not the technology providing it. ■ Ramps are not remunerated.
FULL ACTIVATION TIME	Activation times are justified for system needs and not indiscriminately long. Average durations across different programs: ■ Grid capacity management: 120 min – 240 min. ■ Congestion management: 60 – 120 min. ■ Redispatching: 60- 120 min (or in line with congestion management). ■ Service restoration: 2 hours – 8+ hours. ■ Voltage control: 30 min – 720 min.		Activation times are unnecessarily long to cover system needs and based on technical capacity of traditional assets. DSF is required to activate for 12+ hours across various programs.

List of Acronyms

BRP	Balance Responsible Party
BSP	Balance Service Provider
CAPEX	Capital Expenditure
CBA	Cost-Benefit Analysis
CRM	Core Reference Model
DA	Day-Ahead (Energy Market)
DSF	Demand Side Flexibility
DSO	Distribution System Operator
FSP	Flexibility Service Provider
ICT	Information and Communications Technology
LT	Long-term
mFRR	Manual Frequency Restoration Reserve
NRA	National Regulatory Authority
OPEX	Operational Expenditure
RR	Replacement Reserves
SCADA	Supervisory Control and Data Acquisition
SO	System Operator
ST	Short-Term
TSO	Transmission System Operator

This publication is possible thanks to the support of The smarter E Europe

THE smarter E EUROPE

"Creating a new energy world" – that is the goal of The smarter E Europe, the continent's largest platform for the energy industry. In this new energy world, electricity and heat are generated decentrally from renewable energies. The share of volatile electricity continues to grow due to the new deployment of photovoltaic installations and wind power sites. How renewable energies can be better integrated into our distribution grids is therefore one of the most important questions of the energy transition, to which The smarter E Europe provides answers.

The focus is on cross-sector solutions linking electricity, heating and transportation for an intelligent and sustainable energy supply. The topics comprise all the core areas along the supply chain – from the generation, storage, distribution and usage of electricity and heat to sector coupling.

The smarter E Europe brings together four parallel exhibitions to give energy industry players from around the world a comprehensive overview of the latest innovations and trends. All events take place annually at Messe München:

- Intersolar Europe – The world's leading exhibition for the solar industry
- ees Europe – The continent's largest and most international exhibition for batteries and energy storage systems
- Power2Drive Europe – The international exhibition for charging infrastructure and e-mobility
- EM-Power Europe – The international exhibition for energy management and integrated energy solutions.

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