Analyse van het wettelijk, reglementair en regulerend kader van de flexibiliteitsmarkt

(‘Analysis of the legal, regulatory and regulating framework in the context of the flexibility market’)

Final Report

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Context

Het energielandschap is de laatste jaren onderhevig aan een aantal grote veranderingen. Naast een toename van decentrale en hernieuwbare energiebronnen in de elektriciteitssector, manifesteert zich een tendens naar elektrificatie van toepassingen en gaat de digitalisatie van de samenleving onverminderd voort. De toename van decentrale en hernieuwbare energieproductie als gevolg van het streven naar een koolstofarme samenleving heeft een grote impact op ons energiesysteem. Naast grotere piekbelastingen en bijhorende kosten voor het net, moeten er oplossingen zijn voor periodes zonder wind of zon. Ten slotte dient men ad hoc te kunnen ingrijpen op onverwachte situaties als gevolg van het onvoorspelbare karakter van wind of zon.

De laatste jaren is daarom onder meer sterk ingezet op de actieve deelname van de eindgebruiker in de flexibiliteitsmarkt. Consumenten kunnen flexibiliteit ter beschikking stellen om verscheidene diensten te leveren en/of te ontvangen ten behoeve van een geoptimaliseerd, efficiënt en duurzaam energiesysteem. Deze flexibele oplossingen, waaronder elektrische en thermische flexibiliteit aan de vraagzijde maar ook het slim benutten van allerlei vormen van energieopslag, kunnen een deel van het antwoord bieden op de gestelde uitdagingen.

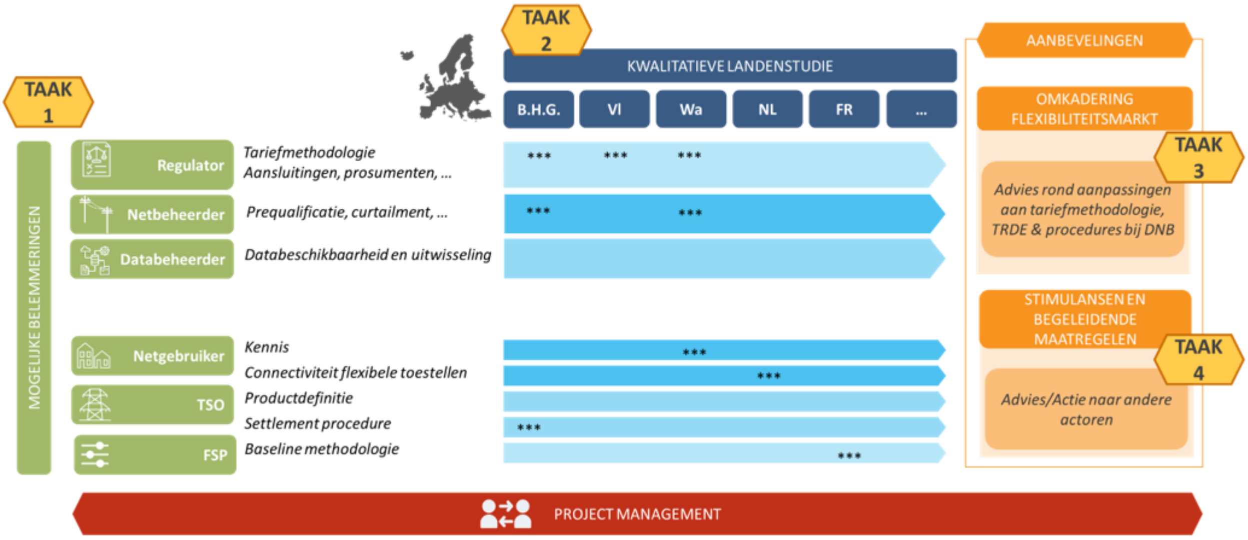
De markt van de flexibiliteit is op dit moment volop in ontwikkeling, gesteund door de geplande veralgemeende invoering van slimme meters en de integratie in het net van meer flexibele belastingen (zoals elektrische voertuigen en warmtepompen, enz.). Momenteel is echter de actieve deelname van eindgebruikers nog beperkt onder andere omwille van bepaalde technische, operationele, sociale en financiële barrières. Daarnaast is het een uitdaging om de veilige netuitbating te garanderen voor alle spanningsniveaus bij een toename van het gebruik van flexibiliteit op laagspanning voor het leveren van verschillende systeemdiensten (zowel balanceren als congestieproblematiek). In het bijzonder voor het Brussels gewest zijn de diversiteit in consumenten, de armoedeproblematiek, de specificiteit van het 230V-net en de grootstedelijke context extra aandachtspunten bij het uitwerken van een faciliterend kader voor flexibiliteit op laagspanning.

Methodologie

EnergyVille/VITO heeft een studie uitgevoerd in opdracht van BRUGEL ‘Uitvoering van specifieke analyses betreffende de omkadering van de flexibiliteitsmarkt’. Deze studie brengt de verschillende barrières in kaart die het ontsluiten van de markt voor flexibiliteit op laagspanning belemmeren. Er wordt vertrokken vanuit de huidige Europese, nationale en regionale regelgeving. Nuttige voorbeelden uit andere regio’s en landen zijn eveneens opgelijst. De studie besluit met een set van aanbevelingen. Deze aanbevelingen focussen in het bijzonder op de ontwikkeling van de flexibiliteitsmarkt.

De aanbevelingen zijn opgedeeld in drie grote thematische blokken (technische aanbevelingen, eindgebruiker aanbevelingen en marktaanbevelingen). De aanbevelingen zijn daarnaast opgedeeld in korte termijn aanbevelingen (2022), middellange termijn aanbevelingen (2025) en lange termijn aanbevelingen (2030). Daarnaast is ook steeds aangegeven welke mogelijke instrumenten BRUGEL ter beschikking heeft om deze aanbevelingen verder uit te werken en te implementeren. Andere maatregelen rond energie-efficiëntie, mobiliteit en groene investeringen vallen buiten de scope van deze studie.

Onderstaande figuur geeft een schematisch overzicht van de project aanpak.



Project aanpak

Technische aanbevelingen

- ✓ De oplossingen voor het hoogspannings-of middenspanningsnet werken vaak niet voor het laagspanningsnet omwille van de verschillende technische realiteit. Het is daarom belangrijk om de specificiteit van het laagspanningsnet op technisch gebeid mee te nemen, en oplossingen op maat van het laagspanningsnet uit te werken. Er wordt hier onder andere gekeken naar specifieke oplossingen voor marktprocessen zoals prequalificatie, selectie en activatie van flexibiliteit. Daarnaast is het noodzakelijk dat naast zuivere marktoplossingen andere concepten zoals tarieven en aansluiting met flexibele toegang verder worden onderzocht.

- ✓ De distributienetbeheerder (DNB) zal de nodige competenties moeten ontwikkelen om de flexibiliteit vanop laagspanning te faciliteren. Daartoe moet er in de eerste plaats een duidelijk beeld zijn van de huidige en toekomstige noden van het laagspanningsnet in combinatie met een goed beeld van de staat van de huidige infrastructuur. Om de huidige en toekomstige noden van het net goed in te schatten, zijn gedetailleerde netstudies noodzakelijk (tot op het niveau van de transformator of de feeder) die de verschillende toekomstscenario's (bijvoorbeeld rond mobiliteit, zonnepanelen,...) meenemen. Daarnaast is het belangrijk dat investeringsplannen in het net rekening houden met de huidige staat van de infrastructuur (bijvoorbeeld transformatoren) en aangeven waar er investeringen nodig zijn en/of waar flexibiliteit een oplossing kan zijn.

- ✓ De specificaties van de volgende generatie slimme meters wordt best voldoende op tijd bepaald om de compatibiliteit met de huidige en toekomstige noden van de eindgebruiker te garanderen. Deze specificaties moeten rekening houden met de specifieke context van flexibiliteit op laagspanning. Het consulteren van de verschillende stakeholders is hier opnieuw essentieel.

- ✓ Er is nood aan transparante criteria waarop de DNB kan terugvallen om te bepalen wat 'redelijke capaciteit' is en/of de DNB noodzakelijke investeringen moet doen of bepaalde flexibiliteit, al dan niet tijdelijk, kan verhinderen. Het bepalen van deze criteria dient steeds te gebeuren in overleg met alle stakeholders.

Aanbevelingen in verband met de eindgebruiker

- ✓ Om de eindgebruiker actief te laten deelnemen aan de flexibiliteitsmarkt is het belangrijk dat de eindgebruiker voldoende kennis heeft. Daarom is het van belang dat de eindgebruiker juiste en bevattelijke informatie ter beschikking krijgt. De beschikbaarheid van accurate meetdata is noodzakelijk. Hulpmiddelen om eindgebruikers feedback te geven over hun gedrag en verbruik zijn eveneens essentieel. In het bijzonder word teen correcte en duidelijke communicatie van de economische voordelen voor de eindgebruiker beschouwd als een belangrijke stimulans om op een meer actieve manier met energie om te gaan. Via geavanceerde profielopmaak van eindgebruikers kan gericht advies gegeven worden in verband met investeringen die de consument toelaten zijn potentieel aan flexibiliteit op laagspanning optimaal te benutten. Het verder onderzoeken van de voorkeuren van consumenten is een belangrijk onderzoeksthema voor de komende Jaren.

- ✓ De eindgebruiker kan naast individuele deelname via collectieve entiteiten flexibiliteit aanbieden. Een stabiel regelgevend kader voor collectieve flexibiliteit is noodzakelijk, bijvoorbeeld voor energiegemeenschappen. De transpositie van de Europese regelgeving is bezig en het is daarbij aangewezen dat de verschillen tussen de regio's beperkt worden gehouden. Dit regelgevend kader moet de noden van de verschillende stakeholders in de waardeketen meenemen waarbij in het bijzonder aandacht moet geschonken worden aan kwetsbare groepen. De waarde van collectieve flexibiliteit, bijvoorbeeld bij het leveren van diensten voor het net (zowel op korte als op lange termijn), moet correct gewaardeerd worden. In het bijzonder kunnen aangepaste tarieven een manier zijn om de waarde van deze flexibiliteit correct te waarderen. De hulpmiddelen en systemen die nodig zijn om collectieve flexibiliteit naar de markt te brengen moeten voldoen aan strenge voorwaarden op vlak van interoperabiliteit en energie-efficiëntie.

- ✓ Kwetsbare consumenten moeten eveneens kunnen deelnemen aan de markt voor flexibiliteit. Dit vereist een specifieke aanpak op het vlak van informatievoorziening. Daartoe moeten de noden van de kwetsbare consumenten duidelijk in kaart worden gebracht. Aanpassingen aan de tarieven voor kwetsbare consumenten kunnen hier een mogelijke piste zijn.

- ✓ De tariefstructuur moet ondersteunend zijn het groeiende belang van flexibiliteit op laagspanning. Er moet vermeden worden dat de tariefstructuur zelf een barrière wordt voor het ontsluiten van flexibiliteit op laagspanning. Om de juiste tariefstructuur en tariefmethodologie te bepalen voor de toekomst is een duidelijk beeld nodig van 1) de toekomstige noden van de DNB, 2) de evolutie van nieuwe technologieën en gebruikersgedrag, 3) de evolutie van andere flexibiliteitsmechanismes zoals flexibiliteitsmarkten en concepten zoals flexibele aansluitingscontracten. De introductie van een nieuw tarief vereist intensief overleg met de stakeholders.

- ✓ Het is belangrijk dat consumenten de verschillende aanbiedingen van mogelijke energiecontracten eenvoudig kunnen vergelijken. Hierbij is het van belang dat factoren zoals de beschikbare flexibele apparaten van de consument, zijn gebruiksgedrag en voorkeuren kunnen meegenomen worden. Dit vereist een verdere uitbreiding van reeds bestaande vergelijkingsalgoritmes.

Marktaanbevelingen

- ✓ De verschillende producten en diensten voor flexibiliteit moeten opengesteld worden voor flexibiliteit afkomstig van alle spanningsniveaus. Flexibiliteit afkomstig van het laagspanningsniveau is voor een aantal producten vandaag nog niet toegankelijk. Daarnaast dienen flexibiliteitsproducten geen onderscheid te maken tussen verschillende bronnen/technologieën en is het belangrijk om in de specificaties informatie met betrekking tot de locatie van de flexibiliteitsbron mee te nemen.

- ✓ Om een antwoord te bieden op de toekomstige uitdagingen voor netbeheerders, kunnen nieuwe flexibiliteitsdiensten en producten worden uitgewerkt. Er dient bijvoorbeeld bekeken te worden welke producten noodzakelijk zijn om de congestieproblematiek mee op te lossen. Mogelijke synergiën met de reeds bestaande producten voor balanceren moeten bekeken worden. Bij een toename van flexibiliteitsdiensten en producten is een voldoende mate van harmonisatie en standaardisatie essentieel. De evoluties op nationaal en regionaal vlak moeten in die optiek in lijn zijn met de toekomstige netwerkcodes en/of aanpassingen aan bestaande netwerkcodes op het vlak van flexibiliteitsproducten.

- ✓ Het bestaande proces van prequalificatie moet vereenvoudigd worden om flexibiliteit vanop laagspanning te faciliteren. Deze vereenvoudiging geldt zowel op operationeel vlak als op administratief vlak. Daarnaast is het belangrijk dat het prequalificatieproces voor de verschillende flexibiliteitsproducten wordt geharmoniseerd. Daartoe is uitgebreid overleg met de stakeholders aangewezen.

- ✓ Bij de verdere ontwikkeling van de flexibiliteitsmarkt moet aandacht geschonken worden aan de integratie van flexibiliteitsmarkten. Deze integratie vindt plaats op verschillende niveaus: over verschillende tijdsdimensies heen, over verschillende spanningsniveaus, over verschillende producten- en diensten en over verschillende flexibiliteitsbronnen. Bij de verdere ontwikkeling van flexibiliteitsmarkten is de coördinatie tussen netbeheerders eveneens essentieel. Hiervoor bestaan verschillende mogelijke modellen die de coördinatie tussen netbeheerders kunnen organiseren. Het meest geschikte model is onder andere afhankelijk van de maturiteit van de flexibiliteitsmarkt en de producten en diensten die er verhandeld worden. Een verdere verduidelijking van de rollen en verantwoordelijkheden in de flexibiliteitsmarkt is noodzakelijk. In het bijzonder de rol van de operator van de markt, al dan niet gereguleerd, moet verder bekeken worden.

- ✓ Het gebruik van flexibiliteit door netbeheerders als alternatief voor netinvesteringen, moet eveneens gealigneerd worden met de financieringsmodellen van netbeheerders. Het gebruik van flexibiliteit moet gelijkwaardig behandeld worden ten opzichte van investeringen. Er kan zelfs worden overwogen om vanuit duurzaamheidsoogpunt het gebruik van flexibiliteit in bepaalde omstandigheden te stimuleren. Naar de toekomst toe kan gedacht worden aan gemeenschappelijke financieringsmodellen voor netbeheerders om mogelijke synergieën op vlak van flexibiliteit te realiseren.

- ✓ De methode voor de baseline of referentiecurve moet aangepast/uitgewerkt worden en rekening houden met de specifieke context van flexibiliteit afkomstig van laagspanning. Bij het bepalen van de methode voor de baseline is harmonisatie op regionaal, nationaal en Europees niveau belangrijk. Aspecten zoals de noodzakelijke meetdata en procedures voor validatie dienen in deze optiek bekeken te worden. Het Belgische model van energieoverdracht moet opnieuw bekeken worden om te onderzoeken op welke manier dit kan uitgebreid en/of aangepast worden om werkbaar te zijn indien de flexibiliteit afkomstig is van laagspanning.

- ✓ Er bestaan verschillende flexibiliteitsmechanismes. Naast expliciete flexibiliteitsmarkten kan flexibiliteit geactiveerd worden via dynamische tarieven of flexibele aansluitingscontracten. Er is specifiek onderzoek nodig om te kijken welk flexibiliteitsmechanisme het meest geschikt is (zowel operationeel, economisch als sociaal) om flexibiliteit op laagspanning in het Brussels Gewest te activeren. Hierbij is het noodzakelijk om een duidelijk beeld te hebben van de verschillende voorkeuren van de eindgebruikers in het Brussels Gewest.

- ✓ De toename van het gebruik van flexibiliteit op stelt een aantal uitdagingen op het vlak van beschikbaarheid van data, het ter beschikking stellen van data en het gebruik van data (o.a. omwille van privacy). Het is belangrijk dat het principe van interoperabiliteit steeds wordt nagestreefd, zowel voor slimme toestellen als voor slimme meters of andere systemen waarbij data opgehaald, verwerkt, opgeslagen of doorgestuurd worden.

1 Introduction

1.1 Context

The Belgian energy system is transitioning to a higher levels of Renewable Energy Sources (RES) as small scale decentralised non-synchronous generation plants (e.g. wind and solar energy) are gradually substituting traditional large centralised synchronous electricity generation plants (e.g. gas and coal power plants). This transition creates new challenges for the grid with respect to security of supply and balancing due to a higher degree of volatility and lower predictability of RES. Moreover, the changing energy mix leads to a higher proportion of flexibility connected to the distribution grid. In particular for the distribution grid, this creates new challenges with respect to congestion and voltage.

A sharp increase[1] of available demand flexibility is also expected in the coming years, especially connected to the Low Voltage (LV) grid, driven by the uptake of (1) smart meters, (2) roof top photovoltaic systems, (3) home batteries, (4) electric mobility and (5) heat pumps. The advent of LV flexibility is further facilitated by the radical shift in the role of consumers from passive to active participants in the energy system. In particular, the Clean Energy Package introduces a framework for community energy ownership, by defining two concepts for collective flexibility: the Renewable Energy Community (REC)[2] and the Citizen Energy Community (CEC)[3]. Consequently, LV flexibility will gain importance in the coming years and has the potential to play an important role, supporting both an adequate and operationally stable Belgian energy system.

Today, the active participation of consumers to the flexibility market is still limited due to the existence of several technical, operational, organisational, social and financial barriers. Products for system services are, for example, not available for or adapted to the requirements of LV flexibility providers. Moreover, challenges arise to ensure a secure grid operation at all voltage levels in case of procurement and activation of flexibility for system services close-to-real time. To note that in order to activate low voltage flexibility, different flexibility mechanisms exist. Both implicit mechanisms (e.g. tariffs, connection agreements) and explicit flexibility mechanisms (e.g. flexibility markets) should be organized in a way that the support each other in the most efficient way and do not create additional barriers.

The Brussels-Capital Region in particular, will face similar challenges due to the expected increase in electric vehicles[4] and solar PV[5]. Moreover, due to its 'urban nature' The Brussels-Capital Region faces specific challenges such as 1) the variety in types of consumers, 2) poverty, 3) the specifics of the 230V-grid and 4) the evolutions related to urban mobility .

EnergyVille/VITO performed a study for BRUGEL "**Uitvoering van specifieke analyses betreffende de omkadering van de flexibiliteitsmarkt.".** This study aims to 1) assess the different barriers that exist for consumers to participate to the flexibility market, 2) provide best practices from surrounding regions/countries and 3) present a set of recommendations how to address the different barriers. The analysis has integrated the perspective of multiple stakeholders (Transmission System Operator (TSO), Distribution System Operator (DSO), Regulator, Aggregator and Grid User). To note that the recommendations in this paper focus on the development of the flexibility market only. Other measures (related to energy efficiency, mobility, green investments, green city areas,...) are out of scope for this study but will, in particular for Brussels Capital Region, go hand-in-hand with the development of the flexibility market. Moreover, the success of these other measures will also determine the need, options and speed of the uptake of low voltage flexibility.

Each recommendation is introduced by a set of objectives. The recommendations are split into three time-windows (short-term, medium-term and long-term). The short-term recommendations (2022) are actions that should be taken as soon as possible to prepare the energy transition for Brussels Capital Region. These actions are necessary (as a pre-condition) to

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1 https://economie.fgov.be/sites/default/files/Files/Energy/Adequacy-and-flexibility-study-for-Belgium-2020-2030-Elia.pdf

2 Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), OJ L 328, 21.12.2018, p 82 (REDII).

3 Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast), OJ L158, 14.6.2019, p 125 (IEMD).

4 http://www.synergrid.be/download.cfm?fileId=Synergrid_EV_Grid_Impact_ExternalReport_v3_0.pdf

5 https://leefmilieu.brussels/het-leefmilieu-een-stand-van-zaken/volledige-versie/energie/energie-uit-hernieuwbare-bronnen-het

'kick-start' the uptake of low voltage flexibility. A second set of medium-term recommendations (2025) are supporting measures to gradually expand the flexibility market and use of low voltage flexibility. A third set of recommendations have a more long-term orientation (2030) and are measures to facilitate the flexibility market in case this market as started to get a certain maturity. To note that the date of '2030' is now fixed to be in line with the 'Energie en Klimaatplan' of Brussels Capital Region. However, the necessity of the actions with target 2030 will depend on the uptake of the market for flexibility, amongst others stimulated by the actions proposed for 2022 and 2025. For each action, one or multiple instrument(s) (Table 2 Instruments) are proposed to realize the action. To note that for some actions, multiple instruments could be used.

The following document provides an overview of identified barriers, best practices and recommendations.

Different barriers and recommendations built further on the European orientations as determined in the Clean Energy for all Europeans Package" , the orientations of the 'Energy-and Climate plan 2030' of the Brussels-Capital Region and the current regulatory framework for the Brussels-Capital Region (Ordonnance relative à l'organisation du marché de l'électricité en Région de Bruxelles-Capitale), the federal law on flexibility, the technical regulation[6] and tariff methodology as defined by BRUGEL and the model contract between DNB and FSP[7].

The recommendations are formulated as concrete actions that could be considered by BRUGEL. To that extent, the recommendations also make the connection towards well known studies and recent initiatives that are important for the Belgian and BCR context, such as the 'Baringa study on flexibility'[8], the Elia white paper on Consumer-centric market design[9] ,the Synergrid market consultation[10], ,...

1.2 Project approach

Figure 1: Project overview presents the overall approach.

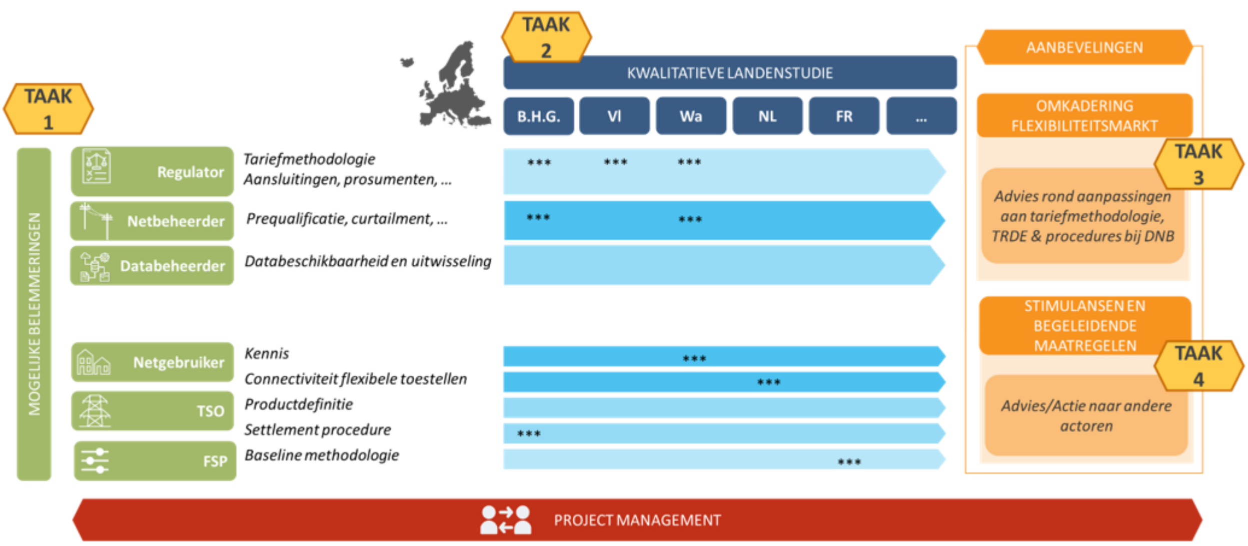

Figure 1: Project overview

In a first task, different barriers to participate to the overall flexibility market are assessed from a multi-stakeholder perspective. for each barrier, the origin of the barrier is explored. In a second task, for each barrier, the situation in the Brussels-Capital Region is analysed and best practices (or worst practices) from neighbouring regions and countries are

6 https://www.brugel.brussels/publication/document/beslissingen/2020/nl/Beslissing-136-goedkeuring-voorstellen-technische-voorschriften-elektriciteit-gas-SIBELGA.pdf

7 http://www.synergrid.be/index.cfm?PageID=16832&language_code=NED# - C8/01

8 http://www.synergrid.be/download.cfm?fileId=Synergrid_EV_Grid_Impact_ExternalReport_v3_0.pdf

9 https://www.elia.be/nl/nieuws/persberichten/2021/06/20210618-elia-group-publishes-white-paper-on-a-consumer-centric-and-sustainable-electricity-system

10 http://www.synergrid.be/download.cfm?fileId=Synergrid_Market_Consultation_210401_NL.pdf&language_code=FRA

highlighted. In case relevant, other good examples within Europe or outside Europe are also mentioned. In order to make the analysis of the barriers and the discussion of best practices as interactive as possible, the first two tasks were organized according to three dedicated workshops: a technical workshop, an end user workshop and a market workshop (see Figure 2: Overview workshops). The market workshop also included aspects related to data.

The final two tasks (task 3 and task 4) are dedicated to the formulation of recommendations, with respect to 1) the instruments under the responsibility of BRUGEL (task 3) such as the tariff methodology or technical regulation and 2) instruments not under the direct responsibility of BRUGEL (task 4).

The final chapter in this document presents a summary of the recommendations presented in the document, together with the time-window and the necessary instrument. For the detailed recommendation, we refer to the text. Each recommendation is connected to a specific objective. Both objective and recommendation have the same numbering. For example, objective 1.2.3 is connected to recommendation 1.2.3.

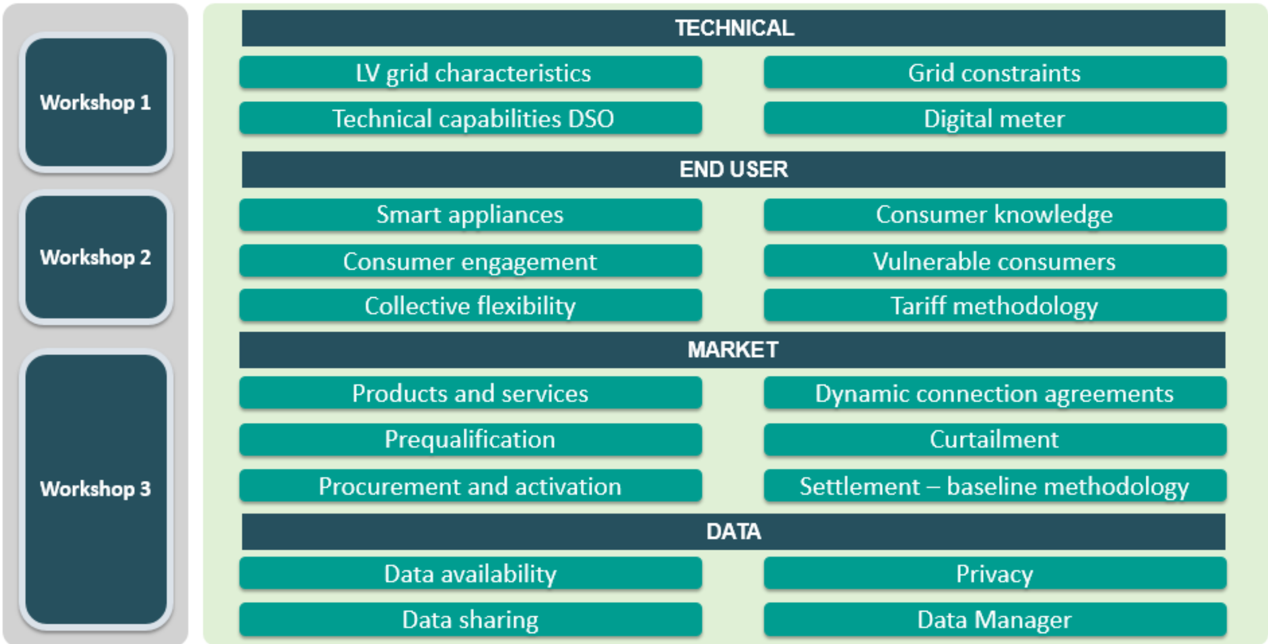

Figure 2: Overview workshops

1.3 Abbreviations

For a good interpretation of this report some key definitions are provided.

Acronym	Definition
ACER	European Union Agency for the Cooperation of Energy Regulators
ACM	Autoriteit Consument & Markt
API	Application Programming Interface
BCR	Brussels Capital Region
BRP	Balance Responsible Party
CAPEX	Capital Expenditures
CCMD	Consumer-Centric Market Design
CEC	Citizen Energy Community
CEER	Council of European Energy Regulators
CEMS	Central Energy Management System
CEP	Clean Energy for all Europeans Package
CIM	Common Information Model
CPAS	centre public d'action sociale
DA	Day Ahead
DER	Distributed Energy Resources
DM	Data Manager
DR	Demand Response
DSM	Demand Side Management
DSO	Distribution System Operator
E.DSO	European Distribution System Operators
EoEB	Exchange of Energy Blocks’
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
ESCO	Energy Service Company
EV	Electric vehicle
ERP	Enterprise Resource Planning
FCR	Frequency Containment Reserve
aFRR	automatic Frequency Restoration Reserve
mFRR	manual Frequency Restoration Reserve
FSP	Flexibility Service Provider
GDPR	General Data Protection Regulation
GIS	Geographic Information System

HP	Heat Pump
HV	High Voltage
ID	Intraday
LV	Low Voltage
MO	Market Operator
MV	Medium Voltage
NEKP	Nationaal Energie- en Klimaat Plan
NC	Network Code
NFS	Network Flexibility Study
OLTC	On Load Tap Changer
OPEX	Operating Expenditures
PLC	Programmable Load Controller
PV	Photovoltaics
R&D	Research and Development
REC	Renewable Energy Community
RES	Renewable Energy Sources
RT	Real Time
SLP	Synthetic Load Profile
SO	System Operator
ToE	Transfer of Energy
TSO	Transmission System Operator
V	Volt
W	Watt

2 Technical perspective

The following chapter analyses which technical barriers exist, related to the operation and capacity of the low voltage grid, and the use of the smart meter, that hinder the further deployment of low voltage flexibility.

The visibility on the low voltage distribution grids throughout Europe is limited: the layout of the grids is only partially known, and measurements are limited. Historically this was acceptable, as a low simultaneity factor – a feeder with a capacity of typically 20-30% of the total connected capacity is sufficient to cover the peak demand – allowed a 'fit and forget' strategy with acceptable cost. That is, we install cables with sufficient capacity to cover all demand peaks, which avoids the need of operational management of the LV grid. However, the use of the distribution grids is rapidly changing: growth of distributed renewable production (solar panels), electrification of heating and transport (electric car charging and heat pumps), and LV flexibility. These evolutions not only lead to higher loads on the grid, but also to increased synchronicity, which in turn leads to higher peak loads. The result is that the 'fit and forget' strategy becomes increasingly expensive. Alternatively, new technologies – such as smart meters -, processes and tools (will) allow for more active system management.

LV flexibility takes an exceptional position in this evolution, as it is at the same time a threat and an opportunity. It is a threat, as LV flexibility is nowadays mostly used to support balancing via ancillary services, and as such does not take the limitations of the LV grid into account. As the use of flexibility for ancillary services does lead to the synchronized switching of smart appliances, this leads to larger peaks in the LV grid. On the other hand, flexibility offers an opportunity for DSO's to influence and alter the load and production on their LV grids, and hence – via the procurement of flexibility or by enforcing grid constraints on the use of flexibility – avoid congestions.

However, for system operators to fully adopt the benefits of an active system management approach, including the use of flexibility from LV customers, several barriers need to be overcome.

In following section, barriers, best practices and recommendations are presented related to low voltage grid characteristics (2.1), technical capabilities of the DSO (2.2), smart metering (2.3) and the grid constraints/reasonable capacity (2.4).

Note: In this study, recommendations are made based on the principle of 'technology neutrality'. This means that a priori, different forms of LV flexibility are treated equally to ensure the same level playing field. Of course, other factors such as investments costs, flexibility requirements, CO_2 requirements, efficiency requirements,…will determine further which type of flexibility source in the end will become most viable.

2.1 LV grid characteristics

2.1.1 Barrier

The technical conditions of the LV grid are different from the MV and HV grid to the extent that solutions from the higher voltage levels cannot be copied as such to the low voltage grid.

Initiatives on LV flexibility and LV traffic lights historically attempted to apply MV/HV solutions to the LV grid. However, these initiatives were confronted with aspects specific to the LV grid, as listed below. The typical approaches for flexibility bidding, clearing, selection and activation for services for HV and MV are not necessarily suited for flexibility and congestion management in LV grids.

Category	HV/MV grid	LV grid
Grid technical nature	• Scale: few large, high CAPEX assets, MW range • Few large interconnected/meshed systems • Inductive grids, with P/f and Q/V separation	• Scale: many small, low CAPEX assets, kW range • Many small radial, independent per transformer systems, which potentially results in non-liquid and gaming sensitive markets. • Resistive unbalanced grids, with location dependent non-linear voltage behavior[11]
Measurement infrastructure	Overmeasured, as the cost of RT communications and measurements is order of magnitudes smaller than the asset value	Undermeasured, as the cost of reinforcement lower than or the same order of magnitude as advanced (RT) measurements & control
Dimensioning and operational infrastructure	• Dimensioned for high simultaneity • Full operational chain deployed	• Dimensioned for low simultaneity • Fit and forget approach, no operational systems deployed to remotely monitor and control the LV grid
Grid Connections	Industrial customers: • Customer priority is RoI and cost • Offtake/injection profiles are stable and predictable	Mostly residential customers: • Customer priority is on comfort, are risk averse, and solutions must be low complexity • Offtake/injection profiles are highly stochastic. No reliable forecast technology of individual LV connections exists. • Privacy/GDPR, consent and user rights • High switching rate, social aspects (budget meters) Many of these aspects are also valid for most of the small enterprises connected to the LV grid

This results in the **LV grid investment paradox**: the cost of traditional reinforcement according to fit&forget is low; in the order of magnitude of 10-100k€ CAPEX[12] for a single feeder. Which means that traditional MV/HV measurement and

[11] Because LV grids are resistive, active power consumption or production influences the voltage across the line, where the ‘size’ of the voltage impact is influenced by the location in the feeder: a load at the end of a long line has a lot more impact than a load close to the transformer. On top of this, LV grid typically have significant unbalance, which also further ‘skews’ the voltage. This is especially the case for 3N400V grids, where unbalance causes currents to flow through the neuter. 230V grids are more resilient to unbalance. Result is that both the available grid capacity, but also the impact and ‘value’ of LV flexibility, is variable and in (non-linear) function of the location and phase of the (flexible) loads.

[12] As the dominant cost for new cables are the placement costs, rather than the cost of the Aluminium, most DSO’s employ a €/m cost. However, there is a large variation, not only from DSO to DSO, but also dependent on the location: placing a

automation solutions are more expensive than traditional reinforcement. However, due to the scale of the LV grid, even a limited percentage of grid reinforcements does result in massive investments.

2.1.2 Examples/best practices

The typical strategy of the traffic light concepts[13] investigated throughout Europe, was to translate HV/MV concepts to the low voltage, after which they quickly encountered the specific barriers of the LV grid as described before. Indeed, these traffic light pilots were pivotal in coming to the understanding grew that the DSO misses crucial LV technical capabilities, and that HV/MV solutions can't be copied as such to the LV environment. Recent projects focus on developing the needed technical capabilities (see also section 2.2), and resort to simpler concepts, such as non-fîrm capacity agreements. For more detailed barriers, best practices and recommendations related to different flexibility mechanisms, see chapter 4 on the 'Market perspective'.

Country	Case	Best (and <u>worst</u>) practices
	USEF[14]	Despite the strong initial push, interest in USEF[15] declined after disappointing pilot results, due to the complexity - it was only partially deployed or strongly simplified in the pilots -, or due to incompatibilities with the LV environment. Load and flex forecast were not accurate enough, and there were insufficient volumes of flex to reliably avoid LV congestions. Often, baseline errors exceeded the volume of available flex[16]. An interesting case is the more recent Interflex Strijp-S pilot with Enexis, TNO and Elaad in Eindhoven. Although started as a pure USEF pilot, due to above issues, the concept of nonfirm connection capacity was later introduced next to USEF.
	BDEW Smart Grid Traffic Light Concept[17][18][19]	In multiple German projects, this concept was to be translated in practice. It was quickly realized that several key DSO capabilities were missing, and the German projects refocuses on developing those:

cable in a rural situation costs less than, say, a cable under the Big Square in Brussels. Furthermore, it is not always necessary to install new cables. Alternatives may be tap changing transformers, auto-transformers, rebalancing the phase connectivity… The cost range in the text reflects all these factors.

[13] Note that traffic light is an umbrella term that holds multiple solutions. The general 'European' and original understanding was that traffic lights are any systems that allow the DSO to procure flexibility to avoid congestions, typically on a day-ahead and/or intra-day basis. However, recent insights have altered this, and the current 'Belgian' interpretation by the Belgian DSO's, is that traffic lights are any system that enforces the constraints of the LV grids on the use of LV flexibility, either via (short- or long term) flex procurements, or by temporarily limiting grid access for flexible LV assets. See also the section on reasonable grid capacity.

[14] USEF focusses on setting up the full chain by simplifying the components in the chain and therefore typically only looks at transformer overloading (current).

[15] USEF Specifications 2014: I.II," Arnhem, 2015.

[16] USEF expects individual households with flexible assets to generate an accurate day ahead baseline of the household or flex baseline (both variations have been tested). However, the stochasticity of residential consumption and human behaviour is such, that at the level of a single LV connections it will always exceed or be same order of magnitude as the LV flex volume at that connection. Aggregators that make use of LV flex typically overcome this issue by defining aggregated baselines on the level of a 'pool' of hundreds or thousands of flexible devices. At that aggregation level, human behaviour related stochasticity is averaged out. The only method to achieve reliable baselines at the level of the LV connections is via dedicated assets (e.g., a battery used exclusively for a single flex service), or by giving absolute precedence of flex over user comfort ('you can't take the extra shower, because the heatpump baseline does not account for it').

[17] The BDEW projects quickly started focussing on first building solid technical capabilities rather than setting up a full chain, and so typically also looks at feeder under- and overvoltage, and feeder over-currents

[18] BDEW-Roadmap--Realistic Steps for the Implementation of Smart Grids in Germany," BDEW Bundesverband der Energie- und Wasserwirtschaft e.V., Berlin, 2013.

[19] BDEW, "Smart Grid Traffic Light Concept - Design of the amber phase," March 2015. [Online]. Available: https://www.bdew.de/media/documents/Stn_20150310_Smart-Grids-Traffic-Light-Concept_english.pdf.

		✓ PaVn-D (Das Proaktive Verteilnetz) (Innogy/Westnetz): The project focusses on probabilistic grid state forecasts and congestion probabilities. ✓ Grid Control (Netze BW GmbH): Focus is on load flow forecasts. The project also replaced flex requests by nonfirm capacity, where the DSO decide up font how much % of an aggregator's portfolio in a congestion area can be activated. Initially, this is either 0% or 100%.
	Ripple Control	Although technologically obsolete, also the historical schemes to remotely switch off heating appliance via ripple control, such as exclusive night in Belgium[20], or Sperrzeiten mit Heizstrom[21] in Germany, are (simple) traffic light examples. They are relevant, as they to this day successfully unlock 100's MW of flexibility, and hence are good references as to what complexity and remuneration schemes work in the LV environment and are acceptable to residential customers.

To note that the 'congestion area' concept is a subject of research in multiple European projects. It is generally understood as a mechanism for the DSO to freely define custom groups of LV assets and hence flex assets that together impact a specific 'congestion problem'. This can be the transformer, the feeder, or a wider area, all depending on the type and severity of the problem that occurs. Although this intuitively makes sense, it is noteworthy that the technical problem to define and calculate the LV congestion areas is a non-trivial and unsolved problem. Therefore, pilots typically resort to setting the 'congestion area' equal to the MV/LV transformer and connected LV feeders.

2.1.3 Recommendations

Objective 2.1.1: *No time should be lost in attempting to translate MV/HV solutions that are incompatible with the LV grid characteristics to the LV grid. Solutions should be defined starting from the specific LV grid conditions.*

✓ **Regarding the calculation of flexibility volumes:**: it is important that the needs of the market, the state of the grid and the specifics of the LV grid user are taken into account. It could be justified that the DSO's first investigate if a different approach for LV is justified (e.g. individual base lines vs pool base lines). However, this might be an unnecessary step. Based on prior experience, it is highly unlikely that the same approach for MV and LV would work, and we can save time by starting immediately from the premise that a custom LV approach is required. This includes that Elia should be open for dedicated LV ancillary services with looser technical requirements than currently applicable for MV/HV assets, and compatible to the LV grid specificities.

Recommendation 2.1.1: Synergrid members should start from the principle that LV flexibility requires a specific and dedicated approach.

This applies amongst others on possible prequalification mechanisms that use static rules for groups of assets, using group criteria that do not correlate to the grid reality (such as geographic spread). These mechanisms should be critically investigated as they may hamper later rollout of mechanisms that better reflect the grid reality.

In a first step, BRUGEL could consult with Synergrid in the context of the Synergrid market consultation[22] to highlight the need for a dedicated LV approach'- ***Timing: 2022.***

In a second step, further consultation for more dynamic prequalification processes is required (see also recommendations Prequalification (section 4.2.3) and necessary pilots should be established to investigate promising options. - ***Timing: 2025.***

[20] Tarieven > type meter > uitsluitend nachttarief | Sibelga

[21] Sperrzeit: Unterbrechung der Stromversorgung - Elektroheizung-Lexikon (heizungsfinder.de)

[22] http://www.synergrid.be/download.cfm?fileId=Synergrid_Market_Consultation_210401_NL.pdf&language_code=FRA

Moreover, also for other aspects in the process (procurement, activation and settlement) dedicated pilots should be defined taking into account the specific nature of LV flexibility (see also recommendations 'Procurement and activation'(section 4.3.3) and 'Settlement' (section 4.4.3)). ***Timing: 2025.***

Objective 2.1.2: *The role of different flexibility mechanisms (in particular. dynamic connection agreements) should be investigated.*

- **Regarding the relevance of the current exclusive night tariff:**
  Exclusive night can be a relevant starting point for such a non-firm capacity agreement, but only if it is updated and modernized. If successfully adopted by users of the novel large devices (EV, HP, PV+battery, …), it allows deferral of many investments. However, updating ripple control to be more flexible and to be compatible with the deregulated markets is not straightforward, and goes beyond the matter of modernizing the communication and control technology: how many capacity limitations are allowed per day/year, how long they can last, what is the recovery time, which components of the tariff are reduced to obtain a good proposition for the customers, can the DSO make participation obligatory for certain large/flexible devices, ….? Debate may/will emerge on the amount of flexibility the DSO is claiming in this way (see 'reasonable capacity' barrier) and how the DSO control impacts, e.g., BRP perimeters or system balance.

Recommendation 2.1.2: Non-firm capacity agreements are an interesting angle to increase the capacity that can be made available for LV flexibility. The Synergrid members can be requested to consider and investigate this potential solution by a dedicated study. ***Timing: 2022***

Additionally, BRUGEL could propose to Synergrid/ Sibelga to define and set up concrete pilots on its own territory to investigate LV flexibility, e.g. to design and investigate non-firm capacity or other solutions. ***Timing: 2025***

See also Recommendation 4.5.1 – Study on the potential of dynamic connection agreements for LV flexibility in the Brussels Capital Region (section 4.5.3)

2.2 Technical capabilities of the DSO

2.2.1 Barrier

The technical DSO capabilities to support LV flexibility are not readily commercially available.

The visibility on the low voltage distribution grids throughout Europe is limited: the layout of the grids is only partially known, and measurements are limited. Historically this was acceptable, as a low simultaneity factor – a feeder with a capacity of typically 20-30% of the total connected capacity is sufficient to cover the peak demand – allowed a 'fit and forget' strategy with acceptable cost. That is, we install (over dimensioned) cables with sufficient capacity to cover all demand peaks, which avoids the need of operational management of the LV grid. However, the use of the distribution grids is rapidly changing: growth of distributed renewable production (solar panels), electrification of heating and transport (electric car charging and heat pumps), and LV flexibility. These evolutions not only lead to higher loads on the grid, but also to increased synchronicity, which in turn leads to higher peak loads. The result is that the 'fit and forget' strategy becomes increasingly expensive as more and more reinforcements will be required.

The opportunity lies in the fact that the grid load varies strongly in time, and that most of the time, there is ample unused 'spare' capacity in the LV grids. If this 'spare' capacity could be made available when the non-controllable load is low, then the LV grids can support large amounts of flexible devices - or electric vehicle charging or heat pumps – without having to resort to grid reinforcements. This however, requires higher grid visibility and predictability, and the means for the DSO to communicate the constraints of the grids to the relevant stakeholders. The technical capabilities to support this functionality are not readily commercially available. Fit and forget is the applied system today. Most of the required capabilities are missing (e.g. many DSO's don't have a digitalized map of the LV grid topology) or/nor commercially available (e.g. LV grid state estimation,…).

2.2.2 Examples and best practices

Driven by the larger European DSO's, a lot of research projects and pilots are working on this, supported by the energy industry and a wide array of new start-ups. We can expect that the required solutions will become widely available in the next few years.

Country	Case	Best / Worst practice
	BDEW smart grid traffic light projects	See projects mentioned in 2.1.2
	Enedis	Enedis is a good example of a large leading DSO, that actively invests in research and pilots to improve both the LV grid measurement and calculation capabilities to improve the grid visibility.[23] [24]

2.2.3 Recommendations

Objective 2.2.1: *A clear view should be established on the actual and future needs for the grid in combination with a view on the current state of the infrastructure. This allows a more targeted development of the necessary technical DSO capabilities to support LV flexibility.*

In order to further develop the technical capabilities of the DSO, it is necessary to have a good view on 1) which technical capabilities should be developed, 2) by when, 3) followed by a gradual implementation of the necessary tooling.

Recommendation 2.2.1: A detailed study should be set-up to define the impact of future ambitious climate scenarios on the distribution grid of the Brussels Capital Region.
The Brussels Energie-klimaatplan 2030 (NEKP)[25], as approved in 2019 by the Brussels government, sets the high-level climate objectives for the Brussels Capital Region. First step is to translate this plan into a concrete 2030 scenario containing the objectives with respect to the LV distribution grid: to realize the climate plan, how many EVs, EV chargers, HPs, PV systems, etc. will be required by what year? What will be the spread of these appliances across the Brussel Capital Region territory, considering socio-economic factors, and preferably on statistical sector resolution? This study could be a more detailed assessment/follow-up of the Baringa study[26]. (see also recommendation 4.3.2) - ***Timing: 2022***

Objective 2.2.2: *The DSO should be stimulated to execute the necessary R&D activities to develop the necessary DSO capabilities.*

Recommendation 2.2.2: To support Sibelga to continue with the active development of the necessary technical capabilities, BRUGEL could initiate following studies:

1. Recommended study, by Sibelga: Sibelga could be proposed to make inventory of the current state of each MV/LV transformer and each LV feeder and to categorize them in strong, intermediate and weak, with results aggregated for Brussels and at statistical sector, and per the category description below Recommendation 2 in Section 2.4. this study would yield a view on the starting position of the Brussel Capital Region's LV grid, it's strengths and weaknesses. The study can assist the decision process on pro-active investments. *Timing: 2022.*
2. Recommended study, by Sibelga: Given the 2030 electricity scenario, Sibelga could be proposed to extend the results from the study mentioned in the previous paragraph and calculate the impact of this scenario on a per transformer and feeder level, with results aggregated for Brussels and at statistical sector. Sibelga can be asked to make inventory

[23] https://www.enedis.fr/les-demonstrateurs-smart-grids
[24] https://www.enedis.fr/la-valorisation-economique-des-smart-grids
[25] Energie-Klimaatplan (NEKP) | Leefmilieu Brussel
[26] http://www.synergrid.be/download.cfm?fileId=Synergrid_EV_Grid_Impact_ExternalReport_v3_0.pdf

of how many feeders are sufficiently strong, will require reinforcement regardless, or if alternative solutions can avoid congestion (e.g., dynamic prequalification, non-firm capacity agreements or other forms of flex procurement). The total aggregated numbers then give a view on the required future investments, and the potential of flex solutions. The statistical sector results give a view on which districts within the Brussels Capital Region require custom solutions. ***Timing: 2022.***

The value of these studies is further justified in recommendations later in the text. Especially the previous two studies will support Sibelga to start building the technical capabilities listed above.

Objective 2.2.3: *The DSO should be stimulated to execute the necessary pilots to develop the necessary DSO capabilities.*

Recommendation 2.2.3: To support Sibelga to make progress on the active development of the necessary technical capabilities, explicit requirements could be taken up in the technical regulation:

Alternatively, or additionally, via the technical regulations, Sibelga could be requested to build the capabilities to categorize the MV/LV transformers and LV feeders, as described above and in Section 2.4, as a required capability to obtain accurate and future proof LV grid investment plans, and as a required tooling to investigate and quantify the impact and effectivity of technical regulation on, e.g., EV charging, flexibility, PV, etc.[27] ***Timing: 2025***

Objective 2.2.4 *Based on a good view of the needs for the grid and the state of the infrastructure, necessary tools/capabilities should be developed by the DSO to support the uptake of LV flexibility.*

A perfectly accurate layout of the LV grid is technically/financially unfeasible, given its scale, complexity and historic legacy. Rather it is a gradual process of collecting more information and continuous (data quality) improvements. Relevant sub aspects are establishing a grid GIS database, converting GIS data to electrical specs, and validating and improving the grid layout and the data quality via the increasing measurement capabilities and the various grid data enhancement tools that are being developed. With the deployment of more measurements and grid enhancement tools, this first steps overlap and evolves into step two: the improvement of the grid visibility.

The precondition for any LV smart grid functionality is a sufficiently **complete and accurate data base on the layout** and topology of the LV grid. The grid layout comprises of: MV/LV transformer specs and switching layout, cable types and lengths, cable switching configuration, connection location and specifications (including phase connectivity and eventually specs on the connected flexible device collected, e.g., via a device reporting duty).

To move beyond fit and forget, with its rule of thumb-based grid dimensioning, hosting capacity calculations, and static worst-case prequalification, a higher **grid visibility** is required. That is, an accurate view on the voltages and currents in the grid. In first instance this is the voltages and currents historically and today (grid state estimation), but later also tomorrow (grid state/congestion forecast). For HV, and to a large extend for MV, such functionality is commercially available. Yet, this technology is unsuited for the LV grid: they require exhaustive measurements, and the HV/MV tools are not suited for resistive and unbalanced grids, nor are they able to handle incomplete (grid layout) data. As many European DSO's recognize the need for improved LV visibility, it is an important research subject, and novel Power Flow and Optimal Power Flow methods, enhanced with statistical, big data and artificial intelligence techniques are in the pipeline.

An important sub-challenge is the investment decision for measurements capabilities: smart meters, transformer measurements (bus and/or feeder head), and/or in cable routing boxes? What is the resolution of the measurement (quarter hour or more frequent), are measurements collected in a daily batch or real time, etc.? The purpose is not to establish exhaustive measurement (for cost reasons) but to define and set up sufficient data collection points so that in combination with calculations that also use the grid layout data, the grid visibility is improved. Also, this aspect is an important DSO research topic. The smart meters will be discussed in more detail in the next section.

An important advantage of improving the grid visibility is that this information can be used to increase the capacity offered with the current infrastructure, and to invest more efficiently, even without/before LV flexibility:

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[27] For instance, such capabilities would help address and provide evidence based data on the question as to how effective V droop control is, given the urban shorter and denser feeders, and the dominance of 230V delta grids in the Sibelga LV grid.

In parallel to the improvement of the grid visibility, capabilities to **optimize the grid infrastructure** can be set up. An improved grid visibility allows to better categorize grids, better hosting capacity calculations, and allows identification of near to congestion grids before the customer is impacted. Investments is sufficiently strong grids are avoided. A more optimal distinction can be made between those feeders that are too weak and require reinforcements regardless (targeted investments), and those feeders where alternative solutions are possible to increase the utilization of the installed capacity:

- ✓ Optimize the feeder/cable switching configurations;
- ✓ Unbalance has a significant impact on the voltage profile, although less so for 230V grids. Rebalancing the mono-phase connections is a cheap method to mitigate voltage congestions due to such unbalance problems;
- ✓ In very specific circumstance, OLTC transformers or autotransformers can be a cost-effective solution;
- ✓ And finally: identify the grids were the use of flexibility can successfully avoid voltage or current congestions.

Finally, necessary tooling and communication procedures need to be developed **to communicate the grid state** to relevant external stakeholders

Finally, grid constraints can be calculated based on sound academic approaches. Grid constraints hide the grid complexity, yet efficiently communicate capacity constraints to the involved customers, energy actors and market platforms. The exact grid constraint formulation depends on the flex market design, and the role of the DSO with regard to the use of flexibility[28], but are always required to move beyond static prequalification.

The technical LV capabilities described above are not readily available. So, the questions emerge: should Sibelga, as a medium sized DSO, wait and follow the larger European DSOs or should they proactively investigate and push solutions, e.g., via teaming up with the other Belgian DSO's in pilots? For Sibelga, as a medium sized DSO, setting up partnerships with the other Belgian DSOs seems the better course.

The basis for such a partnership between the Belgian DSO's is already formed: Atrias, the sharing of digital meter technology, the common vision established via Synergrid, the participation of all Belgian DSO's to the ALEXANDER Federal Energy Transition Fund proposal, where the common vision will be further elaborated with the support of the Belgian research and academia partners. The Belgian DSO's combined have the size to develop smart grid solutions, tailored to the needs of the Belgian grids. This cooperation is to be encouraged and further developed.

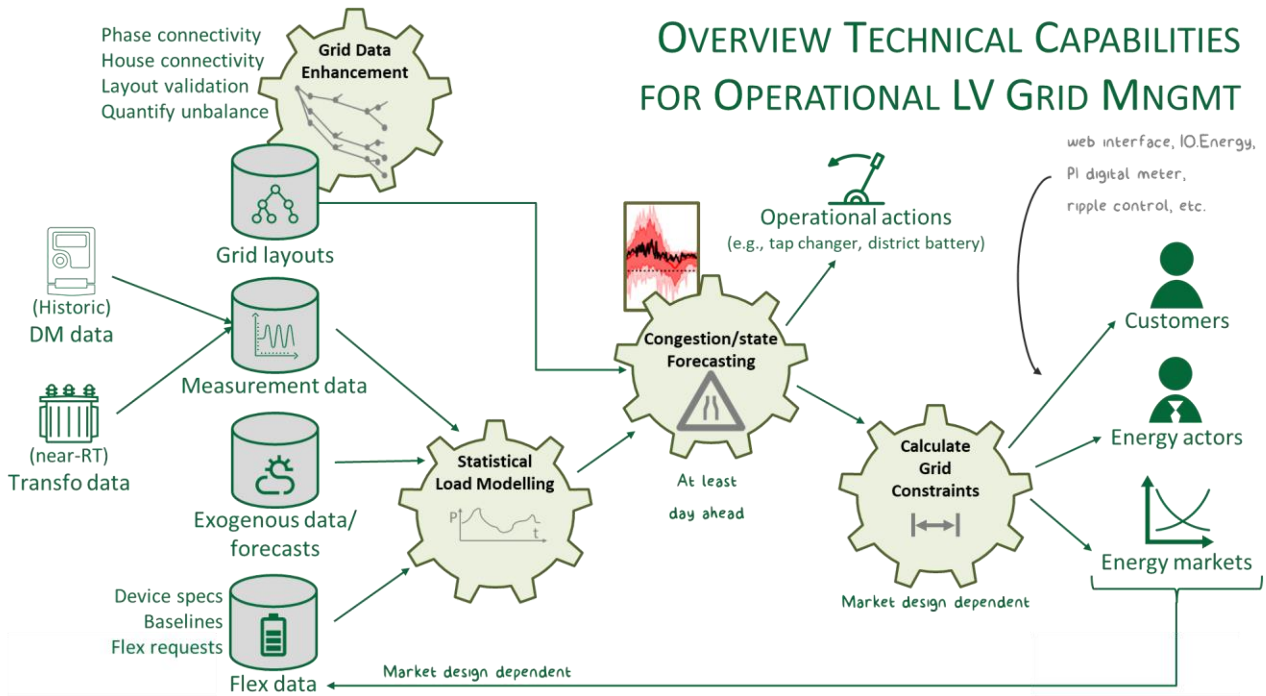
Recommendation 2.2.4: To maximally support LV flexibility in BCR, Sibelga would need following technical capabilities to be able to communicate the grid state:

1. Accurate grid layout database - A necessary step is the set-up of an accurate grid lay-out database according to the best practices and criteria as explained before - ***Timing: 2022.***
2. Accurate view on the grid state (better grid visibility) – a second step is the development of the capabilities to obtain an accurate view on the grid state - ***Timing: 2022.***
3. Optimal infrastructure – in parallel with the previous step. The assessment of the optimal infrastructure should be incorporated/aligned with the investment plan 2022 - 2026 as presented by Sibelga[29] ***Timing: 2022 - 2026***
4. Communicate the grid status externally - ***Timing: 2025***

For Sibelga, as a medium sized DSO, and given the specific elements of the Brussels Capital Region, the pro-active way forward to continue to develop the required LV technical capabilities to fully support LV flexibility, is through partnerships and cooperation with the Belgian DSO's.

[28] Aspects are, e.g., is the DSO to procure flex, or can the DSO enforce capacity limitations on flex assets?, if the DSO can limit the capacity for flexible assets, is the availability of capacity defined individually per connection, or set at the level of the MV/LV transformer so the flex market can decide what connection receives how much of the available capacity?, etc.

[29] https://www.brugel.brussels/publication/document/notype/2021/nl/Investeringsplan_Elek.pdf



Source: EnergyVille

2.3 Smart Metering

2.3.1 Barrier

Smart metering is not static, but evolving technology, with discrete feature jumps in sync with the rollout of the subsequent smart meter generations. This has led to large differences between the European countries, with large variations in support for flexibility.

When the specifications of a new generation of smart meters is defined, an important challenge for the DSO is to decide in which features to invest and to strike the correct balance between being future proof for the next 5-10 years and avoiding overinvestment. There are many – typically national/regional – factors that influence this decision process:
- ✓ Local regulation and tariff structure;
- ✓ Public opinion on smart meters and privacy concerns;
- ✓ Local grid characteristics (3N400V vs 230V, budget meters or not, fraud level, dense urban vs remote rural, …);
- ✓ DSO LV roadmap (see Section 2.2);
- ✓ Prior smart meter legacy and experience, which is a function of the time of the initial smart meter rollout.

Consequence is different speeds of deployment, and a large variety in technologies deployed across Europe. There are differences in:
- ✓ The meter-backend communication technology;
- ✓ The user interface technology;
- ✓ The measurement quantities;
- ✓ The meter reading accuracy and frequency;
- ✓ The method of user access to the measured data;
- ✓ Opt in/outs choices.

This poses large interoperability challenges for applications that make use of the smart meter, including and specifically manufacturers of smart appliances, home energy managers and aggregators. This to the extent that internationally active manufacturers often resort to installing a proprietary electricity meter, rather than supporting the large variety of meters in Europe.

Specifically, regarding the (P1) smart user port:

- Consent management can hinder use of the (P1) smart meter user interface data by aggregators or other energy actors;
- It is not evident to collect qualified data by the data manager from the P1 port. Not so much to readout the meter via the P1 port, but more specifically to reliably get the data from the dongle to the data using parties. Communications from the P1 to the data manager backend via a dedicated (wireless) channel is (too?) expensive, and via the owner's internet connection (too?) unreliable;
- There is no European smart meter user port standard. For international players a proprietary meter is often preferred to support all user port protocols.

2.3.2 Best practices

Today it seems that most EU countries have not reached the E.U. smart meter rollout target. Only Spain, Italy, Norway, Sweden, Estonia and Finland have reached an over 90% penetration rate in 2020[30]. In many countries, it takes time to deploy smart meters. Most noticeably in this example is probably Germany (see below for more details). Some of the pitfalls and success factors of smart meter implementation strategies are summarized below as an example. Together they illustrate the high variability in smart meter setups across Europe.

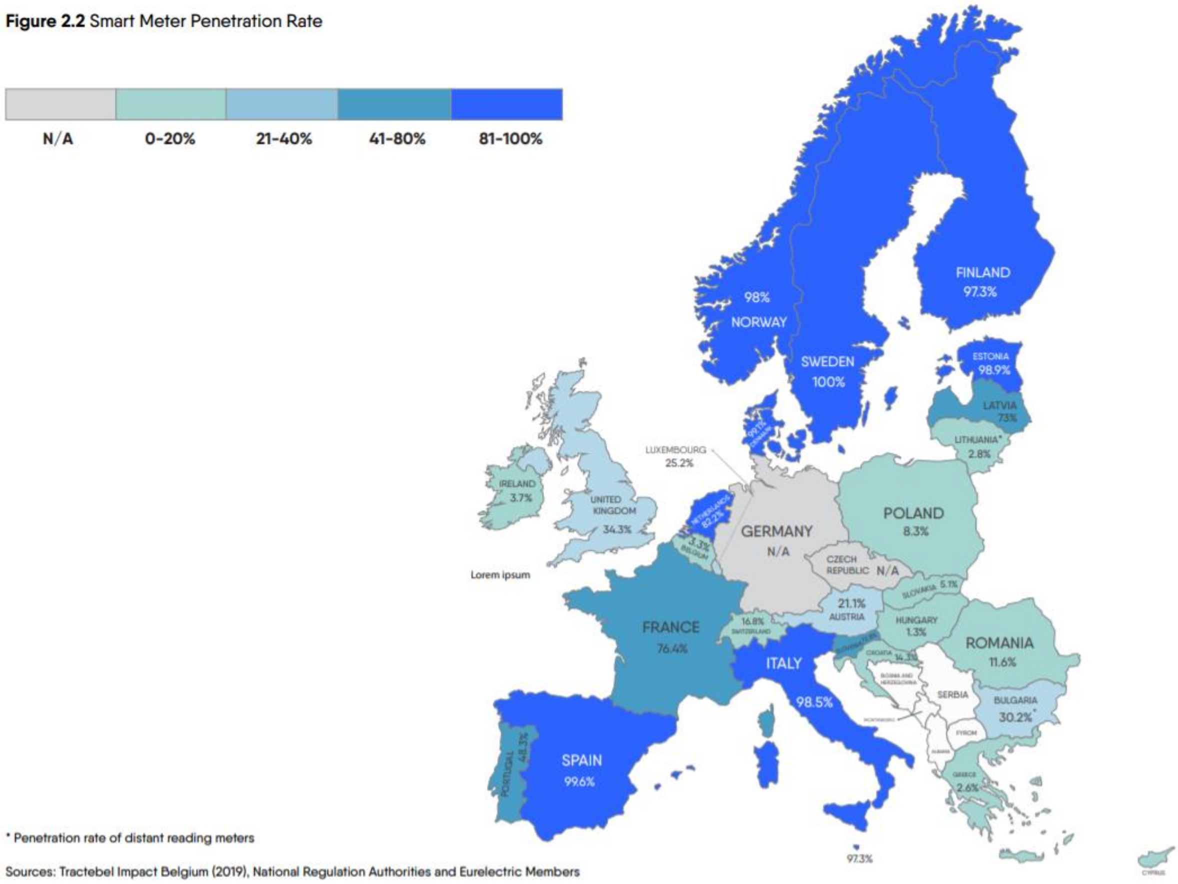


Figure 3 - Smart Meter Penetration Rate (Source: figure 2.2 Eurelectric 2020)

Country	Barrier	Best / Worse practice
	Perceived/proven benefits of the smart meter	In Flanders, there is a clear misperception about the benefits of the digital meter, as for many prosumers it is linked to the abolishment of net metering. There is a difference in tariff methodology between people with and without a digital meter, where people without are perceived to be better off. This

[30] Eurelectric 2020 https://cdn.eurelectric.org/media/5089/dso-facts-and-figures-11122020-compressed-2020-030-0721-01-e-h-57999D1D.pdf

		does not only apply for net metering: the new capacity tariff will be charged at a minimum capacity of 2,5 kW for people without a digital meter.
	Rollout speed	Germany resisted smart meter role out for a long time due to a negative cost-benefit analysis[31]. In January 2020, the large-scale roll-out of smart meters with consumers of over 6.000 kWh yearly consumption has started. Previously, the roll-out focused only on large consumers with average annual consumption more than 10.000 kW. While the slow conservative approach in the role out of smart meters in Germany has been criticized, a benefit of this is that they now have a tailored roll-out strategy and can avoid economic pitfalls that early adopters faced[32]. The smart meter rollout in Germany is currently on hold due to a legal dispute on the smart meter tendering.
	Deployment strategy	In the Netherlands, there has been a lot of controversy regarding privacy issues and measurement accuracy failures[33]. As a result, consumers have the right to opt-out from the meter, or from remote meter readings (about 8% does this).
	Deployment strategy	In countries such as Norway and France, smart meter implementation is obligated. This ensures a higher penetration rate of smart meters[34].
	Perceived/proven benefits of the smart meter	In Sweden[35], smart meter implementation was highly welcomed by consumers as the earlier electricity billing system was perceived to lead to inaccurate invoices, data errors during switching, long settlement periods resulting at large invoices at once… There was a widespread dissatisfaction about energy utilities and consumer organizations were pressuring demand for improved billing systems.
	Regulation	Swedish[36] regulation had an important role in the entire process of smart meters. They mandated out-roll by 2009 for all residential consumers, they adapted the remuneration formula to provide qualitative incentives to DSOs that reward peak shaving and reduced system losses. For the second smart meter roll-out they have set up a list of suggested metering functionalities that will be required by 2025.
	Evolving technology	ENEL (IT) was a very early smart metering pioneer, with the initial rollout as early as 2001[37]. This first smart meter rollout had a very short payback time thanks to fraud detection. The technical capabilities were very limited, however: only 3 registers with a monthly readout, no user port, no encryption, slow communications (9 months to deploy firmware upgrade), and unsuited for asset management (e.g., the voltage measurements did not meet EN 50160 compliancy). In 2016, generation 2 was launched, and with a large technological jump: daily readout of 96 quarter hour values, a PLC based user port, multichannel communications (PLC & radio), and improved PQ measurements to support asset management, including voltage, interruption events, P/Q, etc.

2.3.3 Recommendations

Objective 2.3.1: *The definition of the specifications of the next generation smart meters should be done well in advance to ensure that the smart meter supports both current and future system/consumer needs.*

[31] https://www.cerre.eu/sites/cerre/files/140331_CERRE_SmartMetering_Final.pdf

[32] https://www.bne-online.de/en/news/article/smart-meter-roll-out-the-german-case/

[33] https://www.energievergelijken.nl/slimme-meter/slimme-meter-weigeren#:~:text=80%25%20aan%20slimme%20meters%20voor%202021&text=Nederland%20is%20dan%20namelijk%20in,halverwege%202019%20een%20slimme%20meter.

[34] https://www.cerre.eu/sites/cerre/files/140331_CERRE_SmartMetering_Final.pdf

[35] https://www.diva-portal.org/smash/get/diva2:1232060/FULLTEXT01.pdf

[36] https://www.diva-portal.org/smash/get/diva2:1232060/FULLTEXT01.pdf

[37] Smart Meter vision - Eurelectric – Powering People

Recommendation 2.3.1: Specifications next generation smart meters

Defining the specifications of the next generation smart meters is a key decision point that cannot be underestimated, and - although not limited to it – includes various aspects impacting the support of flexibility. Based on the lessons learned in the other European countries, and considering the specificities of the Brussels Capital Region's grid, Sibelga will need to carefully consider and list which features to invest in. This should be supported by detailed stakeholder consultation about current and future needs. - ***Timing: 2025***

Objective 2.3.2: *The definition of the specifications of the next generation smart meters should consider the specific context of LV flexibility.*

When specifying the next gen smart meters, defining decisions are made regarding the smart meter support for various aspects related to the support of LV flexibility:

- Collection of qualified data to support flexibility, e.g., support of submeters, P/Q data, etc.
- Measurement capabilities to support the rollout of the DSO technical capabilities to support flexibility as listed in Section 2.2) Decisions are needed on the availability of data for the management of the grid (consent management[38]), opt-outs and rollout speed (when are how many data points available), and granularity of data collected (always quarter hour, or only for selected locations).
- Communication capabilities to communicate flexibility related information via the user communication port:
    - Measurements quantities and resolution;
    - Tarif, capacity, or other grid constraint information.
- Method to allow third party access to smart meter data (consent management method).

Recommendation 2.3.2: **The requirements for the next gen smart meters should support the further uptake of LV flexibility:**

1) Smart meters should be able to collect qualified data from submeters (subject to FDM role decisions).

2) The measurement quantities supported by the Flemish digital meter provide a good starting set. However, there are specific points of attention or improvement:

1. Resolution of all quantities should be sufficiently high to support LV flex use, but also to allow Sibelga to obtain an accurate view on the state of the LV grid. Typically, this is at least 0,1 V/A/W.
2. (Phase) current measurements should have a sign (positive for offtake, negative for injection).
3. Default smart meter technology uses the 2W meter method. This should be avoided, as for 3phase meters in 230V grids the 2W meters method results in measurement data not being available for one of the phases.

3) The user port protocol should support the future extension with information on the capacity and state of the grid, passed from the DSO via the digital meter to the user or aggregator (grid constraints, non-firm capacity settings, ...). The free text field in the Flemish P1 protocol is an example of such a mechanism.

4) To support improved asset management capabilities and higher grid visibility, the rollout strategy should ensure that there are digital meters in every feeder that pass quarter hour measurement data, with priority for large consumers/prosumers and end-of-feeder connections.

5) To protect privacy, explicit consent is required to activate the P1 port or to give third party access to smart meter data. However, if too complex, this consent management becomes a barrier. Good practises can be found in the examples of the U.S. Green Button[39] or the Netherlands[40].

- Timing dependent on official planning smart meter

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[38] As illustrated from the Flemish example. In Flanders, retrieval of quarter hour data or opening the P1 port requires explicit consent from the user, via the Fluvius user portal. Logging in to this portal (complex authentication), and then selecting the correct options is technically challenging for many customers. Feedback from aggregators is that convincing and guiding potential customers for this aspect alone has a cost that exceeds the benefits of the LV flex.

[39] https://www.greenbuttondata.org/

[40] www.edsn.nl

2.4 Grid investment and reasonable capacity

2.4.1 Barrier

There is a tradeoff between providing capacity for flexibility, capacity for electrification, and restricting flexibility via grid constraints to avoid reinforcements. What is the reasonable capacity that a DSO should provide?

The grid is dimensioned for traditional non-controllable load, using the fit&forget system. At the core of this, lies the simultaneity factor based pragmatic 'rule of thumb' system to handle the complexity of cable capacity calculations. As explained before, the historic low simultaneity factor allowed us to obtain reliable supply of electricity using underdimensioned grids.

However, the assumptions underlying the simultaneity factor calculation become invalid if offtake (or injection) peaks grow or the offtake patterns change. This is case for the large-scale rollout and combination of electrification of transport and heating, decentralized production and LV flexibility. These novel grid loads in a sense 'compete' for the remaining grid capacity, where current infrastructure does not provide reliable sufficient capacity for all.

The traditional choice for the DSO is then either to reinforce and accommodate the novel loads and their patterns in all circumstances (with the sub choice of whether the costs of this are socialized or to be financed by the customer that adds the loads that may push the feeder into congestion), or to permanently prohibit access to the grid (static prequalification). The development of an operational chain for the LV grids extend this with the option to limit the grid access in risk of congestion circumstances to avoid investments in rarely used capacity. Either the DSO will have to strongly increase the capacity installed per connection (leading to more but rarely used reserve capacity), or the visibility on the LV grids is improved to reduce the capacity margins necessary, which can be further pushed down via non-firm capacity/dynamic prequalification/flexible connections/tariffs with the correct stimuli/technical rules.

Yet every time the DSO limits grid access (permanently or temporarily), and regardless of the form (prequalification, non-firm capacity, …), the DSO effectively claims flexibility via grid constraints to avoid grid investments or to give priority to e.g., fast charging. This is justified if the cost of the reinforcements outweighs the benefits or the (societal) value of the flexibility. But on the other hand, the DSO should not limit the access to the grid as to avoid necessary investments, but rather provide 'reasonable grid capacity' at all times. Grid reinforcements, capacity for electrified transport and heating, and capacity for flexibility, must be carefully balanced to optimize societal costs versus benefits.

Additionally, the question emerges to what extend the DSO should reinforce proactively and then expect the market to work on that given situation (safe option, but may lead to overinvestment)? Or whether the DSO should wait for the market to act and only then invest in function of the outcome of market, i.e., where congestion emerge (at the risk that this may become too late or unmanageable with loss of quality of supply)?

2.4.2 Best practices

Country	Barrier	Best / Worst practice
	Reasonable capacity	Solar production installations that exceed 5kWp or 10kWp are subject to extra limitations to mitigate the impact on the grids[41].
	Reasonable capacity	Germany has a reporting/prequalification duty for vehicles chargers that exceed 22kW[42].

[41] Synergrid Technisch Voorschrift C10/11

[42] For installations that exceed 22kW, the obligated and custom grid study can result in limiting the allowed amount of charging, very much comparable to the current Belgian prequalification system.

2.4.3 Recommendations

Objective 2.4.1: *Considerations on grid capacity and LV flexibility should also take the other changing capacity needs into account, i.e., electrification of transport and heating, and decentralized production.*

Recommendation 2.4.1: Future 2030 scenario for the LV grid in BCR should be established

The study, as proposed in Recommendation 2.2.1 of Section 2.2, is the first step to generate the future 2030 scenario for the LV grid in the Brussel Capital Region which could be further integrated in the future studies and investment plans of Sibelga to ensure that all relevant grid evolutions are accounted for. - ***Timing: 2022***

To break the 'invest proactively' or 'invest in function of the market needs' chicken or egg problem, Sibelga can be requested to launch the studies, as proposed in Recommendation 2.2.2 of Section 2.2, which results in the categorization of the MV/LV transfo's and LV feeders into strong, intermediate, and weak; both for today's situation and for the 2030 scenario. - ***Timing: 2022***

Objective 2.4.2: *A clear categorisation of the state of MV/LV transfo's is necessary to ensure the right investment decisions.*

Recommendation 2.4.2: Categorisation of the state of MV/LV transformers to support investment decisions.

To break the 'invest proactively' or 'invest in function of the market needs' chicken or egg problem, Sibelga could execute the studies, as proposed in Recommendation 2.2.2 of Section 2.2, which results in the categorization of the MV/LV transfo's and LV feeders into strong, intermediate, and weak; both for today's situation and for the 2030 scenario.

Following categorisation is proposed:
1. **Strong**: sufficient capacity to withstand current and foreseen future evolutions. No reinforcement required, but also no business case for flexibility for LV congestion management;
2. **Weak:** reinforcements are required soon and/or regardless;
3. **Intermediate**: the asset does/will/may run occasionally into congestions. This category gives opportunity to investigate (market based) alternatives to reinforcement, such as dynamic prequalification, non-firm capacity agreements or other forms of flex procurement Note that a relevant sub-study would be to make inventory of the flexibility needs/grid constraints for this category of grids. The latter would be highly relevant information for the LV flexibility market design process.

The approach could be proposed for the current and/or next iteration on the **Sibelga electricity investment plan**, presented for consultation in June 2021[43]. Sibelga could integrate the results of studies proposed in recommendation 2.2.2 of Section 2.2 in the future investment plans. Sibelga could take the improved view on the state of the LV grid into account in its current and upcoming investment plans, and invest proactively, and/or when opportunity presents itself, in the assets in the weak category.- ***Timing: 2022 - 2026***

This also requires that the DSO first (partly) develops the necessary capabilities as recommended in section 2.2.

Objective 2.4.3: *The enforcement of grid constraints by the DSO should be based on transparent criteria, maximizing the participation of LV flexibility in a cost-efficient and grid safe manner.*

When enforcing grid constraints, the DSO utilizes flexibility that cannot be used for other flexibility applications. The DSO can be incentivized to strike the right balance between providing capacity and claiming flexibility by:
1. Financial incentive by remunerating the customer for respecting the grid constraints, which is non-trivial in the LV environment;
2. By defining minimum reasonable capacity when the DSO can enforce grid constraints without remuneration.
Which option is the more efficient is to be further investigated

[43] Investeringsplan_Elek.pdf (brugel.brussels)

Setting up a financial incentive, where the DSO reimburses the flexibility used to respect grid constraints, is challenging, as the system needs to be compatible with the LV environment. See for example the USEF experiences If non-firm capacity agreements are considered, the question is what distribution tariff reduction is required to incentivize sufficient people (on the weaker feeders) to participate, where the total cost for the DSO (including the cost for people that choose for a nonfirm capacity agreement, but are located on strong feeders), does not exceed the benefits. This exercise should not only focus on the advantages versus costs of flexibility but should also take electrification and decentralized production into account.

If the option is considered to allow the DSO to impose grid constraints without reimbursement, then it becomes necessary to define what reasonable capacity the DSO should minimally provide for each connection. At the core of this issue is the question of what capacity should be reliably available to all citizens, the costs of which are socialized. Is slow EV charging part of this, or should we even guarantee fast charging for all, etc. This is a policy question.

For the sake of the example let's say that all citizens should have guaranteed access to sufficient capacity for regular electronic devices (TV, mobiles, PC, lighting, ventilation, white goods), electric cooking, a small PV installation, EV slow charging, a small HP, and offering flexibility services with those appliances. Which can be translated per category in a capacity requirement, which would typically sit in the range of 2-4kW per device category (our intuitive estimate).

First option is to translate this into a fixed capacity (e.g., somewhere in the range of 9,2 - 14,7kW, our intuitive estimate). To calculate this properly would require a study on the use of these devices, typical consumption patterns, resulting simultaneity factors, etc. It is then the customer choice as to how use this fixed guaranteed capacity (e.g. no heat pump, but faster car charging). If a customer requests more capacity, any resulting reinforcements can be (partially) reimbursed via the customer. Or, if that option is available, the customer can agree to a non-firm capacity agreement.

Alternatively, the minimum set of electric services can be translated into rules per device type. E.g., when you install a slow charger for an EV, you are free to do so and capacity is guaranteed. If you want to fast charge, then you must request this to the DSO, with potentially reimbursed reinforcement costs or non-firm capacity agreement if the situation so requires.

The prior exposé merely indicates how to tackle the issue. To answer the question of reasonable capacity with evidence-based figures, proper studying and analysis is required, careful consideration of advantages and disadvantages, impact on the various types of users (energy poor, SME's, …), impact on investment cost, etc.

Recommendation 2.4.3: **before defining what should be considered as 'reasonable capacity', more research and stakeholder consultation is needed.**

A study is recommended to investigate the options as explained above. In addition, to determine an adequate answer to questions what should be considered as part of 'reasonable capacity', stakeholder consultations are recommended.

- *Timing: 2022*

This recommendation should be considered together with the recommendations provided in section 4.2 on Prequalification and section 4.3 on Procurement and Activation.

An option of a shorter term unblocking could be to allow FCR access for devices that comply to a static set of conservative (power and/or density) specs, potentially with a V droop fall back. This approach is valuable. Moreover, there is no strict reason to limit such a set of rules to FCR only. A generalization to a simple prequalification mechanism for limited use of flexibility for any flexibility product – including, but not limited to FCR – is feasible. This can take the form of, e.g., x kW/connection for any use (technology and application agnostic), or x kW/device type, as per the earlier discussion on defining reasonable capacity.

Regarding voltage droop control: this is an example of a mechanism that allows the DSO to 'claim' flexibility to avoid congestions and hence requires clear agreements on when capacity is not sufficient and reinforcements are required.

To note that, although the feeder length is indeed an important factor to assess voltage droop, it is not the only one: also, cable material and segment, transformer tap setting, phase unbalance, grid type (230V vs 3N400V), and density of the connections play a role. This is an example of where having a clear view on the Brussel's LV grid, with a technical categorization of the feeders, is important, as it would provide solid data to decide on the effectivity of Voltage droop. The Brussels Capital region, would intuitively have more feeders were overcurrent problems occur before under voltage congestions. But even then, the voltage would start dropping before the current becomes an issue and hence the voltage can be used as an indicator of (too) (heavy) load. V droop control could still be an effective measure. It is possible, however, that the technical specs of the droop control (dead band limits, slope) need be adapted for the Brussels situation. To do so, again, would require a better view on and inventory of the topology and state of the feeders in Brussels.

3 End user perspective

In recent years there has been an ever more increasing focus on the active participation of the end customer (both residential customers as companies and public players) in the energy market to cope with the challenges related to the energy transition. Especially since this end customer can help with the generation of renewable energy, but also with the integration of this energy in a more flexible energy system.

The advantages and added value of the end consumer is also acknowledged by European policy makers. Consumer empowerment and providing 'a fair deal for consumers' is one of the key pillars of the Fourth European Energy Package or the Clean Energy for all Europeans Package. In the legislative proposals, which support the European Clean Energy vision, specific proposals and measures are foreseen to create a level playing field for all consumers within the energy market. To put consumers at the heart of the energy market Member States are to elaborate regulation and supportive actions to, i.e.;

- Facilitate dynamic pricing,
- Entitle them to generate, store, consume and sell self-generated electricity in all organised markets
- Facilitate the participation in flexibility markets individually or via an (independent) aggregator
- Create a framework for energy communities and energy sharing

Given the pivotal role of the end consumer in the future-proof energy system one should make sure that all elements are in place to guarantee that consumers are engaged. Moreover, to engage the consumer, the importance of trust will be essential. To ensure trust and support engagement, several factors will play a role. This engagement is particularly influenced by the level of knowledge and the ownership of smart appliances and flexible technologies. Educated and conscious consumers are more willing to invest time and financial means to assist energy markets and market stakeholders. Given the inherent complexity tied to energy markets and energy activities in general, it is necessary to dedicate sufficient time and effort to involve vulnerable consumers as well. One should pay attention to the potential risks of new technologies on vulnerable consumers as they are more likely to be confronted with difficulties in accessing energy and new smart grid opportunities. For example, a study carried out by the British regulator Ofgem has identified that low income working households may be adversely affected by new pricing practices as they are less able to adapt their house and behaviour or invest in smart appliances and are often forced to use it at peak times[44].

Hence, this chapter zooms in on the aspect of the end consumer, both from the perspective of the signals or price incentives received as from the perspective of the characterizing factors which define the end consumer, see figure below. The aspect of a direct flexibility request is greyed in this figure since it is part of the discussions in chapter 4.

Figure 4: End-user perspective

[44] https://www.ofgem.gov.uk/sites/default/files/docs/2008/04/vulnerable-customer-engagement-with-the-energy-market-research-report.pdf

In the following sections, barriers, best practices and recommendations are presented related to; Consumer engagement and Consumer knowledge (3.1), Collective flexibility (3.2), Vulnerable consumers (3.3), Smart appliances (3.4), Tariff methodology (3.5) and Commodity pricing (3.6).

3.1 Consumer engagement and consumer knowledge

3.1.1 Barriers

Category	Barriers
Comfort & convenience	• Trigger for action: End-users perceive reviewing energy options as a time-consuming activity. A trigger is needed to provide an external push to be engaged/shift/switch… • Comfort is key and should not be questioned nor impacted unless it is incorporated in a comfort service package and the impact on the end consumer is remunerated accordingly
Control	• Loss of control over appliances if there is no override function • Loss of control over actions (e.g. vendor lock-in)
Knowledge & information	• Understandability: Smart grid technologies, market products, price and tariff signals,… are quickly perceived as too complex • Accuracy of data and feedback is essential • Knowledge currently confined and limited to certain groups of users.
Incentives	• Significant savings are needed to trigger participation, but financial incentives limited • Other incentives more stimulating but more difficult to identify
Novelty	• Risk averseness and conservative attitude • Deeply rooted routines and difficulty to tailor products and services to this individual level
Societal impacts	• Perceived adverse health effects (electro-magnetic radiation) • Cross-subsidies between engaged and non-engaged consumers • Discrimination in commercial offers

3.1.2 Best practices

Country	Barrier	Best and worse practices
	Knowledge and information; Social process	Energy Party[45] is a concept like the early "Tupperware parties". One household organises an energy party where a professional energy consultant will be present to guide discussions on energy savings. The organizing households invites friends and neighbours to join the discussion.
	Comfort and convenience	Nuon has over the past years highly focused on making the shift to a company that is more customer-centric and that puts the experience of the customer central. The Nuon consumer service is now organised around two core customer journeys – becoming a customer and being a customer. The cross-functional customer journey teams are controlling the full customer experience and working every day to improve it. The 'journey teams' are striving, not only to functionally meet, but to emotionally exceed customer expectations, thereby creating a sustainable relationship.[46]
	Incentives; Comfort and convenience	An app[47] is designed to change household behaviour to shift energy usage to off-peak hours as well as to reduce overall load. In return for completing specific suggested actions, the participants receive points that can be designated for specific charities.
	Comfort & Convenience ; Novelty	GreenFlux[48] has enabled the possibility of 'High Priority' on the smart charging app. Participants were able to view their charging session and request high priority, which temporarily prioritized their current session over others for which no priority was requested. This was necessary to gain trust and acceptance. Results show that requests for high priority occurred for 2-3% of the charging events, indicating that EV drivers only use it when it is necessary for them.

3.1.3 Recommendations

Objective 3.1.1: *In order to get the end consumer involved and to encourage them to use flexibility, while also taking energy consumption into account, the provision of comprehensible information is a core aspect. Therefore, following elements need to be in place:*
1) Availability of accurate measurement data and feedback towards the end-consumer
2) Availability of self-explanatory and easy-to-use feedback tools
3) Clear communication of (economic) benefits to the end consumer

Accurate measurement data is a requirement. Grid users quickly become frustrated when it turns out that the feedback they receive about their energy use or flexibility provision does not match, for example, in the context of billing data. Accuracy of feedback is a precondition for effective behavioural change. As the responsible party for the certified data, registered on the digital meter for billing purposes, the DSO needs to make sure that the registered data is reliable, and malfunctions are limited. Especially since this data is used for settlement and reconciliation, accurate data is indispensable for multiple market stakeholders. Furthermore, the data registered via the other communication portals of the digital

[45] https://www.energyparty.nl/energyparty-starten/
[46] https://www.pwc.se/sv/pdf-reports/customer-engagement-in-an-era-of-energy-transformation.pdf
[47] CityOpt
[48] https://www.greenflux.com/

meter and connected devices from commercial parties (e.g. aggregator or energy supplier) should be trustworthy as well. Accuracy of feedback is a precondition for effective behavioural change.

The ease of use of the feedback tool is also crucial. In general, the motto is: "The easier, the better" ("plug and play"). If households are expected to install smart plugs themselves, on generally hard-to-reach appliances (built-in refrigerators, dishwashers, etc.), this can be a significant barrier. Services providers like FSPs and energy suppliers can dedicate specific attention to facilitate the ease of use and take over as much complexity as possible to maximize the willingness to be engaged and active in the energy market. Especially since these commercial stakeholders experience clear benefits from the provision of flexibility their efforts will pay off.

In addition, it is important not to communicate purely in terms of financial gains. The satisfaction resulting from energy savings or provision of flexibility should not be sought solely in the financial field, but can also be stimulated, for example, through the introduction of game elements (social competition or competition against yourself). Giving feedback on the reduction of ecological impact because of the behavioural change (e.g. avoided CO2 emissions) can also be considered.

The way in which feedback is given should be meaningful from the point of view of the grid users involved:

- A global feedback (e.g. on the total flexibility provided or energy saved) says little. It also gives grid users no indication of what they can do to reduce the energy consumption or total energy bill; Ideally, feedback is provided per room (for heating) or per appliance, related to the activities of the relevant grid users (lighting, washing, drying, cooking, etc.);
- In addition, it must be possible to indicate, based on the real-time feedback, which devices are switched on at any time. Families must be able to immediately discern the consequences of their actions (e.g. switching off light has an impact on electricity consumption);
- In addition, the feedback should also contain tips on effective behavioural changes (e.g. 'turning the thermostat down one degree gives you an energy gain of x%).
- In addition, give grid users the opportunity to evaluate the behaviour themselves. It is important to provide feedback based on insights into the reasoning households make to decide whether they have done 'enough' to obtain savings on the energy bill. In that regard, the following forms of feedback are promising: Comparison with own consumption (the previous day, the previous week, last year); Comparison with energy consumption of comparable households (social comparison); Comparison with an individual performance standard; Visual feedback (green/red lights, happy/sad faces).
- It is important to consider what grid users are prepared to sacrifice on comfort to achieve energy bill savings. For example, questioning certain practices can possibly cause a negative attitude because certain forms of behaviour (e.g. showering x times a week) are considered non-negotiable. There is usually a willingness to take action in the following areas: Switch off devices or do not put devices in standby mode; Use appliances less (e.g. only set up the dishwasher when fully loaded), stop using them (e.g. if it turns out to be too expensive) or use them in a different way (e.g. use the dishwasher at a lower temperature);
- Short-term pilot studies (usually < 6 months) show that after a while in-home displays are viewed less, and less attention is paid to energy bill savings. This can be mitigated to some extent by switching to other forms of feedback in the longer term, for example by 'alarming' households about unusually high energy consumption or high energy bills.

Recommendation 3.1.1: Study on feedback tools and information needs from the end-consumer perspective

Further research is needed on the needs and preferences of the end-consumer in terms of information provision and end-user solutions and apps as part of flexibility provision (being it explicit or implicit). Such a study could be specifically targeting consumers within the Brussels Capital Region and should also involve actual consumers (via surveys, focus groups,…). Relevant parameters related to consumer preferences in the context of LV flexibility participation, could be obtained from the first-year results (expected mid 2022) of the ALEXANDER project (Energy Transition Fund)[49]. ***Timing: 2022-2023***

Alternatively, such a study could also be performed at a national level. Such a study could also be part of a more general study (see Recommendation 4.3.1).

[49] Energietransitiefonds | FOD Economie (fgov.be)

After this initial phase the proposed solutions should also be piloted. During the study stakeholder consultation is needed, including consumers, aggregators, DSOs, the TSO, regulators,… Best practices with respect to relevant pilot for LV consumers, considering consumer preferences and feedback mechanisms could be obtained from expected outcome of upcoming pilots within IO.Energy 2.0 (results expected mid 2022)[50]. ***Timing pilots: 2023-2024.***

Objective 3.1.2: *Advanced profiling of consumers should guide consumers in more optimal decision making (investments and commercial energy offerings) due to better information tailored to the individual needs of the consumer.*

It is to be expected that most consumers themselves will not have a good idea of the options for offering flexibility nor the different values at play when offering a flexibility service.

In analogy with the financial sector (risk profiling for potential investors), 'consumer profiling' can be carried out for consumers in the energy market. Investor profiling was imposed on the financial sector to increase investor awareness of their financial risk preferences and to check whether certain investments match an investor's risk profile. For example, an analogous consumer profiling for energy users could be proposed.

Recommendation 3.1.2: Consumer profiling' for flexibility consumers in the energy market should be executed to guide consumers in making the correct decisions (e.g. investment decisions and commercial offerings)

Consumer profiling for energy users could include following components:

- A questionnaire or measurement data from the digital meter can be used to check which devices are present in the end user's home. Based on this data, the end user can be made aware of the possibility of saving energy or offering flexibility
- Based on a questionnaire that assesses the importance of various criteria - e.g. desired control over appliances, desired complexity of contract/energy service, desired security with regard to the energy bill, privacy and control over personal data, desired compensation for providing flexibility, etc. – the preferences of the end user can be visualized
- On the basis of the two questionnaires mentioned above, an indication can be given about the type of contract that best suits a particular consumer profile (e.g. a traditional settlement based on a uniform kWh price, a TOU contract, a contract based on dynamic pricing, a contract based on direct control over certain devices, etc.). The ultimate choice for a particular energy service/contract remains the ultimate responsibility of the consumer, of course.

It seems logical to entrust consumer profiling to the providers of the flexibility services. However, a national or regional authority should, within the framework of an adequate market surveillance, be responsible for issuing uniform guidelines for the profiling methodology (e.g. to avoid unnecessary questions that invade privacy). Any form of consumer profiling must be carried out in full transparency for the consumer and can only be started with the consent of the consumer.

Timing: 2025

3.2 Collective flexibility

Europe explicitly creates the concepts of (jointly acting) renewable energy self-consumer(s), (jointly acting) active customer(s), citizens' energy community (CEC) and renewable energy community (REC) to enable different grid users to share energy. Member States are therefore obliged to draw up a framework within which it is possible for self-generated electricity to be consumed and/or exchanged. From the individual point of view, there are regulations and technical concepts that create a framework for the active customer who can use self-generated power (e.g. prosumer). Following chapter describes the barriers, best practices and recommendations in case of 'collective flexibility'.

At the moment of drafting the report, the full ordonnance was not at our disposal. Therefore, a full analysis is not possible. In addition, the full legal framework is not finalized yet as the technical rules, the executive orders, potentially adapted tariff structures or other facilitating rules are not yet in place. The fact that this is important is proven by the Walloon

[50] IO.Energy Ecosystem co-creating a consumer-centric system (ioenergy.eu)

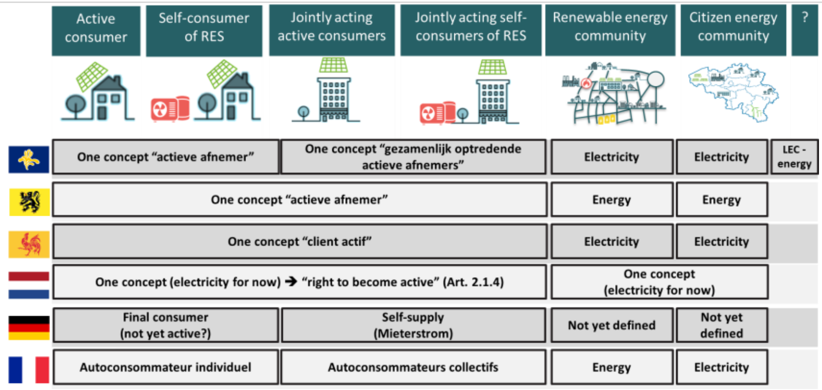
Region who implemented the principle of the Renewable Energy Community already in their Decree of May 2, 2019. However, this regime never came into effect since its implementation required the prior adoption of implementing measures by the Walloon Government.

3.2.1 Barriers

Category	Barriers
Inconsistent implementation	• Different interpretations and ambitions among Member States
High restrictions on collective initiatives	• Some member states place high restrictions regarding for instance who can participate in energy communities or regarding proximity requirements. This leads to unnecessary exclusion of specific initiatives.
Lacking facilitating and executing framework	• Facilitating framework and executive orders are often not in place yet • this will determine the roll-out of collective flexibility in practice • further economic incentives are needed
Added value of collective initiatives is not proven quantitatively yet	• Measures have to be taken with a concrete goal in mind: • Added value still to be defined to guide further incentives • Ensure different target groups are involved
Follow-up necessary	• Evaluation and follow-up of the framework is important • Pilot projects and regulatory sandboxes

3.2.2 Best practices

Country	Barrier	Best and worse practices
	Inconsistent implementation	All over Europe, member states are implementing the concepts of p2p, energy sharing, self-consumption, renewable energy communities, and citizen energy communities differently. This is in particular hard for international initiatives. Belgium, with its three regions, has three different implementations of the different concepts as Flanders, Wallonia and Brussels do not only have a different regulatory framework, but also different implementing measures. In Brussels, for instance, the draft ordinance is proposing to introduce two concepts of active consumers (the individual ones and the jointly acting), while in the Walloon region and Flanders both concepts are merged into one "active consumer". In Brussels, a third community (local energy community) is proposed, while Flanders and the Walloon Region stick to the concepts proposed by the European directives. Yet, even there, Flanders makes adaptations in the sense that the Citizen Energy Community applies to all energy flows (and not merely to electricity as defined by the European Directives). Also, when it comes to the different activities, there are differences. In Flanders, P2P receives exemptions from (among others) supply licence requirements, but only when the P2P is limited to a one-on-one P2P trade. In the Walloon region, a limited supply licence is needed for P2P trade.

		
	Added value of collective initiatives is not prove quantitatively yet	Art. 58 of the Flemish decree states that the VREG needs to execute a CBA for communities and collective consumers (apartments) to examine grid benefits. This is a good starting point to objectively quantify benefits of collective initiatives. However, the scope is limited to grid benefits and one is overlooking other (for instance ecological and social) benefits. In other member states, regulatory sandboxes and pilot projects are used to further gain insights into the benefits of collective initiatives. However, in Flanders, the exemptions for regulatory sandboxes are highly limited.
	Lacking facilitating and executing framework	Wallonia used to be a front running regarding energy communities with their decree of the 2th of May 2019. They introduced the concept of "Renewable Energy Communities" before the REDII was officially adopted[51]. However, more than 2 years later, energy communities in Wallonia are still not implemented (unless in regulatory sandboxes) because the executive orders of the decree were never worked out. The implementing measures were not in place.
	High restrictions on collective initiatives	Wallonia mentioned in its draft decree that participants of citizen energy community (CEC) should be located at the same voltage level. This would exclude initiatives with wind turbines financed by a local community. Furthermore, Europe did not place geographical limitations on CECs. Furthermore, the draft decree indicated that collective self-consumption was only allowed form new installations implemented after the acceptance of the decree. This would exclude all existing installations.

3.2.3 Recommendations

Objective 3.2.1: *Implement a robust regulatory framework for different options of 'collective flexibility', ensuring an equal level playing field for both individual and collective consumers while limiting differences across regions.*

To do so, it is necessary to:

1) Identify all relevant stakeholders and make sure all of them are considered, especially often ignored target groups such as tenants and vulnerable households
2) Make sure that rights and obligations of different stakeholders are fair, proportionate and transparent
3) Frequently review and update the policy framework, maximizing synergies between regions

Collective flexibility is a broad concept with several options possible and multiple stakeholders involved. A regulatory framework should be in place to facilitate all options of collective flexibility in a neutral way. For BCR, cases related to

[51] https://www.h2020-bridge.eu/wp-content/uploads/2020/01/D3.12.d_BRIDGE_Energy-Communities-in-the-EU-2.pdf

‘collective housing’ will become important in a city-context. One of the problems arises for example with collective occupancy or communal occupation of buildings. Currently, there is no equal framework for grid users in a collective housing. The European directives explicitly emphasize that, among other things, these end customers must be given sufficient attention when drawing up a regulatory framework so that such discrimination between end customers is eliminated. Given the practical and legal barriers, a collective approach to RE investments seems appropriate for such target groups. Alternative mechanisms exist, but these are only intermediate and partial solutions as differences remain in the financial, tariff and technical treatment towards the prosumer.

When an energy sharing framework is elaborated, it must also be examined which obligations are assigned to the active customer or the collective activity. The European directives hereby emphasize that it is important that citizens are subject to “fair, proportionate and transparent procedures” and that they are also treated in a “non-discriminatory manner regarding their activities, rights and obligations as final customers, producers, suppliers, distribution system operators, or in any other capacity as market participant”. Current obligations and responsibilities are complex for collective activities and will be outsourced frequently. To facilitate this, it is necessary to investigate the impacts for third parties. For example, the organization of green electricity and the consequences of outsourcing specific activities. In this regard, it is also important to examine the difference in impact of different responsibilities depending on the size of the collective activity.

As the BCR regulation is not final yet (or not publicly available), specific details still must be worked out. For instance, when grid users want to provide flexibility, Art. 26ter. § 1 states the need to possess a “flexibility supply license granted” by Brugel. Alternatively, the grid user can also supply flexibility via a third party (recognized supplier of flexibility services). Currently, the criteria and modalities regarding the flexibility supply license are not defined yet as the government will first ask advice from Brugel. In this regard, it is already positive that the ordonnance is taking up a potential “limited flexibility supply license” for grid users who offer flexibility from their own installations without a third party. It will be important to also consider collective installations for this “limited flexibility supply license”.

When it comes to electricity supply, energy communities are fully exempted from the traditional supply license and balancing responsibility as well can be outsourced. The Ordonnance is also ensuring proper protection of the end user who takes part in the energy communities. In this regard, one can, however, question if Brussels Capital Region should also introducing an alternative Renewable Energy Community (that is the Local Energy Community). The Local Energy Community is quite like the Renewable Energy Community, but it allows that only one of its participants owns the production facilities that the community uses to carry out its activities. This is different from the Citizen Energy Community and the Renewable Energy Community where ownership of production installations need to be in hands of the entire energy community. It is therefore not clear what the underlying reason of this Local Energy Community is, nor whether it is in line with the EU directives as it is a “less-severe” alternative for the Renewable Energy Community.

The ordonnance should also properly verify the usage of the words “energy” and “electricity” as the Renewable Energy Community currently is only allowed to take up activities regarding electricity, while the EU directives allow energy activities in general. This implies that according to the EU directives, Renewable Energy Community can also be engaged in (for instance) district heating. The local energy community is, however, allowed to take up activities regarding green “energy”.

Furthermore, it is worth mentioning that currently, through the framework for regulatory sandboxes (Decision Brugel 97) Brussels is already implementing energy communities. This is important and positive to be able to implement and test new regulation in practice. In the regulatory sandboxes (unlike Flanders) exemptions can be given regarding tariffs, conditions regarding energy supply, measurement rules… A good practice in this regard is the active role of Sibelga, who is clearly aiming to facilitate energy communities. Unlike Flanders, Sibelga already has in place a procedure to manage new activities regarding community energy. An interesting element in this procedure is that the end-consumer currently receives two invoices: one from the energy supplier for the imported electricity flows, and one from the community manager for the local energy flows. This creates opportunities for new commercial initiatives and business models as the energy community can take care of its own invoices. However, this should be followed up as it might also be a burden for consumers and the energy community manager.

The framework on P2P trade is not yet worked out by the Brussels Capital Region. There is one pilot project in the pipeline (Institut Saint-Anne) which will give more insights in the needs for this activity. Finally, in case the energy community should require a license, It is important that an initiative receives a license which is at least long enough to earn back its investments.

Collective activities have an innovative and dynamic character. Moreover, dependent on local factors (degree of urbanisation, type of consumers, grid state, available technologies,…) different business models might emerge as most profitable for a specific region. Given the innovative and dynamic character of collective activities, not all current and future barriers can be mapped out. To capture the dynamics within a proper regulatory framework, regulators should frequently re-assess the framework in place, supporting active testing of new/adapted business models, tools,… via pilots and regulatory sandboxed.

The many differences between collective activities make it hard to set up a "closed" regulatory framework. That is why it is important to make again a distinction between the short-run and the long-run regulatory framework.

In the short-run:

1) Enough freedom for collective activities to keep everything workable and to allow them to tailor certain criteria to their own needs (e.g. depending on project size, activity type and location) is needed.

In the short-medium run:

2) The policy maker needs to make sure that the new policy framework will be evaluated quickly and followed-up on, to analyse its effectiveness and to ensure the still developing playing field.
3) To do so, it is necessary that barriers for these activities are properly mapped. Furthermore, with new insights, it will also be important to continue evaluating benefits of these activities.

The frequency of the review will highly depend on the local context and conditions in the regulatory framework. The review should, however, be based on objective insights gained from existing collective activities active in the existing regulatory framework. Brussels and Wallonia are clearly focusing on first testing through regulatory sandboxes to gain insights into the needs of collective activities. When findings are available, they will be able to update their regulatory framework. This means that in the short run, energy communities can already take place through these regulatory sandboxes. Furthermore, studies will be executed on the development and implementation of energy communities in Brussels, including unjustified barriers and limitations.

For Flanders on the other hand, regulatory sandboxes for energy communities are not very open and accessible. Flanders is aiming to gain more insights through a cost-benefit analysis to be executed by the VREG. However, this CBA would only focus on grid benefits and might not lead to the same type of insights that can be gained from pilot projects (as in the Walloon Region and in Brussels).

Once the pilot projects are over, it is important to follow up the regulatory framework based on evolutions in the market. Blocking factors should ideally be removed as soon as possible. Therefore, depending on the blocking factors per member state/region, more frequent reviews might be needed.

Recommendation 3.2.1: Define and implement a stable, future-proof regulatory framework for collective flexibility

Collective flexibility is a broad topic and several distinct concepts/business models are possible. For BCR, the process of transposition of the EU-directives for CEC and REC should continue (for example with the further detailing of a framework for P2P trade,…), considering best practices from surrounding regions (see also section 3.2.2). In that perspective, it is necessary that too many differences between regional frameworks (Wallonia, Flanders, BCR) will be avoided. See also recommendations made by the working group 'Flexibility' of the 'Stroomversnelling initiative' in Flanders with respect to Energy Communities[52]. ***Timing: 2022-2023***

The implementation of a robust regulatory framework could be supported by further stakeholder consultation to discuss about roles and responsibilities of different stakeholder groups with respect to different concepts that are relevant for BCR. Extensive stakeholder consultation should lead to:

1) A mapping of all the obligations per stakeholder per activity in the existing framework
2) An evaluation of the need of these obligations per activity (this should be in line with the benefits assumed to be achieved by this activity – see further)
3) Where needed, a definition of adapted obligations per stakeholder per activity

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52 https://www.energiesparen.be/sites/default/files/atoms/files/Samenvatting%20Stroomgroep%20flexibiliteit%20sessie%201%202%20en%203_revisie_finaal.pdf

A similar concept as developed in Flanders 'Stroomversnelling'[53] with continuous working groups divided by thematic axes could be considered to ensure that the policy framework is adapted regularly in support of different stakeholders.

Timing: 2022-2023

Objective 3.2.2: *Ensure that the intrinsic value of collective flexibility could be captured by relevant stakeholders by adapting the regulatory framework (e.g. tariffs) and/or providing explicit incentives when applicable.*

To be able to do so, it is indispensable that the benefits of different (collective) activities are known so that incentives provided are in line with the created added value. In this regard, the following steps should be taken:

1) *Identify the different benefits (economic, grid, ecologic, social, socio-economic…) and the receiving stakeholders*
2) *Quantify the different benefits per stakeholder*
3) *Define weights per benefit (which benefits do we value more, do we want to incentivize more?)*
4) *Define incentives in line with the benefits to be achieved*

Furthermore, existing profitability incentives do not always sufficiently consider the added value to the "broader energy system" for certain collective activities. At the moment, the business case for collective activities mainly consists of: i) the valorisation of self-production through the energy component, and ii) the provision of flexibility. However, both aspects have limits, e.g. a discrepancy between the value for internally injected energy and the price paid for the use of this internal energy. Furthermore, the access to certain flexibility markets can be enhanced further (see chapter4), despite the significant efforts towards technology neutrality that have already been carried out. Additional incentives can be necessary, but have to be aligned with specific goals. Starting a collective activity requires investments in both time and means. Yet, the collective activity does not always see these efforts and the created added value being translated into a profitable business case. An additional incentive could be part of the solution (in case the overall value of the collective flexibility towards the entire system is higher compared to the incentives provided). The way such an incentive is put together, has to be in line with both the orientation of the added value and the objectives of the stakeholders involved (i.e. societal objectives for policy makers, cost reflective grid tariffs set by the regulator and a balanced contribution to the grid costs by the distribution grid operator). This way, the additional incentive could be shaped through the energy bill (network tariffs and taxes) or through other options.

For Brussels, specific actions are already being taken in the energy communities accepted through the regulatory sandboxes. This is positive for two reasons: first of all, it allows to test different incentives; secondly it stimulates the pilot projects. Specifically, no administrative costs are charged by Sibelga during the pilot projects. Distribution costs are also reduced in function of the portion of the grid that is used. In this regard, members of the same apartment building would pay less for distribution costs (as they do not use the low voltage and medium voltage grid) compared to members of a community who are located behind the same substation. The figure below is an illustration of Sibelga (2021).

These initiatives regarding grid cost reductions are good in the short run as it allows further examination during the pilot projects. However, as discussed previously, it should also be examined whether these grid cost reductions given are in line with the benefits that these collective initiatives bring to the grid. In case that there are no significant grid cost reductions for the DSO, the DSO will need to recuperate these grid costs through other means. The latter will imply higher average costs for non-community members. In this regard it will also be interesting to look to the Walloon pilots where they implement a similar framework as the Brussels Capital Region. The Walloon Region also allows reductions in grid tariffs in the pilot projects, but only does so to examine its impacts. By 2024 they will reevaluate their tariff structure based on the

[53] Participatief beleid - Energiesparen

findings of the pilots. Brussels should therefore also make a distinction between its short-term incentives and its long-term incentives. In the short run, incentives should be given for projects to start up and to be tested. As such, projects can be evaluated, and lessons can be learned. These findings should be used to update the long-term incentives.

Collective activities can be suitable for specific target groups (e.g. vulnerable consumers and tenants/landlords). Nevertheless, they require adapted policy tools. Considering the special attention of the EU for these target groups, an intervention by the policy maker may be desired, to support similar activities. Policy makers could provide financial support for vulnerable families or act as an independentparty to create a transparent and a fair distribution key. The latter is, for instance, especially relevant for tenants/landlords which need to agree upon a proper allocation of energy flows from an installation that is paid for by the landlord, but from which the tenant receives the benefits. For such cases, a generic regulatory framework specifying how the allocation of the benefits should take place would be beneficial to avoid conflicts between these stakeholders.

In this regard, incentives that are currently still missing in the pilots in Brussels, are incentives for vulnerable consumers. The Walloon DSO ORES is putting a large emphasize on social inclusion. Potentially, interesting lessons learned can follow from their pilot projects (see project SOCCER of ORES, DGO4 living lab).

Recommendation 3.2.2: Proper incentives for collective flexibility should be put in place to properly reflect the value of the collective flexibility from the individual perspective, the collective perspective and a total system perspective. Incentives proposed could be stakeholder specific (e.g. vulnerable consumers,…).

A study is recommended to identify both benefits and possible incentives for collective flexibility from both individual, collective and system perspective. The proposed study should:

1) Identify the different benefits (economic, grid, ecologic, social, socio-economic…) and the receiving stakeholders
2) Quantify the different benefits per stakeholder
3) Define weights per benefit (which benefits do we value more, do we want to incentivize more?)
4) Define both short-term and long-term incentives in line with the benefits to be achieved

The study should be combined with using output from relevant ongoing pilots in different regions (BCR, Flanders and Wallonia – see best practices presented before).

For the identification of the benefits of the grid, we also refer to the necessary technical capabilities of the DSO (section 2.2) that are necessary as input for this study.

For recommendations related to the design of incentives related to tariff structures, we refer to detailed recommendations in section 3.5).

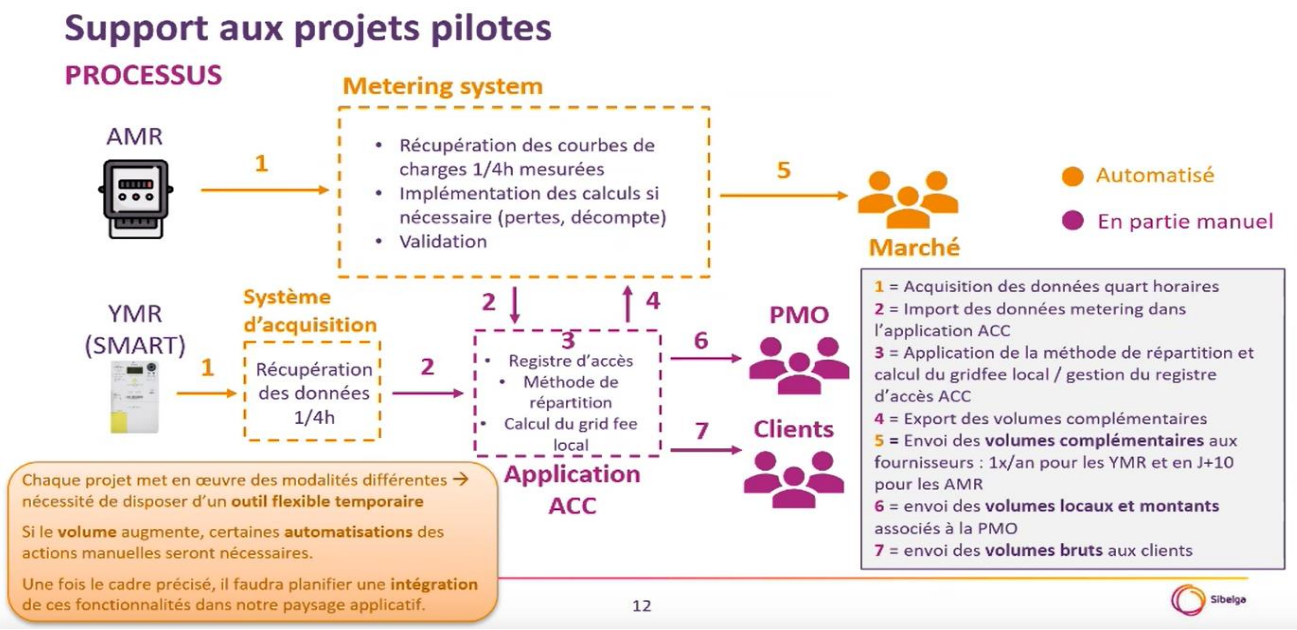
For recommendations related to vulnerable consumers, we also refer to the detailed recommendations in section 3.3)

Timing: 2025

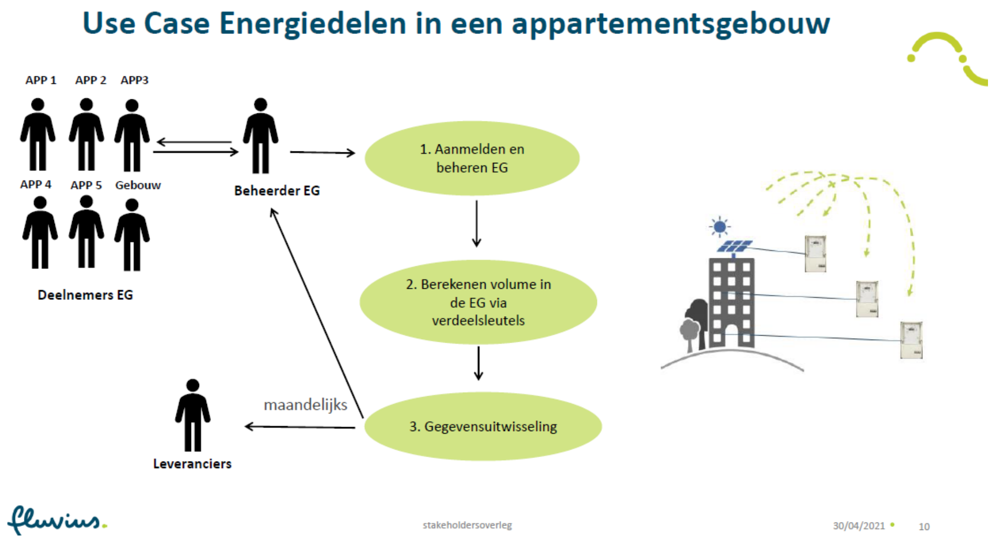
Objective 3.2.3: *The operation of collective flexibility is complex, and tools/systems need to be adapted/developed to support the financial and operational management of collective flexibility, ensuring that systems and tools are robust, interoperable, efficient and avoid that consumers are 'locked-in'.*

Implementing systems for measurement and calculation needs to be done independently and, in a cost, and time efficient way. It is necessary to start thinking about which organizational systems are required for internal calculations or for the optimization of energy flows in collective activities. In the short run, existing stakeholders can play a facilitating role and can help to speed up implementation. This is important as such practical factors should not delay the implementation and roll-out of collective activities.
In both Brussels, Flanders and Wallonia, the DSO is already taking up this role. However, the timing of the initiatives is significantly different. In Brussels, Sibelga already has in place a framework for pilot projects for the collection of data, and the allocation/calculation of different energy flows. They received funding for the project "Facilitation Autoconsommation collective" (ACC). In the short run, this highly facilitates energy communities and other collective initiatives, because systems are in place to allocate different energy flows and to register collective communities. The current system avoids the delay of implementation and roll-out of collective activities. A point of attention for the Brussels framework is,

however, that the invoice for the local energy flows is set up by the community manager. This is positive in the sense that it creates options for commercial initiatives, but it can also create challenges when communities have no experience setting this up. In the long-run, it should be further examined how this framework should evolve.



In Flanders, Fluvius is currently setting up a framework for energy sharing. Today, energy sharing and allocation of different energy flows is therefore not yet facilitated by the DSO and not possible in practice. Fluvius proposes 3 different phases to implement a facilitating framework in which Fluvius would take care of the registration of the collective activity (the different connection points and the single point of contact), the calculation of the allocation key and the data sharing and interaction between the different stakeholders. In a first phase, planned for January 2022, they want to kick-off energy sharing in one building with one supplier. This would only be applicable for new PV-installations. In a second phase, July 2022, households would be able to trade energy (P2P) if they have the same supplier. Afterwards, energy sharing with multiple suppliers in energy communities, P2P, the same building… will be facilitated. While Fluvius would take up similar roles as Sibelga, the situation is different as in Flanders the implementation is more delayed than in Brussels. The strong point about Flanders is, however, that it immediately works out a full development plan in which also P2P trade is worked out. How this will be tackled in Brussels is not yet clear.



Recommendation 3.2.3: The development of necessary operational tools for the day-to-day operation of collective flexibility, including the appropriate data management, should be supported. This includes for example systems for measurement and calculation of energy flows/flexibility and financial flows.

The development of necessary operational tools for the day-to-day operation of collective flexibility, including the appropriate data management, should be supported. This includes for example systems for measurement and calculation of energy flows/flexibility and financial flows. A distinction should be made between systems/tools for the short-run and systems/tools for the long-run. In the short-run, it is important that these organizational systems do not block the roll-out and implementation of more consumer-centric activities. These activities require knowledge, administration, proper technological and ICT systems… which are not self-evident for many grid-users. Therefore, in the short-run, existing stakeholders should play a facilitating role by adapting their existing systems to the need of such activities. In the long-run, it should be examined what all the possible alternative systems are and whether other stakeholders could possibly take up different roles.

The development of necessary tools could be supported via pilots and/or regulatory sandboxes. For BCR, it is worthwhile to invest further in the future design of the framework for P2P and 'energy sharing'. The outcome of the discussions in Flanders could be used as a starting point. ***Timing: 2025***

3.3 Vulnerable consumers

Vulnerability is often confused with energy poverty and vice versa. Both are important challenges that are linked but require different solutions to be resolved. In particular, vulnerable consumer issues concern protection within and full access to the market, and curative solutions. Energy poverty, on the other hand, concerns affordability which is often structural in nature and requires a long-term, preventive approach.

Recognising vulnerable consumers is important. While the definition varies by Member State, it typically includes those individuals and households at risk of energy poverty, but also a broader group of consumers who may be at a disadvantage in the purchasing and use of energy in the electricity and gas retail markets.

The energy market of the Brussels Capital Region (BCR) is a difficult market, characterised by many defaulters. The King Baudouin Foundation estimates that almost 20 percent of Brussels residents live in energy poverty. Sibelga is the social supplier for 0.5 percent of the population. It is estimated that 10 percent live in real energy poverty, and another 10 percent limit consumption themselves to be able to pay the energy bill. Hence, vulnerability and energy poverty are key topics to be considered in the BCR.

Studies in the BCR indicate that vulnerable consumers appear to be insufficiently informed and experience difficulties in comprehending all the tools. There can be a language barrier, they do not understand the choice of words, and are more inclined to only open communication from CPAS.

3.3.1 Barriers

Category	Barriers
Different levels of vulnerability	• Different levels of vulnerability with each their characteristics and desired approach
Financial supporting mechanisms	• Financial supporting mechanisms do not always provide a long-term answer to vulnerability or support inappropriately. Defining the "rules" is a complex exercise.
Physical contact	• The introduction of digital meters and digital solutions remove a lot of physical contact between the end user and 'the energy market'. For vulnerable consumers this physical contact is essential to keep them engaged. Physical contact is found to be the key factor in triggering them for energy efficiency or flexibility.
Tools to get them involved	• Approaching vulnerable consumers also requires tailored (digital) tools, methods and products. This can entail additional costs.

Knowledge and awareness	• Vulnerable consumers are found to have insufficient knowledge of digital applications, reading difficulties, and fear of new technology

3.3.2 Best practices

Country	Barrier	Best and worse practices
	Physical contact; Knowledge and awareness	In the Flemish project "Buurzame stroom" in Gent, energy cooperative Energent did a significant effort to specifically engage vulnerable consumers who did not have the means to invest in PV installations. The consortium worked out a plan in which they guided these people with frequent physical visits through which they could better address specific needs and/or concerns. Also, the physical contacts helped to overcome the language barrier as not all households had proper reading knowledge of the Dutch language.
	Different levels of vulnerability	The Croatian case is interesting because the draft legislation differentiates between those that are medically disadvantaged (e.g. reading disability) and those that are socially (financially) disadvantaged, recognizing different levels of protection that should be afforded between the two groups[54]. This tailored approach guarantees that the different types of vulnerable consumers are tackled in the best manner.
	Financial supporting mechanisms	The energy check - Proposed by the National Energy Mediator, this measure would target all households under a certain income threshold regardless of the energy source used in their home. Households would have the possibility to use the check either to pay their energy bills or to conduct energy performance work. This is certainly a step forward in an integrated approach of energy poverty (curative and preventive). A full integration can include the possibility to use the check for mobility, smart appliances,… expenses.
	Tools to get them involved	Social obligation reporting (as used in the UK) ensures that energy companies identify vulnerable consumers – and in doing so can develop a suitable service provision.

3.3.3 Recommendations

Objective 3.3.1: *Ensure vulnerable consumers can participate in flexibility markets. This requires, targeted information campaigns, adapted tariff schemes and necessary consumer tools for market participation.*

If we do not engage these vulnerable consumers properly and they stay behind in the energy transition, the transition trajectory and energy provision can be even bumpier for them. For example (and not limited to);

- Certain tariff or pricing mechanisms can be unfair and induce negative invoice effects (e.g. high prices at moments when consumers need electricity, negatively impacting consumers without flexible technologies and thus unable to respond to price incentives)
- Cross subsidies between vulnerable consumers and flexible consumers and prosumers (see also section 3.6)
- Vulnerable customers struggle to obtain the best deals from the energy market, or more accurately, usually fail even to attempt to get the best deal. They regard switching as difficult, be unaware of how to change supplier or even that they can switch leaving them with unfavourable commercial offers

[54] Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures (europa.eu)

- Vulnerable customers are less likely than others to have online access, making them less likely to have access to tailored feedback, smart grid technologies and applications aiming for energy efficiency and energy bill savings.

The opportunities to participate in the flexibility market are rather limited for vulnerable consumers, as they are unlikely to have the necessary technology (heat pumps, smart appliances, electric vehicles, etc.) to make participation in the flexibility market interesting; 1) A significant part of the group of vulnerable customers (especially the elderly) is not sufficiently familiar with digital applications. There is also a risk that the roll-out of the digital meter will lead to the disappearance of a number of face-to-face contacts (for example the annual meter reading), which are an opportunity for extra guidance; 2) Vulnerable customers can have budget restrictions making them financially less capable to invest in smart technologies.

To ensure that the roll-out of digital meters and flexibility services also provides sufficient opportunities for vulnerable customers, it is necessary that the introduction of the digital meter is combined with supportive information campaigns. The target group of vulnerable consumers could amongst others be based on following criteria;

- Consumers who are entitled to the social maximum price for electricity and natural gas;
- Consumers who are entitled to an increased reimbursement from the health insurance fund (the health insurance fund code on the sticker ends with 1);
- Consumers with a joint income of up to a certain amount;
- Consumers in debt mediation or in collective debt settlement;
- Consumers who are accompanied by the CPAS because of difficulties with paying energy bills;
- Consumers who rent a home from a social rental agency or social housing company;
- Consumers who rent a home from a CPAS or local government;
- ...

Furthermore, financial schemes (e.g. energy cooperatives, ESCO programs and group sales) and additional support to educate and inform consumers could help vulnerable consumers to get access to own generation and smart grid technologies. These alternative investment models help to overcome the high CAPEX impact for vulnerable consumers. This type of consumers is often characterised by a financial risk and history of non-payment and are therefore less attractive for commercial parties. Assistance of governmental bodies and non-profit organisations might be required to cover the financial risks or to oversee the execution.

The combination of the roll-out of the digital meter with an energy scan guarantees face-to-face contact with an expert, who can provide the necessary explanation about the new functionalities made possible by the digital meter and the in-home display. An additional advantage is that the expert can actively guide the vulnerable customer in the search for an optimal price formula/contract.

For this target group, the installation of the digital meter can best be linked to an in-home display that displays information related to energy use and opportunities for energy flexibility in an appropriate way. The development of these displays can be entrusted to the DSO. Examples are displays with sound for the visually impaired, visual displays with drawings instead of numbers, automatic warnings when a certain amount of energy is exceeded, etc.
For vulnerable consumers, adapted tariffs and prices could be elaborated to support a structural behavioural change. These tariff and pricing mechanisms can be tailored to the possibilities and knowledge of vulnerable consumers. Two examples of such tailored tariff mechanisms for vulnerable consumers are proposed by UK Power Networks.

Prepayment customers have been offered Bonus Time, a dynamic non-punitive ToU tariff with a Critical Peak Rebate structure with notifications provided via SMS. Under this

Credit customers have been offered a static free time ToU tariff. This non-punitive tariff offered the smart credit metered customers the choice to decide whether they

Critical Peak Rebate programme, customers who reduce/shift electricity consumption during predefined periods (DSR events) will be rewarded with monetary rebates.	wanted to receive free electricity on Saturdays or Sundays between 09:00-17:00

Recommendation 3.3.1: **Establish supporting measures targeted towards vulnerable customers**

The following elements could be considered:

- Establish sound information campaign, tailored to vulnerable consumers
- Perform an assessment to check if the current definition of vulnerable consumer is sufficient enough to cover all consumers requiring specific attention
- Develop in-home display with needed information targeted towards the needs of vulnerable customers linked to the digital meter
- Retain the physical contact
- Combine roll-out digital meter with an energy scan
- Assist in the establishment of financial schemes to help them overcome the CAPEX-burden.
- Elaboration of adequate tariffs schemes for vulnerable consumers, considering flexibility provision

To realize these different elements, a combination of actions seems appropriate:

1. Stakeholder consultation would be needed considering all relevant stakeholders at BCR level (consumer associations, regulators, energy market actors, aggregators...) to define the needs of the vulnerable consumers in BCR. **Timing: 2022**
2. Study on adequate tariff schemes and flexibility solutions with specific attention to the information provision targeted to vulnerable consumers. See also recommendations in section 3.5. **Timing: 2022-2023**
3. Translating the outcome of the previous two steps in supporting policy measures. **Timing: 2025**

3.4 Smart appliances

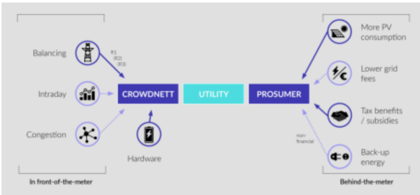
Smart appliances are electronic devices in the household environment, which are applicable to smart grid services like so-called demand response activities, remote monitoring, scheduling, energy consumption adaptation programs, etc. Often there is a misperception that smart appliances consume less energy. Smart appliances do not directly lead to energy savings since their consumption is the same as for ordinary appliances. Their effect is shift loads which enables larger integration of renewable energy sources and provides assistance in the energy market (covering multiple services). The promotion should contain this information to avoid misunderstandings of the audience.

3.4.1 Barriers

Category	Barriers
Misperception	• There is still a misperception of smart appliances. Smart appliance does not always equal less energy consumption or increased energy efficiency
Interoperability	• There is no single global standard for communications between energy utilities and smart appliances. The existence of multiple pathways is itself a market barrier because products that are compatible with one utility's system may not work in another's, and appliance manufacturers find it too risky to commit to a particular communication strategy that may have only limited take-up.
Regulation and market context	• Regulation and market context define roll-out of smart appliances. For example, a net metering policy mutes the need to implement smart, flexible, appliances to boost the instantaneous self-consumption.
Transparency and economic value	• 'Total Service Package' unburdens end consumer but there is also a loss of transparency and economic value transfer to the grid user.

Interactions	• Different smart appliances can have an effect on each other (on the level of operation but also on the business case). Assessment of where to invest and how to operate will be a difficult decision to make as a grid user.

3.4.2 Best practices

Country	Barrier	Best and worse practices
EU	**Interoperability**	A considerable amount of new solutions for smart home automation have been recently developed, but each of them generally has a different communication protocol and requires a specific architecture[55]. Efficient smart home management therefore still has numerous open issues. In this context, the European Committee of Domestic Equipment Manufacturers (CECED) established a preliminary application profile for smart home to collect and transmit data. However, data are rarely converted into significant information and used for real time feedback. Recent studies proposed several system architectures for interoperability and energy management purposes, and several projects have been developed in different countries about these topics: Smart Energy 2.0[56], Energy@home[57], E-Energy[58], ADDRESS[59], REserviceS[60].
NL	**Misperception**	Crowdnett (2016). Grid user buys a battery and gives 1/3th of the capacity in control to Eneco. The grid user benefits from an increase of self-consumption and Eneco provides grid services and (partly) compensates the consumer for  this. It is no success due to high investment (+7k€ , small capacity and net metering policy.[61]

3.4.3 Recommendations

Objective 3.4.1: *Increase interoperability by promoting the use of standards, open APIs and Open Data.*

Last years we increasingly see providers link new price formulas (e.g. a fee for providing flexibility) to a discount on the purchase of certain equipment (e.g. a home battery, smart devices, etc.) or offering of this equipment through a leasing formula. Such a practice could give a competitive advantage to the provider, leading to dominant positions in the market. After all, the dominant provider could gain privileged access to consumer information via this equipment. It could even impede access to the data for other providers. In addition, this could also lead to a lock-in effect because the provider investing in the equipment can make it more difficult to switch providers. After all, the dominant provider could (in the case of leasing) claim ownership of the devices or at least oblige the conclusion of a long-term contract to be able to recoup the investment. Aiming for interoperability and standardisation of processes and products could mitigate the risks to some extent.

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[55] https://hal.inria.fr/hal-01463233/document
[56] https://smartenergycc.org/education/consumer-standards/
[57] http://www.energy-home.it/SitePages/Home.aspx
[58] https://www.digitale-technologien.de/DT/Navigation/DE/ProgrammeProjekte/AbgeschlosseneProgrammeProjekte/E-Energy/e-energy.html
[59] http://www.addressfp7.org/
[60] http://www.reservices-project.eu/
[61] https://www.zelfenergieproduceren.nl/nieuws/verkoop-thuisaccu-nederland-valt/

To increase interoperability, developers and manufacturers of Central Energy Management Systems (CEMS) should be informed about the need to opt for standards. The latest standards and initiatives related to the interfaces of the CEMS should be explained.

Promoting open APIs (Application Programming Interfaces) in power management systems (and other devices) is advised. Open APIs allowing third parties to develop and market their own energy applications. Examples of such an approach are the APPs on smartphones. By providing this possibility to third parties, a greater diversity of energy applications is obtained, and the maturity and performance of these applications will increase due to the larger and more competitive supply. Open APIs also promote innovation in the respective domain.

Promoting Open Data is also essential. Open Data access, granted by the DSO, will allow the development and testing of better algorithms. Providing standard data sets (collections of consumptions/productions and actions) can make it possible to compare different algorithms. When organising the access to an open dataset, one must comply with the privacy regulations in place while also guaranteeing that sufficient data is available. Many anonymised, forming a good statistical representative dataset is advised.

For technical data, relating the actual network activities and characteristics, a balancing exercise needs to be made between transparency by the DSO and promoting open data on the one hand and too much grid insight and potential gaming behaviour on the other side.

Recommendation 3.4.1: **Support research and pilot projects that improve interoperability**

To improve the maturity of control algorithms for the control of flexibility, R&D in developing better algorithms and system architectures could be supported by facilitating pilot projects. In this way, the number of projects and the size of these pilot projects will increase, creating more expertise and know-how in the field. Information campaigns to property developers and home owners about the importance of flexibility can further support this process. Guidelines from the H2020 project Interconnect[62] about relevant pilot outcomes could be used as input. ***Timing: 2023-2025***

We further refer to the **recommendation related to data availability, sharing and privacy** discussed in chapter 5.

3.5 Tariff methodology

Grid tariff structures were defined in the past when the energy provision was still rather unilateral. The basis of the current tariff structure was laid out at a time when renewable energy and self-production were not yet fully penetrated. The active participation of the end-consumers in the energy market and system was not considered. Consumers were assumed to be rather unresponsive to energy price signals and more dynamic grid tariffs. Furthermore, due to limitations regarding the measurement facilities at the end-user, the possible methods for settlement of grid usage were limited as well. Hence, at low voltage, the grid fees are characterized by a static grid charge, a grid tariff depending on the net off-take of active energy (€/kWh).

These volumetric grid fees include both distribution grid costs as well as costs for the usage of the transmission grid. In the latter case, the transmission grid cost displayed on the end-consumers invoice is the result of a recalculation by the distribution system operator of the transferred transmission grid costs, applied by the transmission system operator.

Given the recent trends, one could question the current design of the grid tariffs for end-users at the low voltage grid:

- Because of the current tariff design, too few incentives are given to residential end-consumers to deal rationally with the available network capacity. The volumetric billing basis (i.e. € / kWh) gives insufficient impetus to behave according to grid needs.
- The current rates result in cross-subsidies; i) Grid users with a large net-offtake in kWh partly cover the costs of grid use of end-consumers with a very low net-offtake in kWh, ii) Grid users with a rather flat off-take profile cover part of the costs for the grid use of consumers with a large peak off-take.
- The combination of the increased integration of distributed energy production and the principle of net-metering for prosumers, has led to a decrease in the general net off-take in electricity on the distribution network which can be invoiced. The so-called 'valley of death' refers to the erosion of the financing base of grid operators.

[62] Interconnect Project - Homepage

- A large part of the costs for the system operators is determined by the system peak in the network, this is the peak power that is simultaneously requested (or produced) by all end-consumers connected to the same grid segment. This is not reflected in current grid tariffs for end-users at the low voltage grid.
- With the emergence of local renewable production, different flexibility sources and residential battery storage, the group of residential consumers can play a much more proactive role in its electricity supply. If given the right signals and opportunities, active users or prosumers can become a great asset for the energy system. From a cost efficiency point of view, a reflection should be made if, for example, dedicated tariffs form a more cost-efficient solution to solve grid congestion than the implementation of grid investments.

3.5.1 Barriers

Grid tariff design is subjected to multiple balancing exercises. Multiple points must be considered as indicated in the barrier table below.

Category	Barriers
Multiple objectives	• Grid tariff design brings together the objectives and expectations from multiple stakeholders. Some of these objectives can be conflicting. Designing grid tariffs is a complex balancing exercise between these objectives. E.g. • Simple vs cost reflectivity • Transparency vs cost reflectivity
Triangle of signals	• Grid design is part of a triangle of signals (i.e. grid tariffs, commodity pricing and a flexibility signal). Hence also here a balancing exercise. Certain grid tariff designs could impact the response to commodity pricing and flexibility request.
Means for the grid operator	• Grid tariff design are also part of a larger portfolio of means of a grid operator to execute his tasks (rule-based methods, connection agreements, tariff-based methods and market-based requests).
European coordination limited regarding tariffs	• European countries are tackling this exercise individually while we see European integration and coordination in other perspectives.

3.5.2 Best practices

Country	Barrier	Best and worse practices
Flanders	Multiple objectives	Flanders is introducing in 2022 a capacity tariff based on the effectively used capacity. The tariff is calculated based on the average monthly peak in kW. This average peak is determined based on the average of the 12 latest monthly peaks. This is registered through the digital meter. The introduction of the tariff started after an elaborate process in which multiple stakeholders have been consulted. This was important to create awareness and to create public support.[63]

[63] https://www.vreg.be/nl/toekomst-nettarieven-capaciteitstarief

	Triangle of signals	The ACM reforms grid tariffs in the Netherlands. A revision might include a shift to a capacity-based tariff that reflects actual capacity use instead of a static fuse size-based tariff. The later was already introduced in 2009 and had quite some negative consequences for consumers in the sense that consumers had no incentives for energy efficiency anymore. To compensate the consumers with a relatively low consumption compared to their capacity, consumers who could not reduce the capacity of their connection were given a compensation that added up to 30 million in 2009 and 15 million in 2010. This compensation is called the "Tegemoetkomings-regeling".[64]
	Multiple objectives	The BCR has implemented a new tariff methodology to accommodate the cost reflectivity. The grid tariff design considers the technical capacity (kVA) as the main tariff driver. Two tariff classes are considered, in particular, the connections below or equal to 13 kVA, and the connections exceeding 13 KVA. Although there is a link to capacity, or the reservation of capacity, the actual usage of capacity is not registered or billed. Hence, the cost reflectivity and impulse for rational grid usage is limited. Furthermore, technical capacities are very much historically defined rather than based on the actual need for capacity. From a market point of view, however, there is a limited impact on the provision of commercial flexibility since there are no economic consequences of generating high kWpeaks or consuming energy (kWh) during certain moments in time.

3.5.3 Recommendations

!The following recommendations focus on best practices to be considered for the updated tariff methodology (next regulatory period)[65]. To note that due to the complexity of the topic, more detailed recommendations for Brussels Capital Region can only be formulated after more detailed study work, including modelling of different scenarios for different consumer segments. See section on recommendations how a possible study should look like to prepare the next regulatory period. EnergyVille has executed a detailed study on the Flemish tariff structure – in order to support the introduction of the new tariff methodology. The used methodology could be applied for BCR as well[66].

Objective 3.5.1: : *Implement a grid tariff design which is supportive for the engagement of LV flexibility. This requires:*
1) A clear view on the evolutions with respect to future technologies
2) A clear view on the future expected costs of the DSO
3) A balance between complexity and a tariff which is 'easy to understand'
4) The availability of supporting tools (e.g. automated control)

Grid tariff design requires a balancing exercise. A future-oriented distribution grid tariff design needs to account for the challenges generated by new energy solutions like distributed generation (DG), demand response (DR), electrification of transportation (EV) and heat (HP), storage, and energy efficiency approaches. At the same time, it must allow DSOs to recover the cost of providing network services while respecting overall design principles (e.g. cost reflectivity, non-discrimination, simplicity and non-distortion). This a complex balancing exercise. The regulator could use approaches based on multi-criteria analysis to weigh the different objectives and determine how to balance these competing principles. An example can be found in the VREG decision matrix to funnel the assessment down to a single grid tariff design whereas multiple criteria are considered from three perspectives (i.e. grid user, grid operator and society).

It should also be noted that certain policy guidelines and regulations can impact the weighing of multiple criteria. For example, a renewable energy policy can push tariff triggers which incentivise RES investments.

64 https://www.ceer.eu/documents/104400/-/-/1bdc6307-7f9a-c6de-6950-f19873959413
65 Methodologie - Introductie (brugel.brussels)
66 20180111_studie_vreg_statusrapport_v11_-_eindrapport.pdf

Recommendation 3.5.1: The introduction of a new grid tariff should start from well-defined scenarios for 1) the future needs and costs of the grid, 2) the expected LV consumer preferences, behaviour and engagement strategies. In addition, necessary tools should be made available to facilitate the introduction.

For scenarios related to future needs and costs of the grid – we refer to the recommendations of section 2.2 and section 2.4.

For expected LV consumer preferences, behaviour and engagement strategies – we refer to the recommendations of section 3.1.

For appropriate tool development – we refer to the recommendations of section 3.1 and section 3.4.3

For more specific recommendations related to vulnerable consumers – we refer to section 3.3

Objective 3.5.2: *A future proof tariff methodology should capture the dynamics of new patterns of local production and consumption, by considering the introduction of customized capacity tariffs and/or time-varying tariffs. The design of the tariff is supported by advanced modelling of consumer segments and grid impact.*

Grid tariff can consist of multiple components which increases cost reflectivity but comes at a cost. Grid tariffs can be defined by a multitude of components (i.e. tariff driver, time variability, granularity and dynamic element). The interplay between these different components within a grid tariff design can positively influence the cost-reflectivity since the grid costs relate to different cost drivers. This, however, imposes certain challenges to customers and the party responsible for the implementation. It requires a highly knowledgeable grid user. Moreover, it is hard to identify the interplay between the grid tariff and potentially other signals for the end consumer and subtract the most-optimal behaviour. If multiple components are included in the grid tariff design automated control is a necessity. These automated appliances can be obtained via commercial parties. In Flanders, for example, a kind of meet-and-great platform exists to search for suitable control devices.

Capacity as the main driver to enhance cost reflectivity is a good practice. Typically, operational costs are the most important cost category, and can as such be covered by a 'capacity tariff'. Since capacity constitutes the main cost driver it provides a good approach for cost reflectivity. Capacity can be based on the technical maximum power of the connection, a contractually determined access to capacity or a measured capacity. In general, it is considered that the technical power or contractually determined access to capacity sets the capacity demand on the longer run (for example on a yearly basis). In this perspective the grid operator charges for the reservation of capacity. The use of that reserved capacity on the shorter run is reflected via a measured capacity payment. It should also be noted that a capacity signal can be reflected in a volumetric tariff driver as well (e.g. a capacity threshold which defines the magnitude of the volumetric tariff (i.e. the €/kWh value becomes more expensive when a). the €/kWh value becomes more expensive at times when a lot of capacity is demanded from the grid).

Customized capacity definition is needed to counter adverse effects. Capacity based tariff designs tend to favor households with a large offtake volume and consequently also have a negative effect on the payback time of PV investments[67]. Similar but with a smaller impact, the business case for EVs and heat pump can worsen. The magnitude of the effect depends on the implementation of smart charging and the possibility to spread power demand over a longer time period. In this context, specific attention should be paid to the definition or interpretation of capacity. A capacity threshold or capacity definition based on individual behavior (e.g. threshold based an economic-trade-off or measured capacity) limits the adverse effects.

Static time varying tariffs can be considered a compromise solution. Static time varying tariffs describe predefined (fixed) periods in which the tariffs for the use of the grid differ. Time-dependent static tariffs offer a reasonable balance between efficiency and complexity of grid tariff design but lack the most desirable advantage of more dynamic tariffs which is the

[67] The investment in PV is justified by reducing kWh expenditures, both on the commodity side as on the tariff side (if applicable). If the tariff is thus not expressed in kWh but in capacity, the economic trigger is lower. Especially since the time of production of PV and the anticipated consumption peak generally do not coincide. Thus, while in a kWh-tariff model a grid user is able to reduce grid costs with PV, this is less the case for kW-based tariff models.

reflection of the grid status in short-term tariff changes. Moreover, static tariffs could pose a challenge if they lead to large loads being shifted in response to a tariff signal simultaneously which could lead to new local or system peaks.

Dynamic tariffs can reflect the grid status but impose challenges for the grid user. In the case of dynamic rates, the timing of the tariff blocks may change from day to day (or even more often) for example to reflect a local or system peak. Notably, ex-ante cost determination provides strong signals to grid users for when it is best to restrict grid usage. However, it does not guarantee that the reaction of the grid users will be effective when capacity is scarce since it is based on predictions. For tariff designs to transmit correct signals, grid congestion must be accurately predictable, ahead of real-time, which is rarely the case today. With regards to residential consumers, the principles of simplicity and predictability can be questioned. Also, grid tariffs can become more volatile and harder to predict. However, the growth of automated control and other innovations are likely to address this gap in the future.

Too much generalizations can lead to adverse effects. The time varying price signals have the risk to be counterproductive if they are set by default for every grid user and any grid location without differentiation. If generalized they could influence customer behavior in a way that is not necessary to solve the local needs or grid congestion and seize flexibility which could serve other purposes (e.g. system needs). In parallel, the approach to define the system peak benefits from a differentiation. In particular, the more the system peak is measured on a smaller scale, i.e. closer to the effective grid user, the stronger the tariff can give direction to rational network use at local level.

As mentioned above, the optimal tariff design for BCR should be based on detailed quantitative simulations that analyze different options/combinations for different consumer profiles. The table below is an illustration of such analysis – where the financial impact of different options for the Flemish tariff design were calculated for different consumer groups[68].

KPI 3a	Huidig tarief IMEWO	Tariefmodel consultatie	Tariefmodel vast	Tariefmodel kostenrefl. niet digitale meter	Tariefmodel piek-vermogen	Tariefmodel piek-vermogen inclusief injectie	Tariefmodel piekgemeten klanten	Tariefmodel kostenrefl. digitale meter	Tariefmodel verbruiks-gerelateerd inclusief injectie	TOU tarief	Tariefmodel verbruiks-gerelateerd in capaciteits-schijven
Da	0,00%	188,48%	689,47%	550,24%	122,60%	118,09%	108,65%	455,05%	-19,52%	-14,99%	-25,53%
Db	0,00%	26,38%	147,93%	114,11%	39,81%	36,98%	14,91%	102,19%	-16,39%	-10,39%	-22,63%
Dc	0,00%	23,88%	112,55%	88,64%	52,27%	49,19%	20,70%	86,19%	-2,99%	3,88%	-9,86%
Dc1	0,00%	-16,59%	-24,93%	-23,96%	-23,49%	-25,04%	-23,39%	-23,83%	-15,42%	-8,15%	-12,53%
Dd	0,00%	-14,58%	-56,74%	-48,68%	-27,08%	-28,56%	-21,53%	-43,48%	-0,98%	1,28%	1,75%
De	0,00%	23,69%	1,93%	17,75%	122,46%	117,96%	64,15%	48,35%	58,93%	13,83%	76,26%
De1	0,00%	22,44%	16,65%	25,77%	44,71%	41,78%	27,80%	27,22%	19,54%	0,37%	25,81%
Ia	0,00%	-8,47%	-23,84%	-13,67%	-14,42%	-16,15%	-9,03%	-19,35%	-2,80%	2,42%	-5,73%
Ib	0,00%	-29,54%	-92,41%	-83,52%	-63,82%	-64,55%	-40,53%	-78,18%	-2,96%	2,63%	32,07%
Da prosument	0,00%	-19,42%	92,05%	81,37%	80,10%	135,24%	-11,72%	79,89%	68,53%	19,30%	6,22%
Db prosument	0,00%	-18,06%	31,17%	27,21%	25,75%	49,03%	-17,69%	25,75%	5,96%	-8,18%	-18,94%
Dc prosument	0,00%	-25,39%	8,40%	6,06%	16,37%	43,47%	-22,72%	8,92%	21,39%	2,74%	-7,13%
Dc1 prosument	0,00%	-37,77%	-43,34%	-43,08%	-28,04%	-16,10%	-39,42%	-37,40%	-12,65%	-14,51%	-25,56%
Dd prosument	0,00%	-24,19%	-84,37%	-73,65%	-45,84%	-40,24%	-42,42%	-67,30%	-3,09%	-47,75%	-46,20%
De prosument	0,00%	-11,68%	-45,53%	-25,84%	119,09%	132,17%	45,11%	17,63%	78,65%	17,51%	109,42%
De1 prosument	0,00%	-33,07%	-57,97%	-46,34%	28,00%	50,05%	-16,89%	-25,15%	49,81%	5,33%	41,43%
Ia prosument	0,00%	-32,97%	-56,81%	-50,44%	-51,47%	-33,51%	-41,93%	-53,66%	16,57%	8,00%	-0,60%
Ib prosument	0,00%	-33,40%	-92,84%	-84,44%	-65,85%	-62,20%	-43,79%	-79,39%	2,80%	5,25%	35,44%

Figure 5 Comparison of different tariff models for different consumer groups in Flanders (source: EnergyVille)

Recommendation 3.5.2: Study (qualitative and quantitative) is needed to accommodate an appropriate grid tariff design for BCR for the next regulatory period

The following recommendation highlights the main steps to be considered for a tariff design study. For a more detailed methodology, we refer to the approach as presented by the Flemish VREG study[69].

[68] 20180111_studie_vreg_statusrapport_v11_-_eindrapport.pdf
[69] 20180111_studie_vreg_statusrapport_v11_-_eindrapport.pdf

When designing a future proof grid tariff design certain steps need to be followed to guarantee that the tariff serves both the energy system (e.g. rational grid usage, cost reflectivity, availability of flexibility) and the end-consumer (e.g. fair, simple, transparent tariffs):

1. Establish the future energy scenario and evolution of end consumers
2. Establish a thinking framework with the applicable boundaries and preconditions of grid tariff designs
3. Benchmark the different grid tariff designs qualitatively
4. Develop a quantitative simulation environment which simulates the impact of a grid tariff from two perspectives
   - Impact on the end-consumer, including a deep dive into specific consumer groups
   - Impact on the energy system and society
5. Integrate the qualitative and quantitative assessment into integrated recommendations, funnelling the assessment to a specific grid tariff design
6. Iterations can be executed to assess the impact of design alternatives (e.g. attribution of regulated budget to the respective tariff drivers)

Ideally this process is accompanied with intensive stakeholder management, consulting the stakeholders along the reformation path. This guarantees that the results obtained are supported by all relevant parties. **Timing: 2023-2024**

Objective 3.5.3: *Ensure that the chosen tariff design is complementary to 1) other flexibility mechanisms and 2) commodity pricing and as such is not creating conflicting signals to the end consumer.*

Rule-based methodologies can complement grid tariff design but must be elaborated with caution. Rule based methodologies could provide grid operators with flexibility to assist in grid operation. For example, interruptible mechanisms (like direct load control) will allow the grid operator to use flexibility when it is really needed by allowing for a more dynamic allocation of capacity and curtailment. However, interruptible mechanisms need to be considered with caution as they pose some challenges. In fact, the grid user loses the possibility to decide about the deployment of his flexibility which is highly incompatible with the definition of DR (i.e. a form of flexibility in which a customer, on a voluntary base, adjusts its net offtake up or down based on external signals). Furthermore, since the DR potential (or available flexibility) is not recorded when applying for a connection or applying for a new grid tariff structure, the available margin for direct control is complex (or impossible) to identify. Mechanisms like direct load control can be seen as a parallel system next to other mechanisms (e.g. implicit via tariffs) in certain, limited (emergency) situations. They require very strict regulations on amount of activation times, duration, benchmark for grid investments,…

Interplay between grid tariffs and energy prices can impact the effectiveness of grid tariffs. The two signals perceived by the grid user are not always aligned since they are reflecting scarcity on different levels. While an energy price measures scarcity in the wholesale market at system level, the (dynamic) grid tariff aims to reflect scarcity on the grid (at a local level). There are two possibilities to interfere with the signal from the energy component, i) opposing price signals (e.g. higher grid costs due to peak hour definition), or ii) threshold for consumptions. The latter, capacity threshold, inhabits more potential to mute market signals which is aggravated when the threshold or tariff signal comprises a longer period (e.g. yearly defined).

See also section 2.4 and section 4.5 for detailed insights and recommendations related to tariff design and other flexibility mechanisms.

Recommendation 3.5.3: **Ensure that the design of a future proof tariff is aligned with other flexibility mechanisms**

See recommendation 4.5.1

3.6 Commodity pricing

Under the impulse of European policy, we see the attention paid to dynamic commodity pricing is increasing. Regulation describes that Member States shall ensure that final customers, who have a smart meter installed, can request to conclude a dynamic electricity price contract with at least one supplier and with every supplier that has more than 200 000 final customers. In particular, Article 2 (15) of the recast Electricity Directive defines a dynamic electricity price contract as: *"An electricity supply contract between a supplier and a final customer that reflects the price variation at the spot markets including day ahead and intraday markets, at intervals at least equal to the market settlement frequency."* As the definition prescribes, both day ahead as intraday contracts are a possibility, with each distinct characteristics:

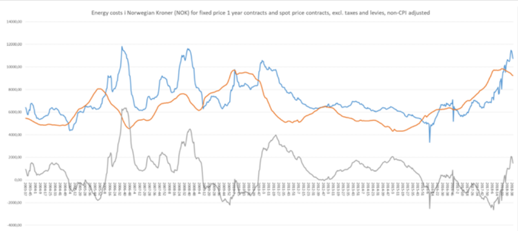
- Day-ahead prices as a reference for the dynamic contract price variation: easier to respond to for customers, as these are published on the day before delivery and can therefore be communicated to the customer in advance. This makes it easier for consumers to adapt their electricity consumption, whether manually or automatically, to realise cost savings.
- Intraday prices as the reference: may be more challenging as different prices will exist for the same delivery period depending on the trading window in which the electricity was procured. Also, customers will only be notified of the actual price within a shorter window prior to delivery (relative to day-ahead prices) and will have less opportunity to respond and adjust their consumption.

3.6.1 Barriers

Category	Barriers
Physical and information and communication technology (ICT) infrastructure requirements	• Most basic infrastructure required is digital meter • In addition, ICT solutions to inform consumers about real-time pricing are also required.
Achieve critical mass of consumers	• Limited market potential: the benefits of dynamic price offers for the system relate to the ability of consumers to adjust their consumption patterns according to the spot price variation. This impact can only be achieved at a system wide level if a critical mass of consumers opts for this type of offer. Conversely, the benefits of a dynamic price offer for the consumer is strongly related to their ability to adjust consumption, based either on the anticipated price or on a short-term basis according to the actual spot price – this may require flexibility. This could limit the market potential of dynamic price offers, at least in the short term.
Limited cross-subsidies	• It is important that households whose consumption pattern is less flexible, which could include vulnerable consumers, should not be disproportionately disadvantaged by the introduction of dynamic price offers. In particular, dynamic price contracts can lead to cross subsidies between flexible consumers (responding to cheaper price periods) and non-flexible consumers, unable to respond.
Triangle of signals	• Triangle of signals (i.e. tariff, commodity price and flexibility signal) defines full response: This situation acts to limit the magnitude of the overall price differentiation between dynamic price offers and other offers and may reduce the incentive for consumers to adjust their consumption according to the spot price signal.
Challenging price comparison	• Challenging price comparison: consumers might find it challenging to assess which is the best market offer for them as they would need some wholesale trading expertise to compare pre-defined prices with dynamic offers whose price is only known ex-post.
Consumer characteristics	• Furthermore, the benefits of dynamic price offers may vary from one consumer to another as they strongly depend on the consumer's consumption profile and their ability to adjust it in response to price variations. Finally, the choice between dynamic price offers and fixed price offers relies on the consumer's aversion to risk and their ability to absorb potential price increases, such as higher economic margin, to capture potential lower prices.

Lack of knowledge	• Consumers must have a sufficient level of knowledge and understand the benefits arising from using dynamic tariffs.

3.6.2 Best practices

Country	Barrier	Best and worse practices
	Consumer characteristics	EDF introduced the Tempo Tariff which has both time-varying and critical peak components. The Tempo tariff divides all days of the year into three categories which are visualised by different colours - blue, white and red. Most of the days are "blue" days, during these days the electricity prices are comparatively low. "Red" days indicate that the balance between power demand and supply is comparatively tight. Consequently, these days are the most expensive. During the "blue" days the power supply-demand balance and power prices lie in between the other two categories. Furthermore, all days are further distinguished in (more expensive) day and (less expensive) night tariffs. An evaluation of the Tempo Tariff shows that it is the least taken tariff by EDF consumers. It is not recommended for consumers with electric heating and it is compared to fixed tariffs the most complicated tariff. Consumers need to inform themselves on the color of the day. Not all consumers therefore seem to can adapt to the different pricing days.[70]
	Physical and information and communication technology (ICT) infrastructure requirements	Estonia is a front-runner in terms of digitalization. This can also be seen in the share of real time tariff, which doubled since its introduction in 2013.
	Achieve critical mass	Currently, in Norway, around 71% of households and 88% of SME und small industries chose real time tariffs. During the 15-year period depicted in the graph, customers who bought an average fixed  price contract saved money compared to if they had bought a spot-based product in 31% of the weeks. In the remaining 69% of the time, customers who bought spot-based contracts saved money compared to customers who bought an average fixed price product the same week.

[70] https://www.kelwatt.fr/prix/tarif-bleu-edf

	Challenging price comparison; lack of knowledge; consumer characteristics	 In general, consumers can choose between three main categories: fixed, combined and exchange packages. Within every package, there are several options available. The fixed package includes the option for a flat rate which is set for the duration between 6 and 36 months. Alternatively, consumers can choose a TOU tariff. In the exchange package, the prices follow the wholesale market prices, therefore this package is also called "spot tariff". Although this package includes the option to choose a RTP, it also includes other options where TOU rates are based on the wholesale market prices from previous months. As the name suggests, the combined package offers a combination of two tariffs types. Half of the power demand is billed with a RTP and the other half with a TOU tariff. Whilst the purpose of a combined tariff is to limit exposure to price risk for the consumers, it may appear unnecessary complicated to the consumers. Although the consumers have many different options and combination of these, this freedom of choice can go at the expense of transparency and clarity. Instead of empowering consumers, these tariff variations might unnerve consumers and lead to resistance.

3.6.3 Recommendations

Objective 3.6.1: *Support improved information sharing on commodity pricing for LV consumers, ensuring that consumers can understand the pricing and can more easily make a cost comparison between different offerings.*

The success of dynamic pricing contracts will depend to a large extent on the trust that end users have in the providers of those contracts. For example, consumers would have more confidence in small and/or local service providers than in large, anonymous energy companies. Trust also largely depends on (the perception of) the reliability of the services offered – in other words, on whether the promised benefits of dynamic pricing contracts are effectively realised. In this regard, the expansion of the range of commodity contracts made possible by the roll-out of the digital meter also poses several potential risks. The complexity of the tariff formulas offered on the energy market can increase enormously. In principle, an optimal rate could even be drawn up almost 'tailor-made' for the specific situation of each consumer. This is a positive evolution, but with a strong increase in the number of price formulas it will be almost impossible for the end consumer to make an objective comparison between different providers. Hence, the introduction of more dynamic price contracts must be accompanied with the introduction of a comparative tool which compares the different price offerings on the market, preferably calculated for the specific consumer. These price contract can (and are expected to) differ significantly (e.g. hourly changing prices, pricing in blocks, price thresholds,...) since each energy supplier will align the price contract with their respective portfolio and business model. Hence, it will become key to establish a comparative basis or comparative factor to be able to rank the different offerings (e.g. based on SLP or average hourly value with risk factor indicating the sensitivity). The V-test of VREG calculates for example a forecasted average price (€/kWh) for the next 12 months, complemented with a forecast of the lowest and highest price (€/kWh) in the next 12 months. In Brussels, the BRUSIM simulator of Brugel is not yet accounting for dynamic pricing as there are currently no suppliers offering such contracts. In the future, the simulator will, however, also have to account for this as well.

Energy providers should be obliged to include sufficiently detailed and comparable cost items in their offer. The offer should make a clear distinction between the cost charged for consumption in kWh (possibly in different time periods), the compensation for the flexibility provided, the possible leasing cost for equipment, costs for using the distribution and transmission network, costs for public service obligations, taxes, etc. This makes it possible to compare the offers of different market players. The British regulator (OFGEM) also imposes an obligation to estimate the (average) annual cost (including all cost factors) over the term of the contract. In addition, end users should also be given a say in the frequency and way in which they can request information about their invoice.

Recommendation 3.6.1: **Introduction of objective, comparative tool to compare different price offerings on the market, tailored to the individual consumer, hosted by the regional regulator**

Such a tool would share information on the different, existing supplier's offerings and would allow consumers to compare these different options and make informed decisions when selecting a supplier and a commodity contract. The tool should consider several factors such as the available flexible devices at consumer's premises, the preferences of the end-consumer, certain profiling of the end-consumer,… For BCR, this could be considered for a potential update or extension of the already existing BRUSIM tool. See also recommendation 4.1.4. ***Timing: 2022-2023, continuously updated***

4 Market perspective

In this chapter we will focus on the market aspects and the barriers which can hamper LV customers to market their flexibility. All potential market segments which can be targeted by residential consumers, now and in the future, are considered, i.e. frequency ancillary services for the TSO, non-frequency ancillary services for the DSO, congestion management for the TSO and DSO, wholesale markets (day-ahead and intraday) and imbalance optimization of a BRP portfolio.

The Clean Energy Package lays the ground for establishing a new electricity market design, in particular the Electricity Directive[71] emphasizes that *"final customers are entitled to act as active customers without being subject to disproportionate or discriminatory technical requirements, administrative requirements, procedures and charges"* (Article 15) and participation of demand response trough aggregation should be allowed (Article 17); Furthermore both the TSO and the DSO should buy ancillary services in accordance with market-based procedures (article 31 and 40).

In the following sections, barriers, best practices and recommendations are presented covering different topics. Firstly, to enable a market-based allocation of these services and thus enable market parties to effectively bid into the aforementioned markets, **products need to be defined for these services**, which will be covered in section 4.1.

In addition, it is important to cover the different market processes or phases. Several distinct phases could be distinguished, which will be covered in the following sections:
1) **Prequalification** (section 0),
2) **Procurement and activation** (section 4.3) and
4) **Settlement** (section 0).

Finally, in the last section, **dynamic connection agreements and curtailment options** are shortly described as these are also considered as potential interesting mechanisms to valorize LV flexibility.

4.1 Products and services

As already mentioned, to enable a market-based allocation of flexibility services and thus enable market parties to effectively bid into these markets, flexibility products should be available and accessible for the different potential providers. It should be noted, that a trade-off is needed between grid investment and flexibility procurement before setting up flexibility markets to solve DSO needs. The H2020 project Flexplan[72] analyses the role of flexibility for grid planning purposes (TSO and DSO). The recently approved project ALEXANDER (Belgian Energy Transition Fund)[73] examines the role of the non-rational/heterogeneous nature of LV flexibility and the impact on the role of demand response flexibility for adequacy purposes.

4.1.1 Barriers

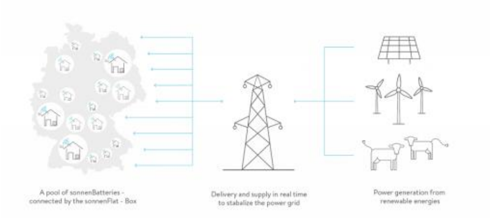
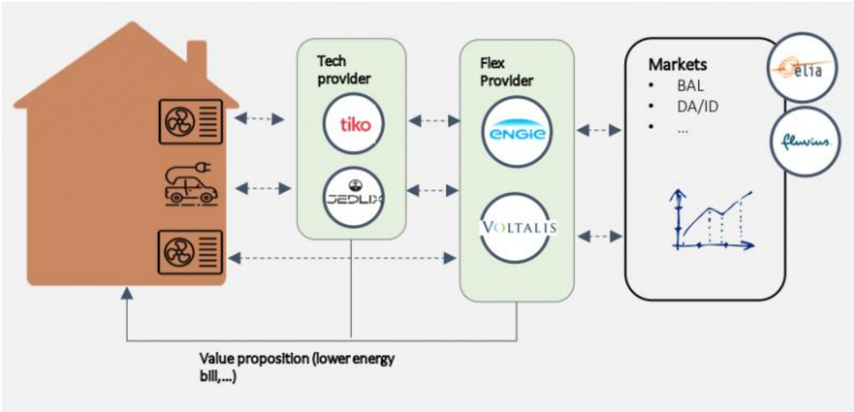
Category	Barriers for LV flexibility
Market access	• Currently not all markets are open to flexible resources connected to the distribution grid. • In Belgium all frequency services can be delivered using resources connected to the distribution grid (up to MV). LV flexibility is currently however only allowed to participate in FCR.

[71] Source: Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU; available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0125.01.ENG&toc=OJ:L:2019:158:TOC.
[72] https://flexplan-project.eu/

[73] https://economie.fgov.be/nl/themas/energie/energietransitie/energietransitiefonds

Product attributes and characteristics	• Depending on the flexibility service, certain requirements, conditions and technical regulations may apply to the flexibility to be provided. This may mean that not every flexibility service is equally accessible to every type of grid user. If other market segments (aside the FCR market, see previous barrier) are opened up towards LV consumers, the product characteristics of these markets should be reconsidered considering all types of potential providers, including aggregated LV consumers. • Example: minimum bid size can still be considered too high for LV flexibility.
Locational information	• It is not straightforward how to include locational information in (aggregated) bids. The need for locational information is mainly linked to flexibility services which have a more local character such as congestion management and voltage control for the DSO, while for other flexibility services such as frequency regulation services for the TSO the needed locational information is limited (e.g. identification of Load Frequency Control area) or even non-existing for flexibility services offered towards commercial actors such as DA market optimization, ID market optimization and Imbalance optimization.
Availability products	• It can be challenging to include LV flexibility in (long-term) availability products. LV consumers might not be willing / able to provide their flexibility for a longer time period (e.g. a year) as their situation may change more rapidly and as they may want the freedom to switch flexibility contracts more often (similar as they currently have the right to switch their energy supplier), while for buyers of flexibility LT reservation of flexibility might be a precondition (especially for DSOs) as a lack of sufficient flexibility volumes during rare situation may necessitate reinforcement and grid investments.
Complex products	• Different resources may present rebound effects or specific technical constraints. A balance must be made between accounting for complex resource characteristics and having simple, standardized and transparent product definitions (see next barrier). • Within this respect, technology-neutrality should always be kept in mind.
Product standardization	• There is a lack of product standardization resulting in a variety of diverse products, but there is also a need to consider local specificities. A clear definition of products is needed, even for local needs, where it is important to avoid too many different and non-comparable products. • This raises the question which level of standardization/harmonization is needed, for which products, and how it can be guaranteed that all relevant market stakeholders can participate (level playing field not always realized).
Impact of aggregation	• Aggregation is a precondition/means for the participation of LV flexibility to flexibility markets, but the revenue sharing approach, pool composition,… impact the value of LV flexibility.
BC for LV customers	• There is no clear business case for LV grid users to take part in flexibility services (system value of flexibility too low, lack of clear information about opportunities, unclear quantification of costs and benefits, including future revenue streams) • More attention should be paid to the development of viable business models for LV customers (focus on comfort, low complexity, considering risk-averseness, non-monetary aspects) • Impact of taxes, grid costs on bids for flexibility services can further decrease the value of LV flexibility.

4.1.2 Best practices

Example	Barrier	Best and worse practices
sonnen	BC for LV customers	The sonnenCommunity is a community of sonnenBatterie owners who are committed to a cleaner and fairer energy future. In Germany, Austria, Switzerland and Italy it is already possible to become a member of the sonnenCommunity.  The sonnenCommunity offers through its "SonnenFlat" offering a possibility to buy a battery that will allow the consumer to offer through a battery pooling ancillary services, in particular **FCR**. FCR is activated by local control systems of the participating technical units. As a financial compensation, they can get the sonnenFlat rate with a 0 € energy cost (within certain limits of energy consumption depending on the chosen options). Detailed offerings are not publicly available.[74]
io.E	Market access Impact of aggregation BC for LV customers	Flexity[75] aims to investigate the flexibility potential on the household level and tests how it can be operated and valorized in the market. Flexity unites a key energy and flexibility provider in the Belgian market (ENGIE) with three service providers: tiko, Voltalis and Jedlix. In doing so, Flexity capitalizes on the expertise and knowledge of each of those parties to test whether households are technically capable to deliver flexibility to the market.  The diagram demonstrates how household flexibility will be operated and valorised in the market. These household assets are operated for a variety of purposes (**balancing, time of use, wholesale**) and flexibility service providers create an integrated value proposition to the end-consumer. Flexity will assess and compare the commercial potential of household assets that are: • being optimized based on time of use tariffs, • and/or being valorised on the balancing and wholesale market.
tiko	BC for LV consumers	Based in Switzerland[76], Swisscom Energy Solutions AG develops flexible and modular solutions under the brand tiko[77] and provides **fast frequency response** with a reaction time of less than 1 second using residential prosumers' devices such as photovoltaic systems, domestic batteries, systems and heating systems. As visualized in the figure

[74] https://sonnengroup.com/
[75] https://www.ioenergy.eu/flexity/
[76] https://smarten.eu/tiko/
[77] https://tiko.energy/

	Impact of aggregation	below, **tiko** provides monitoring for consumers so that they can see and analyze their consumption, it provides options for remote control and ensure energy savings for the end-consumers, and it warns the end-consumers in case of malfunctioning.
Voltalis	Market access Impact of aggregation BC for LV customers	Voltalis[78] has been providing **distributed load shedding** in France since 2009 and was the first aggregator in Europe to be approved for provision of balancing services. The company controls consumer appliances remotely through a smart box which is installed at the end user. As such, Voltalis can aggregate capacity to offer it in balancing and reserve markets. Voltalis controls appliances in over 100.000 households leading to a total capacity of about 2 MW in electricity storage water heaters (ESWHs) alone. As mentioned in the EKSTERN Report of the Thema Consulting and Danish Technological Institute[79]: "Voltalis currently operates at a regional level by selling capacity to the French TSO, RTE. This includes supplying Primary FCR. Depending on whether ESWHs are controlled locally or remotely via internet, response times vary from less than a second to at most 10 minutes, with remote control having the slowest response time. Means can be taken to reduce the remote response times to around one second, well within the 30 second requirement for participation. Voltalis plans to extend its services to the local level (DSO) in the future."
SVENSKA KRAFTNÄT	Aggregation Product attributes and characteristics (minimum bid size) BC for LV customers	In the pilot project "Flexibla hushåll", Fortum controlled the supply of electric storage and water heaters in 90 households in the Stockholm region. It allowed them to deliver about 0,1 MW frequency reserves to Svenska kraftnät[80]. The pilot found out the following, as cited from [81]: - *"It would be necessary to aggregate a somewhat larger number of ESWHs (than the 90 included in the pilot) to ensure the minimum bid size. The ESWHs normally consume power less than half of the day. To ensure symmetrical regulation capacity for up and down regulation, half of the ESWHs were kept on to provide up-regulation, while the other half was kept off to provide down-regulation. The study concluded that if ESWHs are to supply services to the existing FCR-N market, Svk's ICTsystem and market rules has to be adapted, and the quality of meter data needs to be improved. "* - *"The FCR-N market compensates capacity (availability) according to pay-as-bid capacity reservation and for energy (activation) according to the clearing price on the net energy provided during activation. The energy compensation is highly dependent on the hour of activation. The average capacity price for FCR-N in Sweden was 17.04 €/MW/h in 2020. This implies that a symmetrical bid of 0.1 MW every hour (equivalent to the capacity of 100 ESWHs with an average capacity of 2 kW available 50% of the time) will receive availability compensation of 14,927 €/year, corresponding to 75 €/year per kW of installed ESWH capacity with 50 % availability."* [82]

4.1.3 Recommendations

Objective 4.1.1: *Opening up all flexibility services to all types of flexibility providers and all voltage levels is necessary.*

Currently, not all markets are open to all types of flexible resources at the different grid levels. In Belgium all frequency ancillary services can be delivered using resources connected to the distribution grid (up to MV). LV flexibility is currently

[78] https://publikasjoner.nve.no/eksternrapport/2021/eksternrapport2021_05.pdf
[79] https://publikasjoner.nve.no/eksternrapport/2021/eksternrapport2021_05.pdf
[80] https://www.svk.se/siteassets/om-oss/rapporter/2017/slutrapport-pilotprojekt-flexibla-hushall.pdf
[81] https://www.svk.se/siteassets/om-oss/rapporter/2017/slutrapport-pilotprojekt-flexibla-hushall.pdf
[82] https://publikasjoner.nve.no/eksternrapport/2021/eksternrapport2021_05.pdf

however only allowed to participate in FCR. In the Belgian context, Elia has done a lot of efforts to open the frequency products to all technologies, independently from the voltage level and the type of provider. Most notable changes are:

- Contractual opening of the frequency products to all technologies.
- Move from a yearly/monthly/weekly procurement to a daily procurement procedure; By going from longer term procurement to a daily procurement with a lead time of one day, flexibility providers should be able to better forecast available flexibility volumes. A daily procurement procedure could also create lower entry barrier for new technologies and could create opportunities to switch more often between revenue streams.
- Procure the reserved capacity with 4-hour blocks; Shorter product duration – in combination with shorter procurement lead times (i.e. daily procurement) – is expected to have a positive impact on the available capacity potential.
- Decrease in the min bid size (currently set at 1 MW for all frequency services).
- Participation with aggregated pools is allowed to all frequency services.

In addition, a phased approach is targeted to further opening up these markets, also for LV customers in the case of aFRR and mFRR provision, which needs to be followed up and monitored. Other services, such as non-frequency ancillary services or congestion management, still need to be further developed. For these services and related products, it is important to design them in such a way that all potential flexibility providers are already considered during the definition of the products. A recent study in the framework of the H2020 project OneNet (Task 2.2)[83] investigated the minimum bid size for different frequency and non-frequency products for TSOs and DSOs. An extensive survey answered by many system operators, including the sector organisations ENTSO-E and EDSO concluded that for 'TSO-products', 1 MW is the appropriate minimum bid size to balance market participation on the one hand and operational efficiency on the other hand. For DSO-services, the consensus proposal was a minimum bid size of 0,1 MW to take into account the 'locational aspect' of certain services and the smaller size of some DSOs.

Recommendation 4.1.1: Opening up all frequency ancillary services for LV flexibility is needed

Adapt the current product definition in line with the NCs on European level and in consultation with relevant stakeholders (including TSO, DSOs, FSPs including aggregators, national, regional regulators,…) at country level to allow all types of flexibility providers and all voltage levels to offer the product. These modifications should be in line with the new NC for Flexibility (expected end of 2022) and currently in preparation by ACER. – **Timing: 2021-2022**

Objective 4.1.2: *A clear product definition is needed, considering technology-neutrality and a unified approach to include locational information.*

The definition of flexibility products should start with the identification of the underlying need by the requesting party. In addition, consultation with FSPs is needed to guarantee the participation of all resources which have the potential to contribute, and thereby adhering to the principle of technology-neutrality. Flexibility should be understood here in the broad sense as a "*modification of generation injection and/or consumption patterns in reaction to an external signal in order to provide a service within the energy system*"[84]; Services in this respect can be wholesale trade, frequency ancillary services, non-frequency ancillary services or congestion management.

Products on the wholesale markets are already largely unified across Europe. Related to system services, for other than frequency ancillary services where there is already EU legislation requirements, a clear definition of products is needed, also for local needs. As the same flexibility providers could potentially offer several products, it is important to avoid too many different and non-comparable products. For these services it is thus important to consider existing products and assess whether the product definition could start from the existing ones. Specifically, for these products covering local needs, there are some new requirements for the product definition. For services like congestion management, locational information in flexibility bids is key to assess the contribution of the bid to solve the need. It would be good to have an agreed approach on how to include locational information of the flexible resources in a bid. In this context, special attention should be paid on how locational information can be integrated in aggregated bids, potentially aggregating bids from different locations. Specifically, for very local needs, this might be very challenging.

For all flexibility services, a European framework is needed for product definition, similar as is implemented for frequency ancillary services, to avoid discrimination among market parties or technologies. A first step to achieve this is creating a

[83] https://onenet-project.eu/public-deliverables/

[84] Source: adapted from: Flexibility and aggregation requirements for their interaction in the market Eurelectric (2014), available online: https://www.usef.energy/app/uploads/2016/12/EURELECTRIC-Flexibility-and-Aggregation-jan-2014.pdf

template with potential product attributes. This does not mean that the values of these attributes should be the same for a product related to a specific service in all countries, as local circumstances might still require local specifications of certain product attributes, but if the same template is used this would make it easier for flexibility providers, but also solution providers to compare different products. Furthermore, all stakeholders (TSO, DSO, commercial actors,…) should coordinate in defining the flexibility products, according to the set template.

Products should be technology neutral, so that all potential providers (generation, demand, storage) have the same opportunities. Different potential flexible resources may have very specific technical constraints or may present certain behavior (such as rebound effects). A balance must be found between accounting for these complicating resource characteristics in the product definition and defining easy to understand products. When specifically looking into the participation of LV customers, some attributes like the minimum bid size should be defined in such a way that participation of all resources, including pooled LV customers, contributing to system needs is possible. In addition, it might be challenging to include LV flexibility in (long-term) availability products, while these are seen as very important by system operator (see section 4.3.3). It is thus very important that system operators and stakeholders (all potential FSPs including aggregators) define flexibility products together.

Recommendation 4.1.2: Creating a framework on product harmonization and standardization

Following steps should be considered:

1. Creating a common template with product attributes for different system services (frequency and non-frequency, congestion) which can be used by TSOs and DSOs. This action is dealt with in the Network Codes at European level but could be further detailed at National and Regional level. Cooperation between ENTSO-E, EU-DSO and ACER is essential. Similar as for previous recommendation, this action should consider the recommendations as defined in the new NC for Flexibility. The starting point of a framework for Brussels Capital region/Belgium should also follow the recommendations from The H2020 Bridge Regulatory Working group where new recommendations on product harmonisation will be presented at the end of 2021 . **Timing: 2022 – 2023**

2. Agreeing on an appropriate level of product standardisation with relevant stakeholders. Stakeholder consultation would be needed at national level, considering the guidelines at European level. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed. In the final product definition, there should be enough room to consider local specificities (see next recommendation). This topic could also be taken up via the initiative of the Market Consultation (Product Design Working group) organized by Synergrid - **Timing: 2022 - 2023**

Objective 4.1.3: *Product standardization and harmonization should take place at an appropriate level.*

A common terminology and approach for product definition and specifications in Europe covering all services for TSOs and DSOs is currently lacking.

Discussions on product standardization in Europe mainly focus on balancing and mostly entail standardization between TSOs. For balancing services (FCR, aFRR, mFRR, RR[85]) standard products have been defined in the EBGL[86]. A standard product is in this context defined as a *"harmonised balancing product defined by all TSOs for the exchange of balancing services"*. Balancing products for balancing energy and balancing capacity are being standardized across Europe at two levels:

1) the attributes are being defined which should be used to define the product (such as the full activation time, minimum and maximum quantity, minimum and maximum duration of delivery period; mode of activation) and
2) the values of some of these attributes are being fixed for a certain balancing product (i.e. FCR, aFRR, mFRR, RR).

The first level of standardization can be understood as the creation of a product template which can be used to define products for different services (see recommendation 2).

[85] RR are not considered in the Belgian context.

[86] Source: COMMISSION REGULATION (EU) 2017/ 2195 - of 23 November 2017 - establishing a guideline on electricity balancing; available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2195&from=EN.

Propositions for these attributes are made within the following regional initiatives:

- PICASSO for Automatic Frequency Restoration Reserves (aFRR)
- MARI for Manual Frequency Restoration Reserves
- TERRE for Replacement Reserves (RR)

In addition to these initiatives, agreements on standard product requirements for FCR are made within the Frequency Containment Reserves (FCR) cooperation.

For other types of system services, such as congestion management, such a framework is currently non-existing. From our experience in European projects on the topic (H2020 EUSysflex[87], H2020 CoordiNet[88], H2020 OneNet[89]), it seems that a less strict standardization approach would be preferred as specific, local grid conditions, might require more specific product definitions. In this context, the first level of standardization (having a product template and common attributes) seems more appropriate, with potentially some elements of the second level of standardization. In this perspective, cooperation between ENTSO-E, EU-DSO and ACER will be essential, in particular in the context of the design of a new Network Code for Flexibility. This code will integrate amongst others best practices related to product and service standardization currently developed in the EU projects.

In summary, to avoid discrimination among market parties or technologies, categories of products should be defined according to a commonly agreed template for all services but allowing national/regional implementation to select appropriate values for certain attributes where appropriate. Specific attention should be given to avoid very diverse products or the introduction of too many different products, while still leaving enough room to consider local specificities. The latter is very important for flexibility services which answer DSO needs that can only be solved with locational services and which might demand specific solutions due to the particular locational circumstances which cannot be extrapolated easily to other regions.

Recommendation 4.1.3: Design of products for non-frequency ancillary and congestion services considering technology-neutrality and the participation of LV flexibility

Following steps should be considered:

1) Characterization of the need for flexibility for DSOs (for congestion management, voltage control,…) by the DSOs in Belgium. Specifically for the Brussels Capital Region, as study would be needed to identify the current / future flexibility need and potential and the related locations where problems would occur (for instance critical grid zones). More specifically, this means a detailed study on the impact of EVs (including the flexible charging of EVs to provide system services); This study could be a more detailed assessment/follow-up of the Baringa study . This detailed assessment should take into account the more ambitious EV scenario's and should be based on detailed grid calculations. A precondition for detailed grid calculations is the digitalization of the LV grid (see also technical capabilities of the DSO). – Timing: 2021-2022

2) Design of flexibility products for DSOs considering the following elements:

- Defining the flexibility products according to the set template and considering the agreements on product standardization (see recommendation 2)
- Starting from the general principles that will be set in the NC on flexibility
- Consider the LV specificity already in the product design
- Coming to an agreed approach on how to include locational information in the product definition

By organising consultation with relevant stakeholders (TSO, DSOs, FSPs including aggregators, national, regional regulators,…). This can be considered at country level (to seek national alignment) but also at regional level (to include specificities for instance for the Brussels Capital Region). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed or should be incorporated in the scope of the Market consultation organized by Synergrid (see previous recommendation). – **Timing 2022-2023**

[87] Source: https://eu-sysflex.com/
[88] Source: https://www.coordinet-project.eu/
[89] Source: https://onenet-project.eu/

Objective 4.1.4: *More focus should be on the end-consumer and aggregator's business model and related information sharing.*

Aggregation is mostly a precondition for the participation of LV flexibility to flexibility markets, but there are several factors which impact the value of LV flexibility (the revenue sharing approach between the aggregator and the customers, pool composition, impact of flexibility activation on energy bill,…). Moreover, the aggregator's offerings and the business case for LV grid users to take part in flexibility services via an aggregator, are still immature and very often difficult to understand. More attention should thus be paid to the development of viable business models and attractive offerings towards LV customers; These can be very different compared to HV/MV customers, as LV customers typically are risk-averse, want to have a high level of comfort and easy-to-understand contracts and offerings. Moreover, the amount of flexibility and the predictability of LV flexibility is limited, and so is the value of LV flexibility. Very often, the complexity of service delivery is therefore hidden for LV customers and it is typically included in a service package. Further efforts should be done, to increase information sharing on existing aggregator's offerings and to find ways to compare them, considering – among others – the available flexible devices at consumer's premises, quantification of costs and benefits,… The development of objective, supporting tools could be considered to compare these offerings. See also recommendation on commodity pricing (3.6.3).

Recommendation 4.1.4: Development of objective, supporting tools to compare aggregator's offerings hosted by the regional regulator

Such a tool would share information on the different, existing aggregator's offerings and would allow consumers to compare these different options and make informed decisions when selecting an aggregator to valorize its flexibility. The tool should consider several factors such as the available flexible devices at consumer's premises, quantification of costs and benefits,… For BCR, this could be considered for a potential update or extension of the already existing BRUSIM tool .
Timing: 2022-2023, continuously updated

4.2 Prequalification

Pre-qualification is the process to verify the compliance of a resource to provide a service with the requirements set by the requesting party. A distinction can be made between different phases:

- The prequalification typically starts with a request for **market prequalification** from the FSP. The FSP, as a whole, applies to the market operator to qualify as a flexibility resource for a given flexibility market. The MO checks if the FSP complies with financial requirements, including credit rating (or any other market requirements set by the market operator) and has the necessary communication tools to connect to the market platform. If these conditions are met, the MO provides the FSP with all required authorizations and data. The prequalification of the FSP is valid for its whole flexibility portfolio. This phase can also be linked to the procedure for obtaining a regional licence for the supply of flexibility services.
- Once the FSP is qualified at market level, it submits a **product prequalification** application, based on an agreed general framework, for each flexibility providing unit. To this end, the FSP sends to the buyer of flexibility all technical information required to run predefined tests. Prequalification could be checked per unit or per aggregated unit. In case of the latter, the FSP would be responsible to define the aggregation and to submit the necessary information for its characterization. During this product prequalification, the buyer of flexibility checks whether the flexibility unit can deliver the product. This sub-process tests the technical capability and validates technical requirements (response) of an (aggregated) unit. The buyer of flexibility assesses the quality of the response (considering technical characteristics of the unit (e.g., nominal capacity, energy limitations). Results from analysis of the tests are communicated to the FSP: if the response complies with the specificities of the product, the unit is allowed to offer flexibility for this product. If response is negative, i.e. the unit failed in passing the test, modifications at the FSP side are required. Once these modifications are made, the unit could re-apply for the technical qualification.
- For some products (e.g. inertia, FCR, aFRR) a **grid prequalification** can be run at this stage. The goal is to check that the flexibility does not cause congestion and avoids constraint-related checks later during the procurement phase. However, this is only the case for specific products. This is called *static grid prequalification*. In other cases, a grid constraint analysis is preferable during the procurement (see section 4.3).

4.2.1 Barriers

Category	Barriers for LV flexibility
Complex prequalification process	• Operational processes such as prequalification can be rather complex (limited scalability and automation), constituting an important barrier for participants at low voltage. It however remains important that the simplification of processes does not negatively affect the minimum quality of the process.
Variation in prequalification process	• Different standards, prequalification methods and requirements across Europe, but also on country level for different services, leads to single purpose offerings by technology providers (e.g. EMS), leading to increased costs.
Manual process	• Manual prequalification procedures or requests per flexible connection can cause major barriers for FSPs when considering LV flexibility.
Network Flexibility Study (NFS)	• NFS needed when making use of the flexibility of the users of the distribution system. This can constitute a high administrative burden if it is expanded to LV flexibility and would slow down the prequalification process.
Prequalification for aggregated pools	• Not straightforward how to arrange prequalification at an aggregated pool level (with a large number of assets) rather than for each delivery point individually.
Regional licence for the supply of flexibility services	• Insofar as required by the applicable regional legislation, the FSP must have a license for the provision of Flexibility Services and this at least for the period of validity of the DSO/FSP agreement the procedure and conditions for granting a license to provide flexibility services is currently still under discussion and not aligned between the different regions in Belgium.

4.2.2 Best practices

Example	Barrier	Best and worse practices
	Variation in prequalification process	The four German TSOs procure all control reserves (balancing capacity and balancing energy) commonly across their control areas and partly in cooperation with neighboring countries. Precondition for providing balancing services is the pre-qualification procedure of each balancing service provider (BSP) at the connecting TSO. The prequalification (PQ) can be requested for an aggregated pool. Units that are combined to form a reserve providing unit or group must each jointly meet the prequalification conditions at hand. The number of units that make up a reserve providing unit or group is not restricted, also in terms of the combination of technologies involved. The possibility of pooling/aggregation enables small technical units (such as batteries which are currently delivering FCR in Germany) as well as loads to deliver balancing services. The prequalification process is still needed for each service separately, but the process is aligned as much as possible between the different services, so that it is easier to understand the process and prequalify for multiple services. Some requirements apply to all services, while also service-specific requirements apply. Moreover, the process is the same for the four TSOs. This can be seen as first step towards more uniform prequalification processes. [90]. An example can be found in the IT requirements which are not the same for every reserve type, but conceptually they are so similar that they are called "uniform". Detailed requirements for each of the reserve services, together with a check list, can be found online (https://www.regelleistung.net/ext/static/srl/it).
	Regional licence for the supply of flexibility services	Prior to any supply in the Walloon Region, any flexibility service offer on the distribution or local transport network must be covered by a regional license for the supply of flexibility services. The electricity decree in fact provides in article 35quater, §1. "Any supplier of flexibility services is subject to the prior granting of a license to provide flexibility services issued by the CWaPE."[91] By way of derogation from the previous paragraph, a network user who offers flexibility services through a flexibility service provider is not subject to this obligation. There are two categories of flexibility service provision licenses: • the general license; • the limited license granted to a network user to provide flexibility services from their own facilities and without going through a flexibility service provider. The procedure and conditions for granting a license to provide flexibility services are defined by the order of the Walloon Government of March 28, 2019[92]. A list of license holders for the provision of flexibility services in Wallonia can be found here https://www.cwape.be/node/164#liste-des-titulaires-dune-licence.

4.2.3 Recommendations

[90] Source: PQ-Bedingungen für FCR, aFRR und mFRR in Deutschland, 29 May 2020, available online: https://www.regelleistung.net/ext/download/PQ_Bedingungen_FCR_aFRR_mFRR.

[91] http://www.ejustice.just.fgov.be/eli/decret/2001/04/12/2001027238/justel

[92] http://www.ejustice.just.fgov.be/eli/decret/2001/04/12/2001027238/justel

Objective 4.2.1: *Prequalification processes should be simplified. This means for example:*

1) Standardized prequalification processes for different services and countries to the extent possible.

2) Allow prequalification at aggregated pool level.

Different standards, prequalification methods and requirements exist across Europe, but also on country level for different services. Currently separate prequalification procedures are organised for different frequency ancillary services by Elia in the Belgian context and several distinct steps should be taken. It could be worthwhile to organise a similar procedure for different services, whenever and to the extent that this is possible (e.g. a combined market prequalification for different services or simplified process once you are prequalified for one market). This could then even be extended to other services which are to the benefit of other requesting parties such as the DSOs. As a minimum, the processes should be aligned for all flexibility services on country level to avoid unnecessary long pre-qualification procedures, leading to inefficiencies. In addition, manual prequalification procedures or requests per flexible connection, should be avoided (e.g. as part of a Network Flexibility study). As a next step European harmonization should be considered.

In summary, the prequalification process should be user-friendly, the number different steps should be limited, and the process should be standardised whenever possible (for different services, for different beneficiaries, at country level but even also at European level where appropriate). To note that in the future, there might be even the option that the 'grid prequalification' step becomes obsolete for (some) products and services in case grid constraints are properly integrated and managed during the procurement and activation phase of flexibility. In the latter case a notification to the DSO might be sufficient.

Prequalification processes can be rather complex (limited scalability and automation), constituting an important barrier for participants at low voltage. For flexibility resources connected to the LV grid, prequalification should happen at an aggregated, portfolio level to be able to meet the minimum product requirements. Product prequalification would then assess whether the pool of assets can deliver the product, while grid prequalification would check whether the grid can transport the delivered energy. It could even be considered to remove or simplify prequalification procedures and testing requirements for too small, too dispersed volumes (e.g. LV consumers). It however remains important that the simplification of processes does not negatively affect the minimum quality of the process and the service delivery.

Recommendation 4.2.1: organise standardized and combined prequalification for different services for different flexibility buyers

The following steps can be distinguished:

1) Organise consultations with all relevant stakeholders to align the prequalification process of all the flexibility services at Belgium level (market operators, TSO, DSO, BRPs, FSPs including aggregators, national / regional regulators, academia and consultants). Specific attention should be given to lower the administrative burden of the prequalification (e.g. in case of prequalification for multiple or additional services), to consider the specificities of new types of flexibility (such as LV consumers which would participate as aggregated pools) and to consider a relevant level of standardization of the process (e.g. some prequalification tests might still need to be service-specific to prove technical capabilities). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed - **Timing: 2022-2023**, periodic review of procedure (e.g. yearly) and when new services are proposed.

European harmonization could be a next step. The expected NC for Flexibility might already propose more harmonised rules for prequalification - **Timing: to be determined.**

4.3 Procurement and activation

In this section we will focus on the procurement and activation phase of flexibility. In the procurement phase, bids are collected, and the market is cleared. Next the activation of selected FSPs must be performed.

As mentioned in section 4.2, a grid constraints analysis is preferable during the procurement phase. A distinction can be made between

- **Dynamic prequalification**, whereby the DSO determines *day ahead or intraday (ex ante)* where congestion may occur and activation of flexibility should be limited (e.g. by means of power flows or power thresholds) as opposed to static prequalification (see section 4.2).
- **Integration of grid constraints in the market clearing** of the relevant flexibility market. This has important consequences on the *data sharing needs from the DSO to the market operator*.
- After the market clearing, the DSO can perform an **ex post validation**. If the market result can lead to grid problems, the market solution is rejected, and the *activation of certain flexibility is prevented (redispatch).*
- Final **explicit procurement** of flexibility **via a (local) flexibility market** by the DSO.

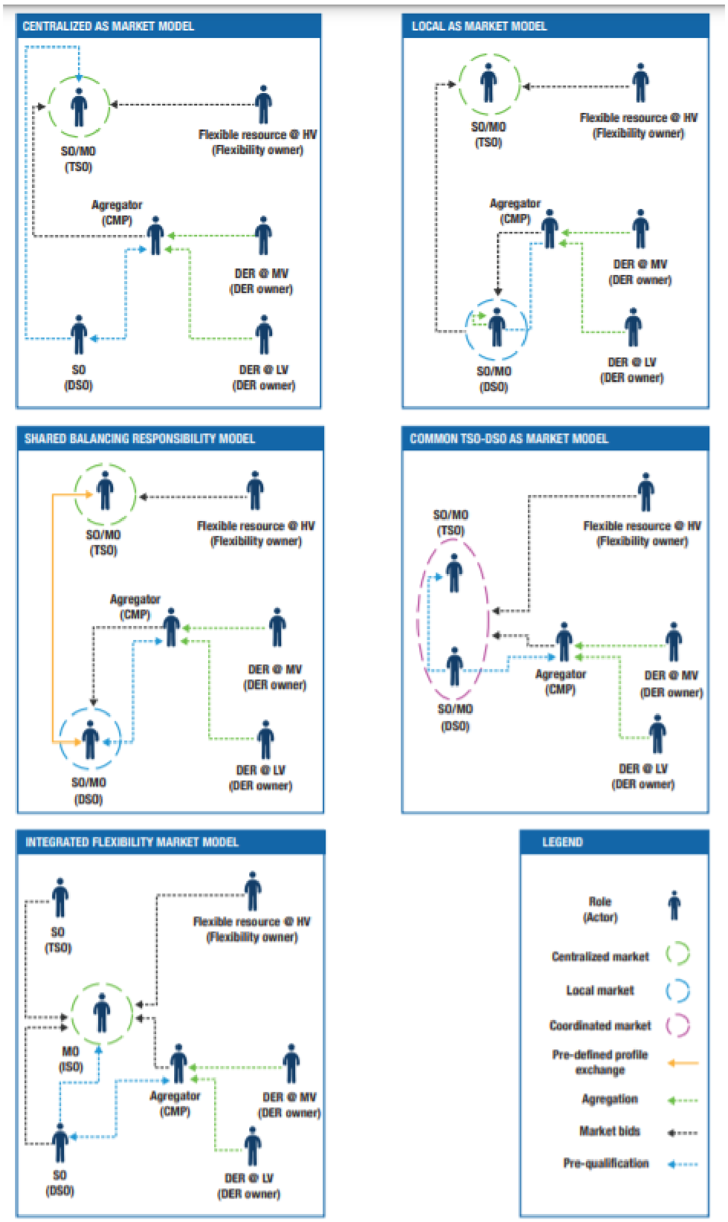
Aside from these options, a **technical fallback** could be put in place as a last option, after the procurement phase. This entails monitoring the grid status in real time, and automatically limiting access to the grid when the grid parameters approach their limits. This can be done centrally, by means of measurements on the transformer, but also, for example, by means of local measurements in the flexible devices (voltage droop control).

4.3.1 Barriers

Category	Barriers for LV flexibility
TSO/DSO coordination	• A variety of coordination models between TSO/DSO exist, with different implications for roles and responsibilities of TSOs and DSOs.
Fragmented markets	• If every buyer (the TSO, the different DSOs) of flexibility organizes its own market to cover its own needs, this could lead to market fragmentation and lack of (price) transparency. From an FSP point of view this would make it more difficult to valorize its flexibility via different markets at different times. From a societal point of view, this would lead to higher costs as possible synergies between markets are not realized.
Energy imbalance	• The activation of local flexibility can create energy imbalances. To account for this, different alternatives are possible either to have strong coordination with the TSO to account for such imbalances or to counter-activate a bid to keep the balance unaltered. This imbalance risk could also be managed as FSP responsibility.
Integration of markets	• The alignment between local flexibility markets with the EU wholesale and balancing markets may be challenging as they often take place in the same timeframe and coherence between market prices, activation signals, etc. should be carefully considered.
Roles and responsibilities	• Clarity is needed about which market functions should be implemented in the commercial domain and which functions in the regulated domain. • Views on the preference of a Neutral market operator vs. DSO / TSO as market operator diverge.
Market-based procurement by DSOs	• There is unclarity about the meaning of “market-based procurement”, especially for DSOs • There are market liquidity concerns in case of DSO markets, certainly for very local grid issues as the number of potential providers is limited. • For DSOs, non-delivery can have a very big impact (e.g. outage, failure of network components), so the DSO should be able to rely on flexibility delivery and would always strive to have a back-up option • There is no framework yet to incentivize and adequately remunerate DSOs to procure flexibility. Financing of grid operators must support the use of flexibility.
Market power	• Market competition is a concern in local flexibility markets due to network characteristics (radial grids) and potentially limited flexible

	resources availability as the ability that FSPs can exercise market power is higher with low liquidity. When liquidity is poor, other alternatives have to be considered.
Network representation in the market	• Accounting for network characteristics and computation of impact factors which consider/estimate the impact of flexibility activation on the grid, will be key to properly remunerate the provision of grid services. Dynamic impact factors computed at short-term timeframes and possibly accounting for different network configurations could be an efficient solution but require significant computational and forecasting efforts and further investigation.
Locational information	• There is a lack of an automated, reliable way for aggregators to determine the location of LV assets in the power grid (e.g. when aggregators want to provide congestion management services, they need to know the location of the congestion).
Market outcome	• The market outcome of flexibility services might not be transparent for LV grid users (no pure economic merit order, also technical aspects; part of aggregator's pool,...)
Mechanisms for LV	• Since flexibility on the low-voltage grid is mainly characterized by a large number of flexible loads, with a low power and flexibility value per device, it is important that proposed mechanisms have a low cost, are simple and can be automated.

4.3.2 Best practices

Example	Barrier	Best and worse practices
SmartNet	TSO/DSO coordination	The SmartNet project[93] proposed and analysed a number of possible interaction schemes between TSOs and DSOs related to ancillary services provision by distribution grid connected resources. As can be seen in the figure below, the project proposed 5 coordination schemes (task lead by VITO/EnergyVille) through which TSOs and DSOs could cooperate. This work has been taken as a starting point for a lot of follow up research and publications in the policy domain such as the Common TSO-DSO report on Active System Management[94]. 

[93] http://smartnet-project.eu/

[94] Source: CEDEC, EDSO, ENTSO-E, Eurelectric, GEODE, 2019. TSO-DSO Report An integrated approach to active system management with the focus on TSO-DSO coordination in congestion management and balancing; Available online: https://eepublicdownloads.entsoe.eu/clean-documents/Publications/Position%20papers%20and%20reports/TSO-DSO_ASM_2019_190416.pdf

The table below gives an overview of the characteristics of some of the pioneering commercial local flexibility markets focusing on congestion management which can be found across Europe.[95] It should be noted that LV customers currently don't participate yet to these markets.

	Piclo Flex	Enera	GOPACS	NODES
	piclo Flex	enera	GOPACS	NODES
Timeframe	Months ahead	Intraday	Intraday	Intraday, weeks ahead
Market clearing	Auction	Continuous trading	Continuous trading	Continuous trading
Participation	Voluntary, no restrictions	Voluntary, no restrictions	Voluntary, no restrictions	Voluntary, no restrictions
Flexibility market operator a third party?	YES	YES	YES	YES
Reservation payment	YES	NO	NO	Optional
Standardized products	YES	YES	YES	NO
TSO-DSO cooperation	NO	YES	YES	YES
Explanation market platform	Piclo Flex[96] is an independent marketplace for trading energy flexibility online. It has over 300 flexibility providers and over 10 GW flexibility capacity. Different network operators (UK power networks, Scottish Southern electricity networks, Western Power Distribution, SP Energy Networks, electricity North West)., energy suppliers and flexibility providers come together in different organized competitions on Piclo Flex.	Enera[97] is an Initiative launched by EPEX Spot (market operator), EWE (energy producers) and the network operators EWE NETZ, Avacon Netz and TenneT focused on the northern area of Germany. The main goal is to enable flexible solutions to avoid uneconomic curtailment of excess wind energy. In Enera, network operators can buy flexibility in the intraday timeframe to proactively alleviate congestion.	GOPACS[98] is an initiative of the Dutch grid operators. It is a platform through which grid operators together with other market parties and large consumers aim to decrease congestion on the grid. The purpose of the platform is to ensure that more parties with flexibility have more easy access to the growing market of congestion services.	The NODES market platform[99] is an independent market place to facilitate a coordinated exchange and interaction among the various market agents. Through the NODES market, flexibility providers can offer their assets into the market where different technologies can compete on a level playing field, ensuring that the DSO is able to buy the right type of flexibility at the lowest price available in the congested area.

[95] Sources:
https://www.sciencedirect.com/science/article/pii/S0957178720300126;
http://www.ceem-dauphine.org/assets/dropbox/CEEM_Working_Paper_47_Th%C3%A9o_Dronne_Fabien_Roques_et_Marcelo_Saguan.pdf
http://www.interrface.eu/sites/default/files/publications/INTERRFACE_D3.2_v1.0.pdf
[96] https://picloflex.com/
[97] https://bremen-energy-research.de/projects/enera/
[98] https://www.gopacs.eu/
[99] https://nodesmarket.com/nodesmarket/

4.3.3 Recommendations

Objective 4.3.1: *Market integration and coordination between system operators should be considered when developing new markets or changing existing markets.*

Different flexibility markets are at different maturity levels: wholesale markets and frequency ancillary services markets are already very mature, while markets for congestion and voltage control (both for the DSO and the TSO) are currently emerging and under development. The importance of TSO–DSO coordination for these market processes to ensure the security of supply, is widely accepted. Discussions on how such coordination should take place have led to different propositions of coordination schemes. A coordination scheme is defined *as "the relation between TSO and DSO, defining the roles and responsibilities of each system operator, when procuring and using system services provided by the distribution grid*[100]". Different schemes have been proposed, but one of the main distinguishing factors is whether separate markets or common markets to procure different services for both the TSO and the DSO are considered. There seems to be a general consensus that there does not exist a one-size-fits-all coordination scheme. This is because local circumstances, market maturities, regulatory conditions… differ between TSO and DSO grids and between countries. Several projects are currently investigating this topic more in detail (H2020 CoordiNet[101], H2020 Interrface[102], H2020 OneNet[103]).

General recommendations are that TSOs and DSOs should pay special attention into implementing coordination between the different market processes they are active in, such as markets for balancing and congestion management. Several options of coordination between market places exist; They should be framed at European level and assessed at national level. A proposed description of models for market coordination for balancing and congestion management is made in the Common TSO-DSO report on Active System Management[104].
Coordination between different market processes and actors should aim to avoid discrepancies such as double activation of the same bid, or counter-effects that could endanger the system, or it could be considered to integrate different market places to avoid market fragmentation. Market integration can be realized in two distinct ways:

1) separate markets (e.g. for congestion) can be organised, but these markets can be integrated in a smart way in the timing sequence of existing markets (wholesale markets, markets for other system services, dispatch mechanisms);
2) integrated or common markets can be set-up which are completely integrated into the operations of existing energy markets (e.g. day-ahead, intraday, balancing markets).

Both options have their merit, and further investigation would be needed. In case of separated markets (e.g. for congestion), the activation of local flexibility can create energy imbalances. To account for this, different alternatives are possible either to have strong coordination with the TSO to account for such imbalances or to counter-activate a bid to keep the balance unaltered. It should be noted that fully separated markets without consideration of the timing and impact of other markets should definitely be avoided. Flexibility can be used in many different markets and products; If every buyer of flexibility organizes its own market, this could lead to market fragmentation and lack of transparency.

The recently started H2020 project OneNet will focus on the question how to integrate markets across different dimensions. OneNet will develop an open and flexible architecture to transform the actual European electricity system, which is often managed in a fragmented country or area-level way, into a pan-European smarter and more efficient one. The aim will be to ensure that markets and network technical operations are reciprocally coordinated closer to real time among themselves and across different countries.

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[100] Source: Gerard, H., Rivero Puente, E.I., Six, D., 2018. Coordination between transmission and distribution system operators in the electricity sector: A conceptual framework. Util. Policy 50, 40–48, Available online: https://doi.org/10/gc49cb

[101] Source : https://www.coordinet-project.eu/

[102] Source : http://www.interrface.eu/content/home

[103] Source: https://onenet-project.eu/

[104] Source: CEDEC, EDSO, ENTSO-E, Eurelectric, GEODE, 2019. TSO-DSO Report An integrated approach to active system management with the focus on TSO-DSO coordination in congestion management and balancing; Available online: https://eepublicdownloads.entsoe.eu/clean-documents/Publications/Position%20papers%20and%20reports/TSO-DSO_ASM_2019_190416.pdf

Recommendation 4.3.1 Development of coordinated and integrated TSO-DSO markets

In coordination with all system operators, following steps should be considered for the coordination between explicit flexibility markets:

1. Study on the future needs for system services (frequency and non-frequency), for both TSO and DSO, in a high RES (2030) scenario. For Brussels Capital Region, this means a detailed study on the impact of EVs (including the flexible charging of EVs to provide system services); This study could be a more detailed assessment/follow-up of the Baringa study . This detailed assessment should take into account the more ambitious EV scenario's and should be based on detailed grid calculations. A precondition for detailed grid calculations is the digitalization of the LV grid (see also technical capabilities of the DSO). – **Timing: 2022**

2. Harmonised product design for balancing and congestion products (following recommendations Network Code Flexibility) – joint agreement between all Belgian SOs – **Timing: 2022 – 2023**

3. 3-phase implementation of TSO-DSO coordination models for the procurement of explicit flexibility use. Each implementation step is ideally prepared and tested in the context of a pilot project. The coordination model could be different between regions
   1. Phase 1: Centralized TSO-DSO coordination model, with DSO grid constraints considered during procurement to the extend needed (different options can be considered, see above) – Timing: 2025 - in this model, the DSO is not yet procuring flexibility for own (congestion) needs
   2. Phase 2: Local flexibility market organized by the DSO, with priority for the DSO to procure flexibility for local needs (remaining flexibility can be used for TSO-services)– Timing 2025 - 2030 – in this model, both TSO and DSO use flexibility from LV, due to the urban nature of Brussels Capital Region, local needs need to be supported first – model is sufficient to kick-start the flexibility market for DSOs as long as availability of flexibility for both TSO and DSO is sufficiently higher compared to the needs
   3. Phase 3: Common TSO-DSO coordination model – no priority for TSO or DSO but flexibility is assigned to the SO to maximize social welfare – Timing (to be followed up) – model is relevant for a mature market for flexibility, in case both TSO and DSO actively need flexibility for multiple services and an integrated approach is needed, in particular in case of close-to-real-time markets

In case of a common TSO-DSO coordination model, it is essential that the system conditions are reflected in real time (both for TSO and DSO) – this would mean an extension of the current proposal of the CCMD (Consumer-Centric Market Design) market model of Elia. **Timing (to be followed up)**

Objective 4.3.2: *Further clarification of roles and responsibilities in particular for the Market operator role*

A role may not always be adopted by the same party. For instance, the flexibility market operator role can be assigned to a third party (independent market operator) or the system operator could be the market operator for system services. This is currently mostly the case for markets for frequency ancillary services, i.e. in Belgium Elia operates the markets for the procurement of FCR, aFRR and mFRR. A Flexibility Market Operator is a *"neutral party that transparently provides a central service between buyers and sellers to facilitate the communication and coordination of all processes related to the procurement of capacity and/or energy bids, i.e. grid or asset registration on its market place, matching of bids, validation (through market monitoring) and settlement*[105]*"*. A market operator can thus be seen as a pivotal stakeholder, fulfilling some key functions related to the operation of the market, necessary for the market to work efficiently. They should safeguard neutrality, transparency and efficiency. These operational objectives, characterising the role of a market operator, influence the decision on which stakeholder can take up this role, given a certain market framework. As mentioned, the activities of a market operator can be performed by an existing stakeholder or by a new, independent market actor. The former implementation model is only possible in a single buyer market in which the system operator (also being the market operator) is the only requestor for flexibility in that relevant market. The latter implementation of a third-party market operator, or an independent market operator, can be applicable in any market set-up since the independence of the new market stakeholder is assured.

[105] Source: Deliverable: D2.2 Business Use Cases to unlock flexibility service provision, Euniversal, April 2021. Available online: https://euniversal.eu/wp-content/uploads/2021/05/EUniversal_D2.2.pdf

Specifically related to local, flexibility markets to solve DSO needs, the DSO has several solutions to solve its needs and the optimum of such solution and flexibility activation can be an interdependent mixture of several solutions. Consequently, if there would be a neutral market operator, to derive the most efficient solution, either iterations between the market operator and the DSO are needed or the market operator needs to receive comprehensive grid information, which depicts the electrical properties of the grid including the network reconfiguration options. In this case, the market operation would become very complex. If the DSO would take up the market operator, iterations between the market operator and the DSOs to find the optimal and secure solution can be avoided. The fact that DSOs would operate their own flexibility markets, could however lead to conflicts of interest and discriminatory access, which may require supporting regulation in terms of market monitoring and auditing[106]. Further investigations are needed on the consequences of both options.

Recommendation 4.3.2 clarification of the role of the market operator in the context of flexibility markets

The following steps could be distinguished:

1) In less mature markets in which there is a single buyer (e.g. a TSO, a DSO) we can assume that a logical first step would be that the flexibility buyer takes up the role of the Market Operator as there would be a certain learning process and liquidity would be limited. Appropriate control on the neutral and transparent market facilitation should be established in the form of supporting regulation in terms of market monitoring and auditing. During the first 2 phases of the 3-phase implementation of TSO-DSO coordination models for the procurement of explicit flexibility use proposed in the previous recommendations, we would therefore assume the TSO and DSO would be acting as market operator for their respective markets**. Timing: according to the market developments.- expectation 2025**

2) When moving towards a common TSO-DSO market, an independent market operator role would be recommended. Further investigations would be needed, which market functions would be attributed to the neutral market operator, to the buyer of flexibility and to the FSPs. A study on the topic would be recommended. – Timing: Study 2023-2025; Move towards independent market operator**: Timing: 2025**

Objective 4.3.3: *Efficient and transparent markets for system services*

As mentioned above, the Clean Energy Package[107] indicates that DSOs should procure flexibility services to cover their flexibility needs under transparent, non-discriminatory and market-based procedures unless the market-based provision of these services is economically not efficient. The directive further emphasizes the need to include all qualified market participants including renewable sources, demand response, storage and aggregators. TSOs already have well-established markets for frequency ancillary services, while similar markets at DSO are still limited.

There are several particularities which should be considered when designing markets for distribution grids. First, DSO grids can be very versatile (e.g. they can encompass HV grids with large consumers and generators up to LV grids where a lot of the grid users constitute residential and commercial consumers and prosumers). The characteristics of the distribution grid where the scarcity is situated will influence the number and type of FSPs that could be used to resolve the issues and consequently, the technical and economic viability of a market solution. Further investigation is needed to determine for which DSO needs and under which circumstances (e.g. down to which voltage level) explicit flexibility markets can be an effective solution to answer DSO needs.

Furthermore, a certain level of grid or locational information should be considered in the market design when establishing markets for non-frequency ancillary services and congestion management, either directly in the market-clearing or during pre-qualification. Dynamic impact factors computed at short-term timeframes and possibly accounting for different network configurations could be an efficient solution but require significant computational and forecasting efforts and further investigation. Several other methods have been studied in literature and in demonstrations, but their practical implications need to be further investigated.

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[106] Source: Deliverable: D2.1 Grid flexibility services definition, EUniversal February 2021. Available online : https://euniversal.eu/wp-content/uploads/2021/02/EUniversal__D2.1.pdf.

[107] Source: Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU; available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0125.01.ENG&toc=OJ:L:2019:158:TOC.

Transparency of market processes and rules should be in place. In addition, clear rules of bids gathering and selection shall be established and the bids selection process should be made transparent towards market parties. Beyond economic merit order, technical aspects such as the geographical location of the provider will be considered in bids selection[108], so that the market outcome might not always be easy to interpret from the FSP point of view.

Specifically related to LV consumers, aggregators need a reliable method to determine the location of LV assets in the power grid. In addition, since flexibility on the low-voltage grid is mainly characterized by many flexible loads, with a low power and flexibility value per device, it is important that proposed mechanisms have a low cost, are simple and can be automated.

Moreover, the DSO should be able to rely on service delivery because the opportunity costs for the DSO can be very high in case of non-delivery (e.g. failing grid assets). Therefore, availability of capacity (reservation of flexibility) can be an important aspect to consider in the design of flexibility markets for DSOs. Moreover, it raises the question of whether priority should be granted to certain flexibility uses to secure the grid operation.

It should be noted that there is general consensus that there is not one market solution which fits all DSO needs and all circumstances, so different solutions will coexist next to each other. As mentioned above considering the context of Brussels Capital Region, we assume that a Local AS Market model (so separate local flexibility markets organized by the DSO) would be the most realistic option in an early stage, while in a later stage these could evolve towards common markets for the TSO and DSOs.

One of the key innovations to be developed and demonstrated is the connection of different market platforms via standard interfaces to enable market participants to access to flexibility products and services offered by different market platforms. The H2020 Euniversal[109] and OneNet[110] are currently focusing on this topic.

Overall, an integrated approach is needed for the design of flexibility markets for DSOs, also considering the integration with other flexibility solutions such as dynamic connection agreements, dynamic grid tariffs and technical solutions using grid assets. Regulatory support is also needed to clarify the exact meaning of what constitutes "market-based procurement" by the DSO. A procedure should also be established to determine whether market-based provision can be considered economically efficient or not.

Recommendation 4.3.3 Study on the different options of local flexibility markets for DSOs applied to the Brussels Capital region, followed by the implementation of a regulatory framework for market-based procurement by the DSO.

1) A study should be carried out on the different options of local flexibility markets for the DSO applied to the Brussels Capital region. **Timing: 2022**

The study should cover several elements which are specific to the DSO context:
1. For which DSO needs and under which circumstances (e.g. down to which voltage level) are explicit flexibility markets an effective solution to answer DSO needs.
2. Comparison of method to include locational information in the market design
3. Options and analysis of different options for bids gathering and selection (economic merit order, techno-economic merit order, DSO optimization)
4. How to include reservation of flexibility in the market design
5. Integration with other flexibility solutions (dynamic connection agreements, dynamic grid tariffs and technical solutions using grid assets)

2) This study should be followed by the implementation of a regulatory framework for market-based procurement by the DSO for BCR.

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[108] Source: CEDEC, EDSO, ENTSO-E, Eurelectric, GEODE, 2019. TSO-DSO Report An integrated approach to active system management with the focus on TSO-DSO coordination in congestion management and balancing; Available online: https://eepublicdownloads.entsoe.eu/clean-documents/Publications/Position%20papers%20and%20reports/TSO-DSO_ASM_2019_190416.pdf
[109] Source: https://euniversal.eu/
[110] Source: https://onenet-project.eu/

Two phases could be distinguished:

1. Regulatory support is also needed to clarify the exact meaning of what constitutes "market-based procurement" by the DSO. This is expected to be clarified at European level within the Network Code Flexibility – **Timing: 2022.**

Afterwards a procedure should be established to determine whether market-based provision can be considered economically efficient or not (compared to grid investments). To set up this procedure alignment at country level between the relevant stakeholders would be useful. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed - **Timing: 2023-2025.**

Objective 4.3.4: *The remuneration of TSOs and DSOs should support the use of flexibility via a market*

The Financing of grid operators (remuneration mechanism) is an important driver for the potential use of flexibility by grid operators. A fundamental prerequisite is the need for combined incentives considering capital and operational expenditures in the DSO revenue regulation, which necessitates similar incentives when weighting between the levels of OPEX and CAPEX to handle a given network congestion over time. Subsequently, this determines their expected remuneration and the most cost-efficient choice of option is made based on the willingness to pay to either carry out, defer or avoid an investment in traditional grid reinforcement. The Flexplan project111 analyses for example the role of flexibility with respect to long term grid planning. Other aspects, e.g. different risks associated with the different solutions, may also be necessary to investigate112. A detailed overview of possible remuneration mechanisms is presented by CEER113. Today, focus is mainly on a shift from traditional Cost+ remuneration mechanisms to mechanisms that stimulate innovation (via direct incentives such as a higher rate of return for specific technologies or via indirect incentives that focus on efficiency gains). Examples are Price/revenue cap regulation, input-based regulation or output-based regulation. In particular output-based regulation is interesting to support an innovative approach. The UK and to a certain extent Italy are examples of an output-based incentive remuneration mechanism114. Although these systems are more suited to support innovations by DSOs, they do not account for possible synergies between a TSO and a DSO as this requires a 'whole system approach'.

In the future, incentive schemes for DSOs to tackle new regulatory challenges, might need to follow a holistic approach, i.e. a "whole system approach". The whole system approach focuses on the "system" concept, trying to identify the net benefit that regulatory decisions may bring for the whole electricity system. Therefore, it is vital to recognize the roles and responsibilities of DSOs and TSOs, e.g. to clarify if benefits in distribution grids have an impact on transmission system operations[115]. This means that also remuneration mechanisms in the future should account for a more 'integrated approach', i.e. in some cases, a certain flexibility activation provides benefits for both TSOs and DSOs. Moreover, a joint approach is beneficial for the entire system (welfare maximization) compared to individual actions of TSOs and DSOs. CEER proposes that *"The regulatory arrangements, and in particular controls on revenue recovery must support a competitive market and efficient 'whole system' outcome. Controls on revenue recovery for DSOs and TSOs should create incentives to optimise outcomes for the system as a whole, rather than focusing on minimising the DSOs' and TSOs' costs in isolation."*[116]

Recommendation 4.3.4 Implementation of integrated approach for TSO and DSO remuneration

The evolution of the remuneration mechanisms for DSOs that support the 2030 goals of the Brussels Capital Region, could be split into several phases:

1. Defining a remuneration mechanism that fosters innovation by the DSO (without focus on an integrated system approach). This means in a first step moving away from a cost+ mechanism to input-based mechanisms (for example revenue cap or price cap). A more disruptive proposal would be to immediately move towards an output-based mechanism

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111 Flexplan H2020 Project (flexplan-project.eu)
112 https://www.ceer.eu/documents/104400/-/-/f65ef568-dd7b-4f8c-d182-b04fc1656e58
113 f04f3e11-6a20-ff42-7536-f8afd4c06ba4 (ceer.eu)
114 adl_fields_of_innovation_for_energy-grid_operators.pdf (adlittle.it)
115 https://www.ceer.eu/documents/104400/-/-/f04f3e11-6a20-ff42-7536-f8afd4c06ba4

116 https://www.ceer.eu/documents/104400/3731907/C16-DS-26-04_DSO-TSO-relationship_PP_21-Sep-2016.pdf

(with output incentives that go beyond the quality factor) - similar as in the UK. We recommend a detailed study on 1) the main drivers for innovation that should be supported by Sibelga (for example based on some of the barriers mentioned in this study) 2) the assessment how different remuneration mechanisms could be aligned with the most important innovation drivers 3) a careful calibration of the different incentives incorporated in the remuneration mechanism. ***Timing: Study to be executed in 2021 – 2022***

Defining a remuneration mechanism that fosters innovation + takes into account a 'whole system approach'. The design of such a system has not been executed yet in Europe. More R&D is needed and the implementation of such a system will only become relevant in case of a more mature common TSO-DSO flexibility market. ***Timing: dependent on market development - expected 2030***

4.4 Settlement

The measurement and financial settlement have to be performed to compensate for the service delivered or penalize the lack of response. To perform these process, measurement data is needed. The financial settlement would require comparing the measurements with the commitments to deliver the service if cleared in the market.

4.4.1 Barriers

Category	Barriers for LV flexibility
Current settlement rules	• Due to the current aggregated allocation of the consumption of low-voltage grid users to BRPs based on market share, activation of LV flexibility cannot be accounted for and has no impact on individual portfolios of BRPs.
Conflicts on remuneration	• Conflicts on remuneration and accounting of energy flows may arise when implicit and explicit flexibility mechanisms are combined (for instance a customer has two different contracts, one with its supplier with implicit DR and one with an independent aggregator providing explicit DR)
Baseline methodology	• Quantifying the amount of flexibility (typically expressed as energy) that has been delivered by LV consumers is not straightforward, due to absence of appropriate data and a lack of an appropriate methodology for baselining of LV consumers.
ToE	• Impact that activated flexibility has on the imbalance must be considered, whether or not through a fee • Note: This is already partly regulated by the ToE rules, but not all flexibility is covered (only balancing products). To enable energy transfer for products of the DSO or other (local) flexibility products, similar rules are needed at regional level. • It should however be noted that ToE rules can constitute an important barrier for LV flexibility accoras this would entail that the aggregator needs to align for each (LV) consumer part of its portfolio with the supplier and the Balance Responsible Party of this consumer in case of flexibility delivery, which is an administratively heavy process, but can also constitute a high cost compared to the value of the flexibility. This is also highlighted as one of the main barriers according to the white paper issued by Elia on the CCMD (June 2021)
Multiple BRPs	• When different BRPs are involved on one LV connection point: it is not straightforward which energy needs to be assigned to which BRP, especially when flexibility is offered.
Sub-metering needed	• The metering point (at the connection point) is not necessarily the optimal place to register flexibility delivery. Typically, sub-metering data could be needed for measuring service delivery in LV context.

4.4.2 Best practices

Baseline methodologies

Several baseline methodologies are used in the context of flexibility markets. An overview is given in the figure below, based on [117].

[117] Source: https://private.coordinet-project.eu/files/documentos/5d72415ced279Coordinet_Deliverable_1.3.pdf

Historical data approach	• It is **based on a demand resource's historical interval meter data**, which may also include other variables such as weather and calendar data (Averaging methods (X of Y variants) , Regression, Comparable day, Rolling average method)
Statistical sampling	• This methodology **uses statistical sampling to estimate the electricity usage** of a flexible resource **where interval metering is not available** on the entire population.
Maximum base load	• It is based solely on a Demand Resource's ability to **maintain its electricity usage at or below a specified level** during the activation of the service (Coincident, Non-coincident)
Meter before/meter after	• Here, the **electricity demand over a prescribed period of time prior to deployment is compared** to similar readings during the sustained response period.

The most widely used historical data approach are the averaging methods, which create baselines by averaging recent historical load data to build estimates of load for specific time intervals. Regression takes an extensive data set and determines the relationship among a number of different variables, such as weather, time of day and demand, among others. The comparable day method allows an aggregator to find a day that is similar to the event day and use the load of that similar day as the baseline for the actual event day. The Rolling average baseline uses historical meter data from many days, but it gives greater weight to the most recent days
Statistical sampling: meter data can be used to create a baseline for a group of sites and, then, a method is used to allocate the load to specific sites. This baseline uses statistical sampling to estimate the electricity consumption of an aggregated demand resource where interval metering is not available on the entire population.
Maximum Base Load (MBL) methods identify the maximum energy usage expected of each customer and, then, set a specific level of electricity usage that is equal to the maximum level, minus the committed capacity of the customer.
For example, coincident uses peak hours that are chosen based on system load peaks, and a non-coincident baseline also uses peak hours, but they are determined according to the individual load behaviour and not by the system load.
Finally, in the meter before/meter after method, the measurement before the activation of the service is used as a baseline.

Best practices of how to create a baseline specifically for LV flexibility are currently not available. The difficulty of establishing baselines for LV is also mentioned in the CCMD as proposed by Elia. A possible solution put forward in the CCMD is the use of the Energy Hub as 15-minute flexibility register to simplify ToE arrangements and possible baseline methodologies and procedures to be implemented.

Aggregator Implementation models and Transfer of Energy models

A classification of Aggregator Implementation Models and accompanying Transfer of Energy models has been proposed in[118] They are summarized in the table below. Only the models with dual BRPs have been mentioned, as these are relevant for the Belgian situation.

Table 1: Overview of Aggregator Implementation models and Transfer of Energy models in the case of dual BRP [118]

Model	Explanation	ToE model
Contractual model	In the contractual model, the Aggregator associates with his own BRP. Balancing parameters are corrected through a hub-deal (ex-post) between BRPagr and BRPsup, transfer prices are based on contractual arrangements.	Aggregator will source the energy ex-post from BRPsup through a hub-deal. Sourcing volume equals the difference between measurement and baseline. A price formula needs to be agreed upon, preferably using a standardized method.

[118] Source: https://www.usef.energy/app/uploads/2017/09/Recommended-practices-for-DR-market-design-2.pdf

Uncorrected model	In the uncorrected model, no perimeter correction is performed and no volume transfers occur between the AGR and SUP. The activated volume is settled through the regular balancing mechanism.	Energy is not transferred. In general, DR activation will result in imbalance for the BRPsup. BRPsup is remunerated through the regular balancing mechanism, if passively contributing to balance restoration is incentivised by the balancing mechanism. If the Aggregator is active on balancing or adequacy services, the remuneration takes place against (in general favourable) balancing prices.
Corrected model	In the corrected model, the Prosumer's consumption profile is modified, based on the amount of flexibility that has been activated (realised) by the Aggregator. In general, this is done by directly modifying the meter reading. The remuneration for energy takes place through the prosumer, based on retail prices. The Aggregator associates with his own BRP	No financial remuneration needed since the SUP can bill the same energy volume as if no activation has occurred. Since energy is transferred through the Prosumer, the Aggregator will (in general) compensate the Prosumer for the energy that has been billed, but not consumed (or vice versa in case of load enhancement), depending on contract conditions
Central settlement model	In the central settlement model, the Aggregator associates with his own BRP. A central entity corrects the balancing perimeters following a DR activation. Compensation for the open supply position is also settled by this central entity, based on a pre-defined price formula	Rules are required to enable the central entity to transfer the energy between BRPsup and BRPagr. In addition, a price formula is needed that is applied for the transferred energy and paid by the party into which perimeter the energy is transferred into.
Net benefit model	The net benefit model is similar to the central settlement model, yet the cost of compensating the BRPsup is not born by the Aggregator but partly or entirely socialized. Socialization may be limited to situations where DR brings energy savings.	The impacted supplier is compensated for the sourced but not delivered energy based on a regulated price formula. The cost of this compensation is socialized if certain conditions are met.

4.4.3 Recommendations

Objective 4.4.1: *Establish clear measurement, validation and settlement procedures, taking into account harmonisation efforts.*

In general, measurement, validation and settlement procedures need to be designed and implemented on national level. However, there is a strong need to harmonise these procedures at EU level to the extent possible, to support cross border exchange of services and avoid market entry barriers for aggregators and FSPs.

Due to the current aggregated allocation of the consumption of low-voltage grid users to BRPs based on market share and a limited set of simplified Synthetic Load Profiles, activation of LV flexibility cannot be accounted for and has no impact on individual portfolios of BRPs. With the introduction of smart meters, allocation based on actual measurements would become possible. These topics are part of the MIG6 processes as discussed in section 5.2 There is however still a lot of uncertainty to which extend this would not bring too much complexity. There are several lines of thought to cope with this, like adapted SLPs with a higher degree of segmentation among different consumer groups. Further analysis of the different options and stakeholder consultation is needed on the topic including discussion on the proposal put forward in the CCMD as presented by Elia.

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Recommendation 4.4.1 Stakeholder alignment on measurement, validation and settlement procedures for different flexibility services and different flexibility buyers

It would be recommended to establish harmonized measurement, validation and settlement procedures at national level to the extent possible. Certain flexibility services might however still need specific procedures due to their technical nature (e.g. FCR). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed **- Timing: 2023-2025.**

Objective 4.4.2: *Establish appropriate baseline methodologies for flexibility services, considering also specificities of LV flexibility*

It is important to note that the baseline methodology used for quantification of the flexibility service delivery should be the same as the one which should be used for the Transfer of Energy or perimeter correction (when applicable, see recommendation 3).

For the FSPs that already have to prepare individual schedules (e.g. CIPU units providing day-ahead nominations to Elia), no additional baseline would be required, as the schedule of the FSP would serve as a baseline. For the other providers, it is recommended to develop a categorisation of best practices for baseline design, and a methodology for selecting and validating baseline methodologies[119].. The scope would encompass all flexibility services, i.e. wholesale markets, frequency and non-frequency ancillary services, congestion management. This action could be led by power exchanges, TSOs and DSOs, with their associations, in close cooperation with market parties. Baseline methodologies can be differentiated depending on the service and product (so considering the technical requirements of the product) and possibly differentiation according to types of flexibility resources (technologies) is needed, but standards could be shared among different countries (e.g. EU level). The latter is certainly needed for quantifying the amount of flexibility (typically expressed as energy) that has been delivered by LV consumers, so a shared uniform approach would be beneficial (although it can be differentiated by types of flexibility providers). At the current moment Member states and even system operators have the liberty to set the baselines. Aggregators need to be involved in this consultation process. An appropriate baseline methodology should take into account a balance between transparency, accuracy, data needs, and gaming potential. A first attempt on a tool to help on the baseline method selection process considering the different characteristics of the product and the participants to which the baseline is applied to, has been developed as part of the H2020 CoordiNet project[120].

An alternative approach, which has certainly its merits for new services and new flexibility providers, is a free choice of a baseline methodology by the FSPs (including aggregators), in consultation with the service requester (as is currently the case for aFRR in Belgium). This would allow the FSP to choose the most appropriate method adapted to the needs and characteristics of its portfolio. This could be seen as an intermediary measure, to allow to test and develop new approaches. When the solutions would then be more mature, they should be proposed as standard technologies, after an approval process. This is important as the remuneration to which the FSP is entitled depends entirely on the establishment of the baseline.

Recommendation 4.4.2 Develop best practices for baseline design

The following phases can be distinguished:

- For new services and new flexibility providers: a free choice of a baseline methodology by the FSPs (including aggregators), in consultation with the service requester (as is currently the case for aFRR in Belgium) can be allowed. This would allow the FSP to choose the most appropriate method adapted to the needs and characteristics of its portfolio. This could be seen as an intermediary measure, to allow to test and develop new approaches. When the solutions would then

[119] Source: Demand Side Flexibility Perceived barriers and proposed recommendations, European Smart Grids Task Force, Expert Group 3, April 2019; Available online: https://ec.europa.eu/energy/sites/ener/files/documents/eg3_final_report_demand_side_flexiblity_2019.04.15.pdf

[120] Source: Deliverable D1.3 Definition of scenarios and products for the demonstration campaigns v1.2; Available online : https://private.coordinet-project.eu//files/documentos/5d72415ced279Coordinet_Deliverable_1.3.pdf

be more mature, they can be proposed as standard technologies, after an approval process – **Timing: starting 2022 – recurring action for new services**

For more mature services and baseline methodologies: a categorisation of best practices for baseline design, and a methodology for selecting and validating baseline methodologies for all flexibility services should be developed. This action could be led by power exchanges, TSOs and DSOs, with their associations, in close cooperation with market parties. - **Timing: starting 2022 – periodic updates for new methodologies**

Objective 4.4.3: *Avoid unwanted gaming or strategic behaviour.*

In addition, market monitoring, at national level or potentially at EU level, should be organised to monitor and prevent strategic behaviour and gaming by market players, certainly when FSPs are allowed to determine their baseline methodology themselves. This is also very important to provide an up-to-date view of how much flexibility is unlocked and available for the market, and how much has been activated in all relevant markets and products.

Recommendation 4.4.3 Market monitoring

Market monitoring, at national level (or potentially at EU level), should be organised to monitor and prevent strategic behaviour and gaming by market players and to provide an up-to-date view of how much flexibility is unlocked and available for the market, and how much has been activated in all relevant markets and products. – ***Timing: starting 2022 – recurring updates (e.g. each quarter)***

Objective 4.4.4: *Correct accounting for flexibility provision and perimeter correction*

Following the CEP[121], member states should establish an appropriate implementation model and approach to governance for independent aggregation. A model for perimeter correction (also called Transfer of energy) is very important; The CEP further stresses that the *"chosen model should contain transparent and fair rules to allow independent aggregators to fulfil their roles as intermediaries and to ensure that the final customer adequately benefits from their activities".*

Regarding the allocation of energy volumes, a distinction can be made between two types of services: flexibility services where the net impact on shifted energy volumes is limited (e.g. FCR) and services where larger energy volumes would be shifted (e.g. aFRR). For the former, a model without BRP perimeter correction could be considered, while for the latter, it is important to have clear rules for the correction of the BRP perimeter. This line of thought is also followed in Belgium currently, where FCR is exempted from Transfer of Energy obligations.

In general, for services where considerable energy volumes are traded, perimeter correction rules should be clarified at a National Level following the principles stated in the CEP. Basic principles are that the effects of the activation of energy by the FSP on the supplier and on the BRP of the grid user in question offering flexibility should be compensated. The Belgian ToE model can be seen as an important and front-running example and a best practice, but it would be advised to also look at alternative perimeter correction mechanisms which are being implemented to challenge the solutions put in place. In particular, the compensation rules should be studied in more detail, in order not to distort the markets. Several recommendations on Transfer of Energy price methodology have been proposed in[122]:

- The price profile used for the Transfer of Energy should have a high resolution, preferably on ISP level (Imbalance settlement period) or on DA spot market resolution, rather than a single price per year, month or day, to reflect actual sourcing costs or actual energy prices.
- Ideally the ToE price should be determined on consumer level. However, to reduce complexity, the number of price methodologies / price levels should be minimized. A diversification between commercial/industrial and residential consumers might be a solution, since the sourcing strategies and costs may differ strongly. It should

[121] Source: Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU; available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0125.01.ENG&toc=OJ:L:2019:158:TOC.

[122] Source: https://www.usef.energy/app/uploads/2017/09/Recommended-practices-for-DR-market-design-2.pdf

however be noted that too much differentiation might be costly and might disclose commercially sensitive information.

- The ToE price methodology should either reflect sourcing costs or avoided (retail) revenues.
- The ToE price methodology should be resource type independent.
- The ToE price methodology should be activation-time dependent (e.g. distinguish between services which are traded day-ahead and intraday)
- The ToE price methodology should be flex-market independent.
- It should be considered whether handling costs should be considered in the calculations.

Further investigations on how these principles could translate to the Belgian flexibility services, would be needed.

To enable energy transfer for products of the DSO or other local flexibility products, similar rules are needed. It should however be noted that ToE rules can constitute an important barrier for LV flexibility according to independent aggregators, so an impact analysis would be needed to determine to what extend the current ToE rules can be extrapolated to LV consumers. Further issues on remuneration and accounting of energy flows may arise when implicit and explicit flexibility mechanisms are combined (for instance a customer has two different contracts, one with its supplier with implicit DR and one with an independent aggregator providing explicit DR). Further study would be needed on how implicit and explicit DR should interact and how this should be reflected in the ToE, but also in the baselining methodology applied. In some cases, sub-metering might be most appropriate to allocate the activated flexibility. In this case, also the baseline methodology should be applied on the level of the sub-meter. The impact of sub-metering on the business case for flexibility for LV customers should however also be considered as this constitutes an additional cost.

An alternative solution to the current ToE rules, specifically targeting also residential consumers, is currently proposed by Elia, in the form of the 'Exchange of Energy Blocks' ('EoEB') hub[123]. This can be seen as a special case of the 'corrected model' (see 4.4.2), in which the consumer's profile is modified, based on the amount of flexibility that has been traded. The EoEB entails a decentralized exchange of power on a 15-minute basis between consumers and any other market party (including different suppliers and service providers). The consumption profile of the consumer will be adapted with the sum of all transactions undertaken within a 15-minute timeframe, while grid tariffs, levies and taxes will be calculated and settled based on the actual (measured) profile. The EoEB hub is an extension of the current BRP hub, through which BRPs exchange energy as it is a mechanism to net out energy volumes settled at the imbalance price. In this case no bilateral contract is needed between FSPs and suppliers as is the case in the current ToE rules. The concept would further allow that energy is sourced from different sources without requiring any additional submetering. Mutual matching could be validated by a neutral third party and would be covered in the settlement. The needed splitting concepts however still need further investigations.

Recommendation 4.4.4: Investigate the suitability of the current Belgian ToE methodology and the proposed EoEB concept for new Flexibility services and providers

The Belgian ToE model was one of the front-running example to allow independent aggregations, but it is not easily extendable to LV consumers. It would therefore be advised to also look at alternative perimeter correction mechanisms which are being implemented to challenge the solutions put in place. The EoEB concept is recently proposed by Elia as an alternative solution. The EoEB concept should be further investigated in terms of practical implementation and scalability and afterwards an accompanying regulatory framework needs to be drafted (access rules for the EoEB hub, to what extend flexibility trades need to be validated with measurements, splitting concepts to determine traded volumes and subtract them from the measured profiles,…). Also, some measures to protect the final consumers would be needed (e.g. restrictions on exchanges). Further study would also be needed on how implicit and explicit DR should interact and how this should be reflected in the proposed methodology.
This action could be realized via several actions:

1. Stakeholder consultation to further develop the concept, also focusing on the future procurement of Flexibility by DSOs. The latter could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed - **Timing: 2023.**
2. Demonstration of the EoEB concept with a representative consumer group (pilot) – **Timing 2024**
3. Drafting of an accompanying regulatory framework– **Timing 2025.**

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123 https://www.elia.be/-/media/project/elia/shared/documents/elia-group/publications/studies-and-reports/20210618_elia_ccmd-white-paper_en.pdf

4.5 Dynamic connection agreements and curtailment options

Different regulators are starting to consider the implementation of dynamic connection agreements. These are agreements between the system operator and the Grid Users (which can be large consumers and generators, but also small consumers) in which the latter agrees to have the connection curtailed in some periods, according to certain predefined rules. Demand could for instance be temporarily reduced during the periods of load peak demand, whereas generation could be curtailed to avoid network contingencies such as congestions or voltage issues in case of generation peaks. . Such dynamic contracts can also be considered for EV charging points.

4.5.1 Barriers

Barriers for LV flexibility	
Dynamic connections	• The potential of dynamic connection agreements (e.g. curtailment in shorter timeframes) is today not yet considered while it can increase the grid hosting capacity, also in the context of LV grids.
Curtailment	• The process for access restriction must be done according to transparent and fair rules. • A compensation fee (a curtailment fee) could be considered.

4.5.2 Best practices

See also all examples listed in Section 2.1.2

Example	Barrier	Best and worse practices
	Dynamic connections	In Flanders, connection with flexible access ("Aansluiting met Flexibele Toegang (AmFT)") can be permitted for connecting a production installation if this connection would be refused in accordance with the standard rules in force due to a lack of capacity due to congestion, but this is seen as a temporary measure.
	Nonfirm capacity	Flex GV was a MV nonfirm capacity agreement trial by Alliander, that ended December 2017. It targeted industrial CHP and flex loads. The DSO communicated a red/green grid status 15 minutes ahead. Green means that the access capacity can be exceeded up to the connection capacity; red that the offtake must be limited below the contracted capacity. The pilot was discontinued, as participants did not respond to a red signal, as there were no financial penalties when constraints were not respected.

4.5.3 Recommendations

Objective 4.5.1: *Identify the potential of dynamic connection agreements, taking into account other flexibility mechanisms as well.*

As mentioned in the barriers section, the potential of dynamic connection agreements is today not yet considered while it could be an approach which can increase the grid hosting capacity, also in the context of LV grids. Our main recommendations here would then also be to further investigate the potential of dynamic connection agreements and the different options which are available to implement these agreements:

- The extent to which access can be curtailed (completely, partly);
- Whether this would be a temporary solution or not;
- Whether it would be an optional or mandatory measure;
- To which types of grid users it would apply;

- The compensation offered for the curtailment.

In any case the process for access restriction in the context of dynamic connection agreements, must be done according to transparent and fair rules. A compensation fee (a curtailment fee) should be considered, although it is also an option that a certain 'free band' is considered. Alternative financial incentives could be for instance cheaper connection cost. The remuneration should be designed properly and the limitations to grid access must be transparent and predictable for grid users. An appropriate policy framework would be needed.

Recommendation 4.5.1 Comparison of different flexibility mechanisms in the context of LV flexibility

A study is necessary to assess if for Brussels Capital Region, the required participation of LV flexibility is best obtained by the use of a dynamic tariffs, via dynamic connection agreements (active by the SO when needed) or via explicit flexibility markets. **Timing: 2022 .**

This study can start from 1) the Energy Transition Fund Project 'ALEXANDER' (2021 – 2025) which will examine the heterogeneous nature of LV consumers in relation to the design possible flexibility mechanisms and 2) the output of the sandboxing phase of the IO.Energy use case (IO.Energy 2.0) where the impact of a joint tariff signal for congestion management (Elia – ORES) will be analysed for a selection of LV customers.
In particular, in relation to the proposed CCMD (Consumer-centric Market Design) as presented by Elia, it is important to define a market design that includes both implicit and explicit flexibility mechanisms + ensures that the design of both implicit and explicit flexibility mechanisms is aligned to avoid conflicting signals to end consumers.

5 Data perspective

In the following sections, barriers, best practices and recommendations are presented covering the data perspective. The topics covered are: data availability (section 5.1), data sharing (section 5.2), privacy (section 5.3).

5.1 Data availability

5.1.1 Barriers

Barriers for LV flexibility	
Low LV grid observability	• Full automation of the LV grid ("the last mile") is costly (CAPEX for sensors and measurement units and OPEX for communication) and complex due to its size. DSOs therefore usually lack good observability in the LV grids, while, with increasing DER penetration rates, good observability will become a necessity for flexibility delivery validation (for TSO/DSO)
Sub-metering needed	• The metering point (at the connection point) is not necessarily the optimal place to register flexibility delivery. Typically, sub-metering data needed for service delivery in LV context to collect data at the right time interval (depending on the product definition).

Forecasting	• Forecasting not easy at LV distribution level
	  • Good quality forecasting of grid load and generation in the future will become an essential capability as the dynamic nature of the flows in the grid will increase due to changing weather patterns and new user behavior, triggered by dynamic prices (set by suppliers), new types of usage (e.g. EV, heating) and TSO & DSO actions on re-dispatch and balancing across TSO & DSO grid boundaries.
	  • Good forecasting, in Imbalance Settlement Period time frame granularity (by grid operators), is essential to determine whether flexibility needs to be procured in the day ahead or intraday timeframe.

Conservative restrictions	• Due to a lack of data availability, more strict (market) restrictions may be applied then what actually would be required (grid operators stay on the safe side in their grid safety analysis).

5.1.2 Best practices

Please refer to the examples and best practices as given in section 2.1 and section 2.2.

5.1.3 Recommendations

Objective 5.1.1: *Increasing LV observability using digital meter data and by investing in improved forecasting tools.*

A first logical aspect to increase LV observability is the introduction of smart meters. This topic is already considered in section 2.3. In addition, forecasting of load, generation and congestion should be improved at distribution level. Further research is needed on the topic and this is one of the research tracks targeted by the H2020 EUniversal project[124]. It is recommended to investigate how the accuracy of forecasting within distribution grids could be further improved in the day-ahead and intraday timeframes by all market actors and how best practices can be shared (even between countries). In addition, improved registration of existing and future customer assets providing flexibility, should also be implemented (see also section 5.2). The result should be that DSOs and market parties (BRPs) would have better insight through better data input, what load and generation levels to expect in defined timeframes. In this way, the reliability of the need for market-based flexibility improves, and flexibility could be procured in a more efficient and timely manner. In addition, this would allow to enable DSOs to set the threshold levels in a more precise and dynamic way. It should however be noted that the related costs should be considered in the analysis.
For recommendations, we refer to the chapters on LV grid characteristics (2.1.3), Technical capabilities of the DSO (2.2.3), Smart Metering (2.3.3) and Smart Appliances (3.4.3).

[124] Source: https://euniversal.eu/

5.2 Data sharing

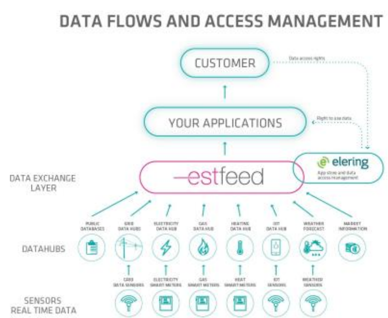
5.2.1 Barriers

Barriers for LV flexibility	
Data framework	• In the context of flexibility delivery, exchange of data between involved stakeholders (grid users, market parties, grid operators etc.) is very important (timely access to correct data, level playing field in data access and data sharing, while respecting customer privacy). A clear framework is currently still lacking.

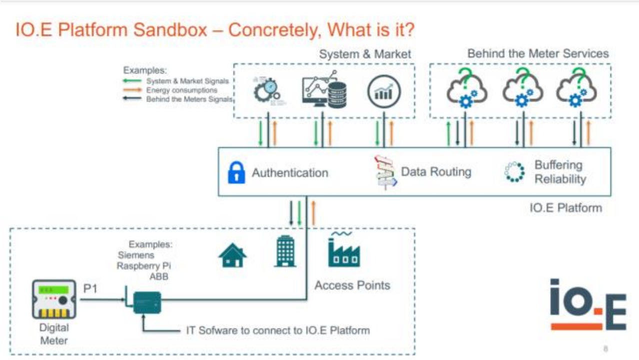
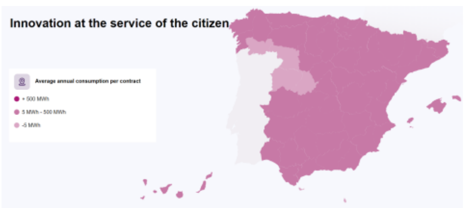
Data access	• Not always clear who should have access to what information.
	  • Consumers also need to have access to their smart meter or other household level data, and give others access to it.
	  • This data will need to be made available in adequate formats for further use by multiple stakeholders. Open questions:
	    • Who gets access to what data?
	    • What data is made public?
	    • Who obtains the permission from the customer to share the data?
	    • Who has responsibility for that data?

Data platform	• Use of data from the end customer for applications of different players can be facilitated via a real time data platform.
Unexploited potential	• There is a huge potential of unused flexibility at distribution level. • A large part of the available residential flexibility cannot be leveraged towards system operators due to the limited information sharing between SOs, FSPs and flexible consumers.
Data manager	• Unclarity about which actor should take up the role of data manager in the future.
Validation of flex delivery	• Clear rules and responsibilities needed for the validation of delivered flexibility. • This is especially a challenge in the case activated volumes need to be determined for aggregated portfolios w.r.t. established baselines.

5.2.2 Best practices

Example	Barrier	Best and worse practices
estfeed	Data platform	Estfeed[125] is the first highly secure platform for exchanging private energy metering data between Data Providers and Data Users with the consent of the Data Owner. Estfeed is designed and operated by Elering AS, the Estonian transmission system operator (TSO). The platform is capable to connect any data source and any data user (consumers as well as 3rd party applications) enabling exchange of personal and commercially sensitive data based on data owner's consent. This includes any data relevant for TSO-DSO, TSO-TSO and DSO-DSO exchanges – e.g. connecting data hubs for meter data or for grid data as data sources or connecting applications relevant for TSO and DSO processes that need access to data. Different data providers can 

[125] https://www.estfeed.eu/en/home

		therefore share both public (like energy price) and private (like metering) data through Estfeed.
	Data platform	The IO.Energy Platform[126] is an "Open and Secured near Real-Time Communication Platform which will ensure secured direct routing and exchange of information (e.g. consumption/injection at access points & market signals) between authenticated energy actors, ranging from market parties and system operators to the consumers themselves". Through the platform, information with a higher granularity and frequency will be shared. This is important to set up energy services to the needs of consumers today and in the future. It will rout the data (1-to-Many), Manage the authentication of the end Points, give the control of the data routing to the Grid users, Transport end-to-end encrypted data. The platform will not store the transported data (except for technical buffering) and it will not be able to decrypt the data nor process them). For more information, check the footnote [127]. 
	Data access Data platform	Via https://mijn.fluvius.be/ end-consumers can consult their personal energy data. This platform is created by the Flemish DSO Fluvius. Consumers with a digital meter can check their energy consumption every day. Fluvius reads out the data from a distance and presents them to the consumer through the mijn.fluvius online platform. Via the website, consumers can also choose whom they share their data with. 
	Data platform	The Green Button[128] initiative is an industry-led effort that responds to a 2012 White House call-to-action to provide utility customers with easy and secure access to their energy usage information in a consumer-friendly and computer-friendly format for electricity, natural gas, and water usage. Green Button aims at standardizing the format and communication of energy data to ensure more easy access to and exchange of the data by any stakeholder.
	Data access Data platform	Datadis[129] is the initiative of a consortium of Spanish DSOs to allow consumers accessing their information on their electricity consumption. Its objective is to ensure that all consumers with a smart meter have access to the 

[126] https://www.ioenergy.eu/about/
[127] https://ioenergy.eu/wp-content/uploads/2019/02/20190220-IO.E-Kick-off_Use-Case-Platform_v_Final.pdf
[128] https://www.greenbuttondata.org/
[129] https://datadis.es/en/about-us

		same functionality and data service. It does not store data, but it acts as an easy-to-use gateway, which even allows to perform administrative tasks on the connection contacts.[130]

5.2.3 Recommendations

Objective 5.2.1: *Improved data sharing through a data framework and platform.*

The past years, a lot of discussions were focused on which actor in the market would take up the role of "data manager". This can be an independent role, but also a system operator (TSO or DSO). In the UK, the role of data manager is assigned to an independent actor, while in Estonia, this role is assigned to the TSO. However, in most European countries, the DSO takes up this role (e.g. Portugal). In Belgium, this activity is entrusted to the DSOs.The data manager is responsible for acquiring and validating meter data and plays an important role in the flexibility settlement process. The responsibilities of the data manager are becoming more complex: aside from measuring and validating metering data, validation of (potentially aggregated) flexibility volumes w.r.t. baselines should be realized to be able to settle delivered flexibility volumes, but also to be able to perform perimeter correction (see also section 4.4). A clear description and division of tasks and responsibilities is needed with respect to the validation of flexibility volumes between the FSP and the data manager (the DSO for the Belgian case).

In addition, the responsibilities and associated tasks of the data manager should be supported by a sound data framework and platform.

Data sharing between system operators, flexibility providers and market parties is in the core of the 'ongoing debate' and a lot of data initiatives and standards exist but none of them are sufficiently implemented by the solutions/market yet. In order to enable smooth data exchange between all parties, important steps must be taken to implement a shared data platform in practice. There must also be rules regarding the desired data format, data standards and simple procedures for sharing data.

The adoption and use of available European standards can be an important basis to improve interoperability, i.e. use a common information model for semantics, for example consider building on the available IEC CIM model.[131] In addition, there should be on-going efforts on smart appliances interoperability, such as SAREF and InterConnect (DT-ICT-10-2018-19) Horizon 2020 project[132] in order to reach an industrial maturity of this technology and its wide implementation by the solution providers.

The creation of a new federal clearinghouse and the implementation of the new energy market process model, MIG6 (operational second half 2021), will have a significant impact on the data exchange and market processes that structure the electricity market today.

The new clearinghouse will simplify data exchange between energy market participants, while the new market model will integrate the latest technologies. With the establishment of a federal central access register, in combination with the MIG6 processes, the information exchange should become uniform. It should simplify the Belgian energy market and increase economies of scale. The MIG6 processes include important enablers for flexibility: the move from 1 single access point (EAN) to 1 head point (HP), with multiple service delivery points (SDP) (e.g. off-take, injection) to allow for more services to be offered and the use of RLPs (Real Load Profiles) which will replace the SLPs (Synthetic Load Profiles)

The individual DSOs will still have the detailed metering data and communicate the necessary data to the data hub that will be responsible for the access register. This approach lowers the threshold for new, external market players to request information from DSOs to provide their services. The use of the described model makes the process flows more flexible and centralized. In addition, greater synergy between suppliers and DSOs is achieved, which means that aggregator switching can take place more easily.

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[130] EDSO Data management position paper (edsoforsmartgrids.eu)
[131] https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf
[132] Source: https://interconnectproject.eu/

Under the current MIG6 proposal, the backend supplies measurement data according to two regimes. A distinction is made here between

- measurement regime 1 (i.e. aggregated measurement data over 1 month or year of the two meters for the offtake and injection) and
- measurement regime 3 (i.e. 15 minutes of measurement datafor offtake and injection).

Sufficient granularity in measurement data is necessary to ensure flexibility in the energy market. A registration of 15 minutes is the desired measurement frequency because the energy market is adjusted to this, although for some services a higher time granularity and thus other measurement equipment would still be needed. The coverage factor of the measurement regime 3 and of the roll-out is therefore very important.

Recommendation 5.2.1: Further clarification roles and responsibilities related to the validation of delivered flexibility trough stakeholder consultation is necessary, in particular further alignment and analysis of the current proposed data framework and initiatives in the context of flexibility delivery towards DSOs should be carefully investigated before implementation.

A clear description and division of tasks and responsibilities is needed with respect to the validation of flexibility volumes between the FSP and the DSO, which is the data manager for the Belgian case. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed - ***Timing: 2022 (for existing flexibility services provided by new flexibility providers) -2025 and beyond (for new flexibility services).***

In addition, the creation of a new federal clearinghouse and the implementation of the new energy market process model, MIG6 will answer a lot of needs related to the measurement and settlement of flexibility delivery. An analysis is however needed on the impact and (future) needs when DSOs start to procure explicit flexibility to cover their own needs. This could be a mix of study work and stakeholder consultation. This could be part of a more general initiative, i.e. a flexibility data task force which would discuss on several relevant topics for which alignment is needed. - **Timing: 2021-2030 (continuous process).**

Objective 5.2.2: *Improved data sharing through the registration of flexibility assets via a Flexibility Resource Register*

As already mentioned, improved registration of existing and future customer assets providing flexibility should also be implemented. This can be realized via a Flexibility Resource Register. The objective of this register is to gather and share relevant information on potential sources of flexibility to improve the competition and utilization of flexibility resources. All data needed by the system operators to use the flexibility from customers would be available. A flexibility resources register will allow system operators to have visibility of which flexibility resources are connected to their grid and to their connected grids, so they know what resources they potentially have available to solve their needs. Responsibility for entering and maintaining the data of the register should be decided at national/regional level.

The flexibility resources register can be used during

- Prequalification: to store data as agreed and evaluated in the pre-qualification process for one or more services (technical information, location, baseline information)
- Market phase: to evaluate bids from FSPs (e.g. location of the flexible resources van be provided in the register)
- Activation phase: to assess the impact of activating the resource in relation to the status of the grid
- Settlement phase: to verify if and how much energy is delivered when comparing the measurements of the meter to the baseline (which is defined in the register).

Recommendation 5.2.2: Implementation of Flexibility Resource Register covering all Flexible resources and all Flexibility services

Establishment of a register in which all relevant information on flexible resources is shared. This could be broadened, and a portal could be foreseen on which potential FSPs find all the necessary information and forms related to the prequalification process of the flexibility services. A first step towards the establishment of such a register is consultation with all relevant stakeholders (on national level, including all regions) on the scope of the register. This could be part of a more general initiative, i.e. a flexibility data task force which would discuss on several relevant topics for which alignment is needed. The scope of the register can also be extended in time. A first simplified "light" version could be implemented first ***– Timing consultation: as from 2022; Timing "light" version: 2023 which is then updated regularly.***

5.3 Privacy

5.3.1 Barriers

Barriers for LV flexibility	
Privacy control	• The use of flexibility requires increased sharing of data, both existing data and new types of data. There is thus a need for appropriate privacy and security controls.
GDPR / e-Privacy	• With the implementation of new privacy legislation (GDPR and future e-Privacy regulation), it is not always clear to the relevant stakeholders, which smart meter data, for which purposes and under which restrictions, could be used without customer consent.
Horizontal legislation	• As the privacy legislation applies horizontally to a number of different sectors, it is sometimes unclear for which particular use cases or under which circumstances smart meter data could be used by SOs.
Smart meter data	• Currently there are different understandings in EU Member States of how the GDPR should translate to the use of smart meter data for grid operations and planning.
Sub-metering data	• A framework for sub-meters data is needed to guarantee the privacy of the end consumer, to guarantee interoperability and to support the "unburdening" of the consumer (requirements for these sub-meters; rights and obligations of sub-meter operators, network operators, end users,…).

5.3.2 Best practices

Example	Barrier	Best and worse practices
SIEMENS energy	Privacy control	 Siemens Energy[133] created e-ing3ni@, a European Energy trading blockchain platform that ensures "person to person" energy transactions across Europe through Blockchain. Due to it, the different agents (producer, consumer and energy retailer) are able to manage their master data, operate the purchase and sale of energy, access reports to know the operation's results, integrate their ERP systems to settle their customers. This blockchain platform shows, at all times, the origin of the energy sources. This provides traceability and transparency of the market agents. Blockchain helped to build transparency where there was none.
Critical	Smart meter data	n3rgy data[134] is created with the aim to eexposee Smart Meter Data to Innovators. They ensure third parties have access to smart meter data. The n3rgy data system makes it easy for innovative organizations to get access to smart meter data. The software is being used to help smart meters communicate across the whole of the UK.
	Privacy control	In countries such as the Netherlands[135], consumers have the right to opt-out from the meter (about 10% does this), or to op-out from remote meter readings (about 3% does this).[136]
	Privacy control	In France, you are obliged to take a digital meter, but the daily consumption indexes are only sent to the DSO once a day. The consumer can give explicit permission to the DSO (opt-in) to allow the Linky meter to transmit data at a higher frequency (half an hour).[137]
	Privacy control	In Flanders, Fluvius collects by default only day values. If the user gives explicit consent, quarter hour data can be collected (exception: use of quarter hour data for the good operation of the grid. But if such data is collected/used, then Fluvius must motivate the use on a case by case basis, and measurements must be limited in time). The P1 user port is closed by default. Via the mijn.fluvius.be platform it can be opened by the user: informed consent and action required by the user self. However, this mechanism has been flagged as too cumbersome by aggregators or other parties trying to make use of P1 data. Via the same platform, the user can close the P1 gate remotely and on simple request.
inrupt	Privacy control	In the medical world, there is increased interest in Berners-Lee's Solid concept, now further developed by his startup Inrupt[138], on the decentralized storage of privacy sensitive data, fully under the control to the user. These 'data vaults' could not only be applied for medical data, but, e.g., also for digital meter data.

[133] https://new.siemens.com/global/en/company/topic-areas/energy-transition/e-ingenia.html
[134] https://www.criticalsoftware.com/en/industries/energy
[135] https://www.energievergelijken.nl/slimme-meter/slimme-meter-weigeren#:~:text=80%25%20aan%20slimme%20meters%20voor%202021&text=Nederland%20is%20dan%20namelijk%20in,halverwege%202019%20een%20slimme%20meter.
[136] https://www.rijksoverheid.nl/onderwerpen/energie-thuis/vraag-en-antwoord/slimme-meter-weigeren#:~:text=U%20mag%20de%20slimme%20meter,uitlezen%20van%20de%20slimme%20meter.
[137] Compteur Linky : obligatoire ou pas ? | lesfurets
[138] https://inrupt.com

5.3.3 Recommendations

Objective 5.3.1: Clear rules on privacy and data security should be established

DSOs need to have a proper legal basis in place to make use of smart meter data to manage the distribution grid. Current national implementation of the privacy protection regulation (GDPR) and also future stricter e-Privacy regulation on data collection should not prohibit this. Although the CEP clearly states that smart meter data also enables DSOs to have better visibility of their networks, there are different understandings in EU Member States of how the GDPR should translate to the use of smart meter data for grid operations and planning. A common EU interpretation on this topic is needed to clarify for what purposes the use of smart meter data (individual and/or aggregated) by market participants and grid operators is allowed without customer consent.

Clear rules must be established to determine: who has access to certain data (with permission or without permission from the owner and/or regulator), who manages the data, under what conditions and at what cost this data can be consulted. This data must be made available in a transparent, neutral and non-discriminatory manner. These rules must be applicable to smart meter data, but also to sub-meter data, where applicable.

Recommendation 5.3.1: Create a common EU interpretation on privacy and data security, followed by information sessions on regulations on privacy and data security.

A common EU interpretation on privacy and data security is needed to clarify for what purposes the use of smart meter data (individual and/or aggregated) by market participants and grid operators is allowed with or without customer consent

To enhance the effect of regulations on privacy and data security, information sessions and training on privacy legislation can be organized for developers of systems that process user data, in order to reduce the number of privacy violations. Sufficient information must also be given to data owners (e.g. LV consumers) so that distrust (about what happens to the data) would not be a barrier to participate in flexibility services

– Timing: 2022-2025

6 Roadmap and outlook to 2030

The following chapter provides a summary overview of the recommendations presented in previous chapters.The recommendations provided in this document provide guidance how the potential of low voltage flexibility can be maximally exploited. For each recommendation, it is indicated if the proposed measures are relevant for the short term (2022), medium term (2025) or long term (2030).

Next, for each recommendation, the possible instruments or relevant actors to consult/coordinate with are highlighted. Table 2 *Instruments* provides an overview of the instruments used for the purpose of this study.

!The recommendations listed in this chapter are a summarized version of the detailed recommendations explained before. The numbering refers to the numbering in the respective previous sections. Each recommendation is connected to a specific objective. This objective has the same number as the related recommendation.

Table 2 Instruments

Instrument	Description
Advice	BRUGEL can define an advice towards the government or other relevant stakeholders.
Ordinance (electricity)	Ordinance of19th of July 2001 related to the organisation of the electricity market in Brussels Capital Region
Tariff Methodology	In line with article 9quater of the Electricity Ordinance, the tariff methodology, determined by BRUGEL, will allow the

	DSO Sibelga to make a tariff proposition, to be presented to BRUGEL for approval.[139].
Technical regulation	Article 92 of the Electricity Ordinance (23/07/2018) defines that BRUGEL is responsible for the approval of the technical regulation as prepared by Sibelga[140].
R&D (study)	Necessity to organize a study (by BRUGEL) or to request the DSO to execute a study as input for decision making
Pilot	In addition to a desk study, pilot projects with innovating character could be set-up as well[141]
Synergrid Working groups	Working groups (permanent and ad hoc) between all Belgian system operators[142]
Stakeholder consultation	General public consultation – including consumer participation
DSO investment planning	Investment planning SIBELGA for the period 2022 - 2026[143]
European Network Codes	Rules drafted by ENTSO-E, with guidance from the Agency for the Cooperation of Energy Regulators (ACER), to facilitate the harmonization, integration and efficiency of the European electricity market. Important codes are the NC for Electricity Balancing (EB)[144], the System Operation Guideline (SOGL)[145] and the ongoing discussion for a possible future NC for Flexibility
Model Contract FSP-DSO[146]	Model contract between the DSO and de FSP in the context of: primary reserve (FCR), secondary reserve (aFRR), tertiary reserve (mFRR), strategic reserve (SDR), capacity remuneration mechanism (CRM) and Transfer of energy in day-ahead and intraday (ToE)
ACER	European Union Agency for the Cooperation of Energy Regulators (ACER)[147]
FORBEG	Forum of Belgian Energy Regulators[148] – consultation forum for all Belgian regulators (federal and regional)
CREG	The Commission for the Regulation of Electricity and Gas[149] - federal regulator for gas and electricity
ELIA	Belgian Transmission System Operator
Sibelga	Distribution System Operator BHG
Other	Other regulation in place (e.g. privacy regulation, regulation for European standards,…)

139 https://www.brugel.brussels/publication/document/notype/2019/nl/Methodologie-Tariefmethodologie-Inleiding-doelstellingen-Elek.pdf

140 https://www.sibelga.be/uploads/assets/1298/fr/20190412071511000000-Reglement-technique-gestion-reseau-distribution-electricite-Region-Bruxelles-Capitale-acces-a-celui-ci.pdf

141 https://www.brugel.brussels/publication/document/decisions/2021/fr/DECISION-159-APPROBATION-FINANCEMENT-PROJETS-INNOVANTS.PDF.pdf

142 http://www.synergrid.be/index.cfm?PageID=16881

143 https://www.brugel.brussels/publication/document/notype/2021/nl/Investeringsplan_Elek.pdf

144 https://www.entsoe.eu/network_codes/eb/

145 https://www.entsoe.eu/network_codes/sys-ops/

146 http://www.synergrid.be/index.cfm?PageID=16832#

147 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0001:0014:EN:PDF

148 https://www.vreg.be/nl/overleg-belgische-energieregulatoren

149 https://ca.practicallaw.thomsonreuters.com/w-030-3627?transitionType=Default&contextData=(sc.Default)&firstPage=true

Recommendations		2022	2025	2030	Instruments
TECHNICAL PERSPECTIVE					
2.1 LV grid characteristics Objectives: ✓ *No time should be lost in attempting to translate MV/HV solutions that are incompatible with the LV grid characteristics to the LV grid. Solutions should be defined starting from the specific LV grid conditions.* ✓ *The role of different flexibility mechanisms (in particular. dynamic connection agreements) should be investigated*					
2.1.1 Synergrid members/ should start from the principle that LV flexibility requires a specific and dedicated approach.	a) BRUGEL could consult with Synergrid in the context of the the Synergrid market consultation[150] to highlight the need for a dedicated LV approach'	✓			Synergrid working groups Advice Technical regulation
	b) Further consultation for more dynamic prequalification processes is required (see also recommendations Prequalification (section 4.2.3) and necessary pilots should be established to investigate promising options		✓		Stakeholder consultation Pilot Technical regulation
	c) For other aspects in the process (procurement, activation and settlement) dedicated pilots should be defined taking into account the specific nature of LV flexibility (see also recommendations 'Procurement and activation'(section 4.3.3) and 'Settlement' (section 4.4.3)).		✓		Stakeholder consultation Pilots Technical regulation
2.1.2 Non-firm capacity agreements are an interesting angle to increase the capacity that can be made available for LV flexibility.	a) The Synergrid members can be requested to consider and investigate this potential solution (non-firm capacity requirements) by a dedicated study. See also Recommendation 4.5.1	✓			R&D Synergrid working groups
	b) Sibelga could be requested to to define and set up concrete pilots on its own territory to investigate LV flexibility, e.g. to design and investigate non-firm capacity or other solutions		✓		Pilot Technical regulation
2.2 Technical capabilities of the DSO Objectives: ✓ *A clear view should be established on the actual and future needs for the grid in combination with a view on the current state of the infrastructure. This allows a more targeted development of the necessary technical DSO capabilities to support LV flexibility.* ✓ *The DSO should be stimulated to execute the necessary R&D activities to develop the necessary DSO capabilities.* ✓ *The DSO should be stimulated to execute the necessary pilots to develop the necessary DSO capabilities* ✓ *Based on a good view of the needs for the grid and the state of the infrastructure, necessary tools/capabilities should be developed by the DSO to support the uptake of LV flexibility*					

[150] http://www.synergrid.be/download.cfm?fileId=Synergrid_Market_Consultation_210401_NL.pdf&language_code=FRA

Recommendation 2.2.1 A detailed study should be set-up to define the impact of future ambitious climate scenarios on the distribution grid of the Brussels Capital Region.	The Brussels Energie-klimaatplan 2030 (NEKP)[151], as approved in 2019 by the Brussels government, sets the high-level climate objectives for the Brussels Capital Region. First step is to translate this plan into a concrete 2030 scenario containing the objectives with respect to the LV distribution grid: to realize the climate plan, how many EVs, EV chargers, HPs, PV systems, etc. will be required by what year? What will be the spread of these appliances across the Brussel Capital Region territory, considering socio-economic factors, and preferably on statistical sector resolution? This study could be a more detailed assessment/follow-up of the Baringa study[152]. (see also recommendation 4.3.2)	✓	R&D
Recommendation 2.2.2 To support Sibelga to continue the active development of the necessary technical capabilities, BRUGEL could initiate following studies:	a) Recommended study, by Sibelga: Sibelga could be proposed to make inventory of the current state of each MV/LV transformer and each LV feeder and to categorize them in strong, intermediate and weak, with results aggregated for Brussels and at statistical sector, and per the category description below Recommendation 2 in Section 2.4. this study would yield a view on the starting position of the Brussel Capital Region's LV grid, it's strengths and weaknesses. The study can assist the decision process on pro-active investments.	✓	R&D
	b) Recommended study, by Sibelga: Given the 2030 electricity scenario, Sibelga could extend the previous study results and calculate the impact of this scenario on a per transformer and feeder level, with results aggregated for Brussels and at statistical sector. Sibelga could be asked to make inventory of how many feeders are sufficiently strong, will require reinforcement regardless, or if alternative solutions can avoid congestion (e.g., dynamic prequalification, non-firm capacity agreements or other forms of flex procurement). The total aggregated numbers then give a view on the required future investments, and the potential of flex solutions. The statistical sector results give a view on which districts within the	✓	R&D

151 Energie-Klimaatplan (NEKP) \| Leefmilieu Brussel

152 http://www.synergrid.be/download.cfm?fileId=Synergrid_EV_Grid_Impact_ExternalReport_v3_0.pdf

	Brussels Capital Region require custom solutions				
Recommendation 2.2.3: To support Sibelga to make progress on the active development of the necessary technical capabilities, explicit requirements could be taken up in the technical regulation:	Alternatively, or additionally, via the technical regulations, Sibelga could be asked to build the capabilities to categorize the MV/LV transformers and LV feeders, as described above and in Section 2.4, as a required capability to obtain accurate and future proof LV grid investment plans, and as a required tooling to investigate and quantify the impact and effectivity of technical regulation on, e.g., EV charging, flexibility, PV, etc.[153]		✓		Technical regulation
Recommendation 2.2.4 : To maximally support LV flexibility, Sibelga needs following technical capabilities to be able to communicate the grid state:	a) Accurate grid layout database - A necessary step is the set-up of an accurate grid lay-out database according to the best practices and criteria as explained before	✓			Technical regulation
	b) Accurate view on the grid state (better grid visibility) – a second step is the development of the capabilities to obtain an accurate view on the grid state	✓			Technical regulation
	c) Optimal infrastructure – in parallel with the previous step. The assessment of the optimal infrastructure should be incorporated/aligned with the investment plan 2022 - 2026 as presented by Sibelga[154]	✓	✓		Sibelga investment planning
	d) Setting-up of the relevant communication on the grid status to the relevant external stakeholders, where the calculation of grid constraints is based on sound academic fundamentals.		✓		Technical regulation
	e) For Sibelga, as a medium sized DSO, and given the specific elements of the Brussels Capital Region, the pro-active way forward to continue the development of the required LV technical capabilities to fully support LV flexibility, is through partnerships and cooperation with the Belgian DSO's.	✓	✓	✓	Synergrid working groups

2.3 Smart Metering

Objectives:

✓ *The definition of the specifications of the next generation smart meters should be done well in advance to ensure that the smart meter supports both current and future system/consumer needs.*

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[153] For instance, such capabilities would help address and provide evidence based data on the question as to how effective V droop control is, given the urban shorter and denser feeders, and the dominance of 230V delta grids in the Sibelga LV grid.

[154] https://www.brugel.brussels/publication/document/notype/2021/nl/Investeringsplan_Elek.pdf

✓ *The definition of the specifications of the next generation smart meters should consider the specific context of LV flexibility.*			
Recommendation 2.3.1: Specifications next generation smart meters	Defining the specifications of the next generation smart meters is a key decision point that cannot be underestimated, and - although not limited to it – includes various aspects impacting the support of flexibility. Based on the lessons learned in the other European countries, and considering the specificities of the Brussels Capital Region's grid, Sibelga could be requested to carefully consider and list which features to invest in. This should be supported by detailed stakeholder consultation about current and future needs	✓	Sibelga Stakeholder consultation
Recommendation 2.3.2 The requirements for the next gen smart meters should support the further uptake of LV flexibility:	1) Smart meters should be able to collect qualified data from submeters (subject to FDM role decisions). 2) The measurement quantities supported by the Flemish digital meter provide a good starting set. However, there are specific points of attention or improvement: 1. Resolution of all quantities should be sufficiently high to support LV flex use, but also to allow Sibelga to obtain an accurate view on the state of the LV grid. Typically, this is at least 0,1 V/A/W . 2. (Phase) current measurements should have a sign (positive for offtake, negative for injection). 3. Default smart meter technology uses the 2W meter method . This should be avoided, as for 3phase meters in 230V grids the 2W meters method results in measurement data not being available for one of the phases. 3) The user port protocol should support the future extension with information on the capacity and state of the grid, passed from the DSO via the digital meter to the user or aggregator (grid constraints, non-firm capacity settings, …). The free text field in the Flemish P1 protocol is an example of such a mechanism. 4) To support improved asset management capabilities and higher grid visibility, the rollout strategy should ensure that there are digital meters in every feeder that pass quarter hour measurement data, with priority for large consumers/prosumers and end-of-feeder	✓	Sibelga Synergrid working groups Forbeg

	connections. 5) To protect privacy, explicit consent is required to activate the P1 port or to give third party access to smart meter data. However, if too complex, this consent management becomes a barrier. Good practises can be found in the examples of the U.S. Green Button[155] or the Netherlands[156].			

2.4 Grid investment and reasonable capacity

Objectives:

- ✓ *Considerations on grid capacity and LV flexibility should also take the other changing capacity needs into account, i.e., electrification of transport and heating, and decentralized production.*
- ✓ *A clear categorisation of the state of MV/LV transfo's is necessary to ensure the right investment decisions.*
- ✓ *The enforcement of grid constraints by the DSO should be based on transparent criteria, maximizing the participation of LV flexibility in a cost-efficient and grid safe manner.*

Recommendation 2.4.1: Future 2030 scenario for the LV grid in BCR should be established	The study, as proposed in Recommendation 2.2.1 of Section 2.2, is the first step to generate the future 2030 scenario for the LV grid in the Brussel Capital Region. In its studies and investment plans, Sibelga could be requested to plan and account for this scenario, so the focus is not on flexibility solely, but that all relevant grid evolutions are accounted for.	✓		R&D
Recommendation 2.4.2: Categorisation of the state of MV/LV transformers to support investment decisions.	To break the 'invest proactively' or 'invest in function of the market needs' chicken or egg problem, Sibelga could be requested to execute the studies, as proposed in Recommendation 2.2.2 of Section 2.2, which results in the categorization of the MV/LV transfo's and LV feeders into strong, intermediate, and weak; both for today's situation and for the 2030 scenario. Following categorisation is proposed: 1. **Strong**: sufficient capacity to withstand current and foreseen future evolutions. No reinforcement required, but also no business case for flexibility for LV congestion management; 2. **Weak:** reinforcements are required soon and/or regardless; 3. **Intermediate**: the asset does/will/may run occasionally into congestions. This category gives opportunity to investigate (market based) alternatives to reinforcement, such as dynamic prequalification, non-firm capacity	✓	✓	R&D Sibelga investment planning

155 https://www.greenbuttondata.org/

156 www.edsn.nl

	agreements or other forms of flex procurement Note that a relevant sub-study would be to make inventory of the flexibility needs/grid constraints for this category of grids. The latter would be highly relevant information for the LV flexibility market design process. The approach could be proposed for the current and/or next iteration on the **Sibelga electricity investment plan**, presented for consultation in June 2021[157]. Sibelga could compose an investment plan that is based on the results of studies B and C. Sibelga could take the improved view on the state of the LV grid into account in its current and upcoming investment plans, and invest proactively, and/or when opportunity presents itself, in the assets in the weak category This also requires that the DSO first (partly) develops the necessary capabilities as recommended in section 2.2.		
Recommendation 2.4.3: before defining what should be considered as 'reasonable capacity', more research and stakeholder consultation is needed.	A study is recommended to investigate the options as explained above. In addition, to determine an adequate answer to questions what should be considered as part of 'reasonable capacity' , stakeholder consultations are recommended. This recommendation should be considered together with the recommendations provided in section 4.2 on Prequalification and section 4.3 on Procurement and Activation.	✓	R&D Stakeholder consultation FORBEG

END USER PERSPECTIVE

3.1 Consumer engagement and consumer knowledge

Objectives:

- ✓ *In order to get the end consumer involved and to encourage them to use flexibility, while also taking energy consumption into account, the provision of comprehensible information is a core aspect. Therefore, following elements need to be in place: 1) Availability of accurate measurement data and feedback towards the end-consumer, 2) Availability of self-explanatory and easy-to-use feedback tools, 3) Clear communication of (economic) benefits to the end consumer*
- ✓ *Advanced profiling of consumers should guide consumers in more optimal decision making (investments and commercial energy offerings) due to better information tailored to the individual needs of the consumer.*

Recommendation 3.1.1: Study on feedback tools and information needs	Further research is needed on the needs and preferences of the end-consumer in terms of information provision and end-user solutions and apps as part of flexibility	✓	R&D

[157] Investeringsplan_Elek.pdf (brugel.brussels)

from the end-consumer perspective	provision (being it explicit or implicit). Such a study could be specifically targeting consumers within the Brussels Capital Region and should also involve actual consumers (via surveys, focus groups,…). Relevant parameters related to consumer preferences in the context of LV flexibility participation, could be obtained from the first-year results (expected mid 2022) of the ALEXANDER project (Energy Transition Fund)[158]. Alternatively, such a study could also be performed at a national level. Such a study could also be part of a more general study (see Recommendation 4.3.1).		
	After this initial phase the proposed solutions should also be piloted. During the study stakeholder consultation is needed, including consumers, aggregators, DSOs, the TSO, regulators,… Best practices with respect to relevant pilot for LV consumers, considering consumer preferences and feedback mechanisms could be obtained from expected outcome of upcoming pilots within IO.Energy 2.0 (results expected mid 2022)[159].	✓	Pilot Stakeholder consultation
Recommendation 3.1.2: Consumer profiling' for flexibility consumers in the energy market should be executed to guide consumers in making the correct decisions (e.g. investment decisions and commercial offerings)	Consumer profiling for energy users could include following components: • A questionnaire or measurement data from the digital meter can be used to check which devices are present in the end user's home. • Based on a questionnaire that assesses the importance of various criteria - the preferences of the end user can be visualized • On the basis of the two questionnaires mentioned above, an indication can be given about the type of contract that best suits a particular consumer profile	✓	Advice CREG

3.2 Collective flexibility

Objectives:

✓ *Implement a robust regulatory framework for different options of 'collective flexibility', ensuring an equal level playing field for both individual and collective consumers while limiting differences across regions. To do so, it is necessary to:1) Identify all relevant stakeholders and make sure all of them are considered, especially often ignored target groups such as tenants and vulnerable households, 2) Make sure that rights and obligations of different stakeholders are fair, proportionate and transparent, 3) Frequently review and update the policy framework, maximizing synergies between regions.*

[158] Energietransitiefonds | FOD Economie (fgov.be)

[159] IO.Energy Ecosystem co-creating a consumer-centric system (ioenergy.eu)

- ✓ *Ensure that the intrinsic value of collective flexibility could be captured by relevant stakeholders by adapting the regulatory framework (e.g. tariffs) and/or providing explicit incentives when applicable. To be able to do so, it is indispensable that the benefits of different (collective) activities are known so that incentives provided are in line with the created added value. In this regard, the following steps should be taken:1) Identify the different benefits (economic, grid, ecologic, social, socio-economic…) and the receiving stakeholders, 2) Quantify the different benefits per stakeholder, 3) Define weights per benefit, (which benefits do we value more, do we want to incentivize more?), 4)Define incentives in line with the benefits to be achieved*
- ✓ *The operation of collective flexibility is complex, and tools/systems need to be adapted/developed to support the financial and operational management of collective flexibility, ensuring that systems and tools are robust, interoperable, efficient and avoid that consumers are 'locked-in'.*

Recommendation 3.2.1: Define and implement a stable, future-proof regulatory framework for collective flexibility	For BCR, the process of transposition of the EU-directives for CEC and REC should continue (for example with the further detailing of a framework for P2P trade,…), considering best practices from surrounding regions (see also section 3.2.2). In that perspective, it is necessary that too many differences between regional frameworks (Wallonia, Flanders, BCR) will be avoided. See also recommendations made by the working group 'Flexibility' of the 'Stroomversnelling initiative' in Flanders with respect to Energy Communities[160].	✓		Ordinance Technical regulation Forbeg Stakeholder consultation
	The implementation of a robust regulatory framework could be supported by further stakeholder consultation to discuss about roles and responsibilities of different stakeholder groups with respect to different concepts that are relevant for BCR. Extensive stakeholder consultation should lead to: 1) A mapping of all the obligations per stakeholder per activity in the existing framework 2) An evaluation of the need of these obligations per activity (this should be in line with the benefits assumed to be achieved by this activity – see further) 3) Where needed, a definition of adapted obligations per stakeholder per activity A similar concept as developed in Flanders 'Stroomversnelling'[161] with continuous working groups divided by thematic axes could be considered to ensure that the policy framework is adapted regularly in support of different stakeholders.	✓		Stakeholder consultation
Recommendation 3.2.2: Proper incentives for	A study is recommended to identify both benefits and possible incentives for		✓	R&D Pilots

160 https://www.energiesparen.be/sites/default/files/atoms/files/Samenvatting%20Stroomgroep%20flexibiliteit%20sessie%201%202%20en%203_revisie_finaal.pdf

161 Participatief beleid - Energiesparen

collective flexibility should be put in place to properly reflect the value of the collective flexibility from the individual perspective, the collective perspective and a total system perspective. Incentives proposed could be stakeholder specific (e.g. vulnerable consumers,…).	collective flexibility from both individual, collective and system perspective. The proposed study should: 1) Identify the different benefits (economic, grid, ecologic, social, socio-economic…) and the receiving stakeholders 2) Quantify the different benefits per stakeholder 3) Define weights per benefit (which benefits do we value more, do we want to incentivize more?) 4) Define both short-term and long-term incentives in line with the benefits to be achieved The study should be combined with using output from relevant ongoing pilots in different regions (BCR, Flanders and Wallonia – see best practices presented before). For the identification of the benefits of the grid, we also refer to the necessary technical capabilities of the DSO (section 2.2) that are necessary as input for this study. For recommendations related to the design of incentives related to tariff structures, we refer to detailed recommendations in section 3.5). For recommendations related to vulnerable consumers, we also refer to the detailed recommendations in section 3.3)		Tariff methodology
Recommendation 3.2.3: The development of necessary operational tools for the day-to-day operation of collective flexibility, including the appropriate data management, should be supported. This includes for example systems for measurement and calculation of energy flows/flexibility and financial flows.	The development of necessary operational tools for the day-to-day operation of collective flexibility, including the appropriate data management, should be supported. This includes for example systems for measurement and calculation of energy flows/flexibility and financial flows. A distinction should be made between systems/tools for the short-run and systems/tools for the long-run. In the short-run, it is important that these organizational systems do not block the roll-out and implementation of more consumer-centric activities. These activities require knowledge, administration, proper technological and ICT systems… which are not self-evident for many grid-users. Therefore, in the short-run, existing stakeholders should	✓	Pilots Regulatory sandbox Technical regulation

	play a facilitating role by adapting their existing systems to the need of such activities. In the long-run, it should be examined what all the possible alternative systems are and whether other stakeholders could possibly take up different roles. The development of necessary tools could be supported via pilots and/or regulatory sandboxes. In particular for BCR, it is worthwhile to invest further in the future design of the framework for P2P and 'energy sharing'. The outcome of the discussions in Flanders could be used as a starting point.			
3.3 Vulnerable consumers Objectives: ✓ *Ensure vulnerable consumers can participate in flexibility markets. This requires, targeted information campaigns, adapted tariff schemes and necessary consumer tools for market participation.*				
Recommendation 3.3.1: Establish supporting measures targeted towards vulnerable customers	a) Stakeholder consultation would be needed considering all relevant stakeholders at BCR level (consumer associations, regulators, energy market actors, aggregators...) to define the needs of the vulnerable consumers in BCR.	✓		Stakeholder consultation
	b) Study on adequate tariff schemes and flexibility solutions with specific attention to the information provision targeted to vulnerable consumers. See also recommendations in section 3.5.	✓		R&D Tariff methodology
	c) Translating the outcome of the previous two steps in supporting policy measures		✓	Ordinance Advice
3.4 Smart appliances Objectives: ✓ *Increase interoperability by promoting the use of standards, open APIs and Open Data.*				
Recommendation 3.4.1: Support research and pilot projects that improve interoperability	To improve the maturity of control algorithms for the control of flexibility, R&D in developing better algorithms and system architectures could be supported by facilitating pilot projects. In this way, the number of projects and the size of these pilot projects will increase, creating more expertise and know-how in the field. Information campaigns to property developers and home owners about the importance of flexibility can further support this process. Guidelines from the H2020 project Interconnect[162] about		✓	R&D Pilot Advice

[162] Interconnect Project - Homepage

	relevant pilot outcomes could be used as input. See also recommendation related to data availability, sharing and privacy			

3.5 Tariff methodology

Objectives:

- ✓ *Implement a grid tariff design which is supportive for the engagement of LV flexibility. This requires:1) a clear view on the evolutions with respect to future technologies, 2) a clear view on the future expected costs of the DSO, 3) a balance between complexity and a tariff which is 'easy to understand', 4) the availability of supporting tools (e.g. automated control)*
- ✓ *A future proof tariff methodology should capture the dynamics of new patterns of local production and consumption, by considering the introduction of customized capacity tariffs and/or time-varying tariffs. The design of the tariff is supported by advanced modelling of consumer segments and grid impact.*
- ✓ *Ensure that the chosen tariff design is complementary to 1) other flexibility mechanisms and 2) commodity pricing and as such is not creating conflicting signals to the end consumer.*

Recommendation 3.5.1: The introduction of a new grid tariff should start from well-defined scenarios for 1) the future needs and costs of the grid, 2) the expected LV consumer preferences, behaviour and engagement strategies. In addition, necessary tools should be made available to facilitate the introduction.	For scenarios related to future needs and costs of the grid – we refer to the recommendations of section 2.2 and section 2.4. For expected LV consumer preferences, behaviour and engagement strategies – we refer to the recommendations of section 3.1. For appropriate tool development – we refer to the recommendations of section 3.1 and section 3.4.3 For more specific recommendations related to vulnerable consumers – we refer to section 3.3		✓	Tariff methodology
Recommendation 3.5.2: Study (qualitative and quantitative) is needed to accommodate an appropriate grid tariff design for BCR for the next regulatory period	The following recommendation highlights the main steps to be considered for a tariff design study. For a more detailed methodology, we refer to the approach as presented by the Flemish VREG study[163]. When designing a future proof grid tariff design certain steps need to be followed in order to guarantee that the tariff serves both the energy system (e.g. rational grid usage, cost reflectivity, availability of flexibility) and the end-consumer (e.g. fair, simple, transparent tariffs): 1. Establish the future energy scenario and evolution of end consumers 2. Establish a thinking framework with the applicable boundaries and preconditions of grid tariff designs 3. Benchmark the different grid tariff designs qualitatively	✓		R&D Stakeholder consultation Tariff methodology

[163] 20180111_studie_vreg_statusrapport_v11_-_eindrapport.pdf

	4. Develop a quantitative simulation environment which simulates the impact of a grid tariff from two perspectives • Impact on the end-consumer, including a deep dive into specific consumer groups • Impact on the energy system and society 5. Integrate the qualitative and quantitative assessment into integrated recommendations, funnelling the assessment to a specific grid tariff design 6. Iterations can be executed to assess the impact of design alternatives (e.g. attribution of regulated budget to the respective tariff drivers) Ideally this process is accompanied with intensive stakeholder management, consulting the stakeholders along the reformation path. This guarantees that the results obtained are supported by all relevant parties.				
Recommendation 3.5.3: Ensure that the design of a future proof tariff is aligned with other flexibility mechanisms	See recommendation 4.5.1				
3.6 Commodity pricing Objectives: ✓ *Support improved information sharing on commodity pricing for LV consumers, ensuring that consumers are able to understand the pricing and can more easily make a cost comparison between different offerings.*					
Recommendation 3.6.1: Introduction of objective, comparative tool to compare different price offerings on the market, tailored to the individual consumer, hosted by the regional regulator	A tool is necessary to share information on the different, existing supplier's offerings and would allow consumers to compare these different options and make informed decisions when selecting a supplier and a commodity contract. The tool should consider several factors such as the available flexible devices at consumer's premises, the preferences of the end-consumer, certain profiling of the end-consumer,… For BCR, this could be considered for a potential update or extension of the already existing BRUSIM tool. See also recommendation 4.1.4.	✓	✓	✓	Advice In-house tool Forbeg
MARKET PERSPECTIVE					
4.1 Products and services Objectives: ✓ *Opening up all flexibility services to all types of flexibility providers and all voltage levels is necessary.*					

- ✓ *A clear product definition is needed, considering technology-neutrality and a unified approach to include locational information.*
- ✓ *Product standardization and harmonization should take place at an appropriate level.*
- ✓ *More focus should be on the end-consumer and aggregator's business model and related information sharing.*

Recommendation 4.1.1: Opening up all frequency ancillary services for LV flexibility is needed	Adapt the current product definition in line with the NCs on European level and in consultation with relevant stakeholders (including TSO, DSOs, FSPs including aggregators, national, regional regulators…) at country level to allow all types of flexibility providers and all voltage levels to offer the product. These modifications should be in line with the new NC for Flexibility (expected end of 2022) and currently in preparation by ACER.	✓			ELIA Synergrid working groups ACER/CEER European Network code
Recommendation 4.1.2: Creating a framework on product harmonization and standardization	a) Creating a common template with product attributes for different system services (frequency and non-frequency, congestion) which can be used by TSOs and DSOs. This action is dealt with in the Network Codes at European level but could be further detailed at National and Regional level. Cooperation between ENTSO-E, EU-DSO and ACER is essential. Similar as for previous recommendation, this action should consider the recommendations as defined in the new NC for Flexibility. The starting point of a framework for Brussels Capital region/Belgium should also follow the recommendations from The H2020 Bridge Regulatory Working group where new recommendations on product harmonisation will be presented at the end of 2021 .	✓			ACER/CEER Network Codes Forbeg Synergrid working groups
	b) Agreeing on an appropriate level of product standardisation with relevant stakeholders. Stakeholder consultation would be needed at national level, considering the guidelines at European level. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed. In the final product definition, there should be enough room to consider local specificities (see next recommendation). This topic could also be taken up via the initiative of the Market Consultation (Product Design Working group) organized by Synergrid		✓		Stakeholder consultation Synergrid working groups
Recommendation 4.1.3: Design of products for	a) Characterization of the need for flexibility for DSOs (for congestion	✓			R&D Sibelga

non-frequency ancillary and congestion services considering technology-neutrality and the participation of LV flexibility	management, voltage control,…) by the DSOs in Belgium. Specifically for the Brussels Capital Region, as study would be needed to identify the current / future flexibility need and potential and the related locations where problems would occur (for instance critical grid zones). More specifically, this means a detailed study on the impact of EVs (including the flexible charging of EVs to provide system services); This study could be a more detailed assessment/follow-up of the Baringa study . This detailed assessment should consider the more ambitious EV scenario's and should be based on detailed grid calculations. A precondition for detailed grid calculations is the digitalization of the LV grid (see also technical capabilities of the DSO).				Synergrid working groups
	b) Design of flexibility products for DSOs considering the following elements: • Defining the flexibility products according to the set template and considering the agreements on product standardization (see recommendation 2) • Starting from the general principles that will be set in the NC on flexibility • Consider the LV specificity already in the product design • Coming to an agreed approach on how to include locational information in the product definition By organising consultation with relevant stakeholders (TSO, DSOs, FSPs including aggregators, national, regional regulators,…). This can be considered at country level (to seek national alignment) but also at regional level (to include specificities for instance for the Brussels Capital Region). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed or should be incorporated in the scope of the Market consultation organized by Synergrid (see previous recommendation).	✓	✓		Stakeholder consultation Synergrid working group Technical regulation
Recommendation 4.1.4: Development of objective, supporting tools to compare aggregator's offerings hosted by the regional regulator	A tool is necessary to share information on the different, existing aggregator's offerings and would allow consumers to compare these different options and make informed decisions when selecting an aggregator to valorise its flexibility. The tool should consider several factors such	✓	✓	✓	Inhouse tool

	as the available flexible devices at consumer's premises, quantification of costs and benefits,… For BCR, this could be considered for a potential update or extension of the already existing BRUSIM tool .				
4.2 Prequalification Objectives: ✓ *Prequalification processes should be simplified. This means for example:1) Standardized prequalification processes for different services and countries to the extent possible,2) Allow prequalification at aggregated pool level.*					
Recommendation 4.2.1: organise standardized and combined prequalification for different services for different flexibility buyers	Organise consultations with all relevant stakeholders to align the prequalification process of all the flexibility services at Belgium level (market operators, TSO, DSO, BRPs, FSPs including aggregators, national / regional regulators, academia and consultants). Specific attention should be given to lower the administrative burden of the prequalification (e.g. in case of prequalification for multiple or additional services), to consider the specificities of new types of flexibility (such as LV consumers which would participate as aggregated pools) and to consider a relevant level of standardization of the process (e.g. some prequalification tests might still need to be service-specific to prove technical capabilities). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed. European harmonization could be a next step. The expected NC for Flexibility might already propose more harmonised rules for prequalification.	✓	✓	✓	R&D Stakeholder consultation Elia Synegrid Model contract FSP-DSO NC Flexibility
4.3 Procurement and activation Objectives: ✓ *Market integration and coordination between system operators should be considered when developing new markets or changing existing markets.* ✓ *Further clarification of roles and responsibilities in particular for the Market operator role* ✓ *Efficient and transparent markets for system services* ✓ *The remuneration of TSOs and DSOs should support the use of flexibility via a market*					
Recommendation 4.3.1 Development of coordinated and integrated TSO-DSO markets	a) Study on the future needs for system services (frequency and non-frequency), for both TSO and DSO, in a high RES (2030) scenario. For Brussels Capital Region, this means a detailed study on the impact of EVs (including the flexible charging of EVs to provide system services); This study could be a more detailed assessment/follow-up of the Baringa study . This detailed assessment should consider	✓			Synergrid working groups R&D

	the more ambitious EV scenario's and should be based on detailed grid calculations. A precondition for detailed grid calculations is the digitalization of the LV grid (see also technical capabilities of the DSO).				
	b) Harmonised product design for balancing and congestion products (following recommendations Network Code Flexibility) – joint agreement between all Belgian SOs .	✓	✓		Synergrid Forbeg Technical regulation
	c) 3-phase implementation of TSO-DSO coordination models for the procurement of explicit flexibility use. Each implementation step is ideally prepared and tested in the context of a pilot project. The coordination model could be different between regions 1. Phase 1: Centralized TSO-DSO coordination model, with DSO grid constraints considered during procurement to the extend needed (different options can be considered, see above) – Timing: 2025 - in this model, the DSO is not yet procuring flexibility for own (congestion) needs 2. Phase 2: Local flexibility market organized by the DSO, with priority for the DSO to procure flexibility for local needs (remaining flexibility can be used for TSO-services)– Timing 2025 - 2030 – in this model, both TSO and DSO use flexibility from LV, due to the urban nature of Brussels Capital Region, local needs need to be supported first – model is sufficient to kick-start the flexibility market for DSOs as long as availability of flexibility for both TSO and DSO is sufficiently higher compared to the needs 3. Phase 3: Common TSO-DSO coordination model – no priority for TSO or DSO but flexibility is assigned to the SO to maximize social welfare – Timing (to be followed up) – model is relevant for a mature market for flexibility, in case both TSO and DSO actively need flexibility for multiple services and an integrated approach is needed, in particular in case of close-to-real-time markets In case of a common TSO-DSO coordination model, it is essential that the system conditions are reflected in real time (both for TSO and DSO) – this would mean an extension of the current proposal of the CCMD (Consumer-Centric Market	✓	✓	✓	R&D Pilot Synergrid Technical regulation

	Design) market model of Elia. **Timing (to be followed up)**				
Recommendation 4.3.2 clarification of the role of the market operator in the context of flexibility markets	a) In less mature markets in which there is a single buyer (e.g. a TSO, a DSO) we can assume that a logical first step would be that the flexibility buyer takes up the role of the Market Operator as there would be a certain learning process and liquidity would be limited. Appropriate control on the neutral and transparent market facilitation should be established in the form of supporting regulation in terms of market monitoring and auditing. During the first 2 phases of the 3-phase implementation of TSO-DSO coordination models for the procurement of explicit flexibility use proposed in the previous recommendations, we would therefore assume the TSO and DSO would be acting as market operator for their respective markets.	✓	✓		Technical regulation
	b) When moving towards a common TSO-DSO market, an independent market operator role would be recommended. Further investigations would be needed, which market functions would be attributed to the neutral market operator, to the buyer of flexibility and to the FSPs. A study on the topic would be recommended. – Timing: Study 2023-2025; Move towards independent market operator:		✓		R&D Stakeholder consultation Synergrid Technical regulation
Recommendation 4.3.3 Study on the different options of local flexibility markets for DSOs applied to the Brussels Capital region, followed by the implementation of a regulatory framework for market-based procurement by the DSO.	a) A study should be carried out on the different options of local flexibility markets for the DSO applied to the Brussels Capital region. **Timing: 2022** The study should cover several elements which are specific to the DSO context: 1. For which DSO needs and under which circumstances (e.g. down to which voltage level) are explicit flexibility markets an effective solution to answer DSO needs. 2. Comparison of method to include locational information in the market design 3. Options and analysis of different options for bids gathering and selection (economic merit order, techno-economic merit order, DSO optimization) 4. How to include reservation of flexibility in the market design 5. Integration with other flexibility solutions (dynamic connection	✓			R&D Sibelga

	agreements, dynamic grid tariffs and technical solutions using grid assets)			
	b) This study should be followed by the implementation of a regulatory framework for market-based procurement by the DSO for BCR. Two phases could be distinguished: 1. Regulatory support is also needed to clarify the exact meaning of what constitutes "market-based procurement" by the DSO. This is expected to be clarified at European level within the Network Code Flexibility.	✓		R&D ACER/CEER
	c) Afterwards a procedure should be established to determine whether market-based provision can be considered economically efficient or not (compared to grid investments). To set up this procedure alignment at country level between the relevant stakeholders would be useful. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed.		✓	Stakeholder consultation Synergrid working groups
Recommendation 4.3.4 Implementation of integrated approach for TSO and DSO remuneration	The evolution of the remuneration mechanisms for DSOs that support the 2030 goals of the Brussels Capital Region, could be split into several phases. 1. Defining a remuneration mechanism that fosters innovation by the DSO (without focus on an integrated system approach). This means in a first step moving away from a cost+ mechanism to input-based mechanisms (for example revenue cap or price cap). A more disruptive proposal would be to immediately move towards an output-based mechanism (with output incentives that go beyond the quality factor) - similar as in the UK. We recommend a detailed study on 1) the main drivers for innovation that should be supported by Sibelga (for example based on some of the barriers mentioned in this study) 2) the assessment how different remuneration mechanisms could be aligned with the most important innovation drivers 3) a careful calibration of the different incentives incorporated in the remuneration mechanism.	✓		R&D Sibelga Tariff methodology

	b) Defining a remuneration mechanism that fosters innovation + considers a 'whole system approach'. The design of such a system has not been executed yet in Europe. More R&D is needed and the implementation of such a system will only become relevant in case of a more mature common TSO-DSO flexibility market.			✓	R&D Sibelga Tariff methodology

4.4 Settlement

Objectives:

- ✓ *Establish clear measurement, validation and settlement procedures, taking into account harmonisation efforts.*
- ✓ *Establish appropriate baseline methodologies for flexibility services, considering also specificities of LV flexibility*
- ✓ *Avoid unwanted gaming or strategic behaviour.*
- ✓ *Correct accounting for flexibility provision and perimeter correction*

Recommendation 4.4.1 Stakeholder alignment on measurement, validation and settlement procedures for different flexibility services and different flexibility buyers	It would be recommended to establish harmonized measurement, validation and settlement procedures at national level to the extent possible. Certain flexibility services might however still need specific procedures due to their technical nature (e.g. FCR). This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed.		✓		Stakeholder consultation Technical regulation Model contract FSP-DSO
Recommendation 4.4.2 Develop best practices for baseline design	a) For new services and new flexibility providers: a free choice of a baseline methodology by the FSPs (including aggregators), in consultation with the service requester (as is currently the case for aFRR in Belgium) can be allowed. This would allow the FSP to choose the most appropriate method adapted to the needs and characteristics of its portfolio. This could be an intermediary measure, to allow to test and develop new approaches. When the solutions would then be more mature, they can be proposed as standard technologies, after an approval process.	✓	✓	✓	Advice Elia Synergird Technical regulation
	For more mature services and baseline methodologies: a categorisation of best practices for baseline design, and a methodology for selecting and validating baseline methodologies for all flexibility services should be developed. This action could be led by power exchanges, TSOs and DSOs, with their associations, in close cooperation with market parties.	✓	✓	✓	Advice Synergird Stakeholder consultation
Recommendation 4.4.3 Market monitoring	Market monitoring, at national level (or potentially at EU level), should be organised to monitor and prevent strategic behaviour and gaming by market players and to provide an up-to-date view	✓	✓	✓	CEER Forbeg

	of how much flexibility is unlocked and available for the market, and how much has been activated in all relevant markets and products.			
Recommendation 4.4.4: Investigate the suitability of the current Belgian ToE methodology and the proposed EoEB concept for new Flexibility services and providers	The Belgian ToE model was one of the front-running example to allow independent aggregations, but it is not easily extendable to LV consumers. It would therefore be advised to also look at alternative perimeter correction mechanisms which are being implemented to challenge the solutions put in place. The EoEB concept is recently proposed by Elia as an alternative solution. The EoEB concept should be further investigated in terms of practical implementation and scalability and afterwards an accompanying regulatory framework needs to be drafted (access rules for the EoEB hub, to what extend flexibility trades need to be validated with measurements, splitting concepts to determine traded volumes and subtract them from the measured profiles,...). Also, some measures to protect the final consumers would be needed (e.g. restrictions on exchanges). Further study would also be needed on how implicit and explicit DR should interact and how this should be reflected in the proposed methodology. This action could be realized via several actions: 1. Stakeholder consultation to further develop the concept, also focusing on the future procurement of Flexibility by DSOs. The latter could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed -	✓		Stakeholder consultation Synergrid working groups
	b) 2. Demonstration of the EoEB concept with a representative consumer group (pilot) , followed by the drafting of an accompanying regulatory framework		✓	Pilot Technical regulation Model contract FSP-DSO

4.5 Dynamic connection agreements and curtailment options

Objectives:

- ✓ *Identify the potential of dynamic connection agreements, considering other flexibility mechanisms as well.*

Recommendation 4.5.1 Comparison of different	A study is necessary to assess if for Brussels Capital Region, the required participation of LV flexibility is best	✓	✓	R&D Technical regulation

flexibility mechanisms in the context of LV flexibility	obtained by the use of a dynamic tariffs, via dynamic connection agreements (active by the SO when needed) or via explicit flexibility markets. This study can start from 1) the Energy Transition Fund Project 'ALEXANDER' (2021 – 2025) which will examine the heterogeneous nature of LV consumers in relation to the design possible flexibility mechanisms and 2) the output of the sandboxing phase of the IO.Energy use case (IO.Energy 2.0) where the impact of a joint tariff signal for congestion management (Elia – ORES) will be analysed for a selection of LV customers. In particular, in relation to the proposed CCMD (Consumer-centric Market Design) as presented by Elia, it is important to define a market design that includes both implicit and explicit flexibility mechanisms + ensures that the design of both implicit and explicit flexibility mechanisms is aligned to avoid conflicting signals to end consumers.				Tariff methodology
DATA PERSPECTIVE					
5.1 Data availability Objectives: ✓ *Increasing LV observability using digital meter data and by investing in improved forecasting tools.*					
Recommendations	For recommendations, we refer to the chapters on LV grid characteristics (2.1.3), Technical capabilities of the DSO (2.2.3), Smart Metering (2.3.3) and Smart Appliances (3.4.3).	✓			Technical regulation DSO tool-set
5.2 Data sharing Objectives: ✓ *Improved data sharing through a data framework and platform.* ✓ *Improved data sharing through the registration of flexibility assets via a Flexibility Resource Register*					
Recommendation 5.2.1: Further clarification roles and responsibilities related to the validation of delivered flexibility trough stakeholder consultation is necessary, in particular further alignment and analysis of the current proposed data framework and initiatives in the context of flexibility delivery towards DSOs	A clear description and division of tasks and responsibilities is needed with respect to the validation of flexibility volumes between the FSP and the DSO, which is the data manager for the Belgian case. This could be part of a more general initiative, i.e. a flexibility market task force which would discuss on several relevant topics for which alignment is needed.	✓	✓		R&D Stakeholder consultation
	In addition, the creation of a new federal clearinghouse and the implementation of the new energy market process model, MIG6 will answer a lot of needs related to	✓	✓	✓	R&D Stakeholder consultation

should be carefully investigated before implementation.	the measurement and settlement of flexibility delivery. An analysis is however needed on the impact and (future) needs when DSOs start to procure explicit flexibility to cover their own needs. This could be a mix of study work and stakeholder consultation. This could be part of a more general initiative, i.e. a flexibility data task force which would discuss on several relevant topics for which alignment is needed.				
Recommendation 5.2.2: Implementation of Flexibility Resource Register covering all Flexible resources and all Flexibility services	Establishment of a register in which all relevant information on flexible resources is shared. This could be broadened, and a portal could be foreseen on which potential FSPs find all the necessary information and forms related to the prequalification process of the flexibility services. A first step towards the establishment of such a register is consultation with all relevant stakeholders (on national level, including all regions) on the scope of the register. This could be part of a more general initiative, i.e. a flexibility data task force which would discuss on several relevant topics for which alignment is needed. The scope of the register can also be extended in time. A first simplified "light" version could be implemented first	✓	✓		Stakeholder consultation Elia Sibelga Synergrid
5.3 Privacy Objectives: ✓ *Clear rules on privacy and data security should be established*					
Recommendation 5.3.1: Create a common EU interpretation on privacy and data security, followed by information sessions on regulations on privacy and data security.	A common EU interpretation on privacy and data security is needed to clarify for what purposes the use of smart meter data (individual and/or aggregated) by market participants and grid operators is allowed with or without customer consent To enhance the effect of regulations on privacy and data security, information sessions and training on privacy legislation can be organized for developers of systems that process user data, to reduce the number of privacy violations. Sufficient information must also be given to data owners (e.g. LV consumers) so that distrust (about what happens to the data) would not be a barrier to participate in flexibility services	✓	✓		Privacy regulation ACER Forbeg Advice

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