Deliverable 1.2

Definition of common case studies

Authors in alphabetical order

Marie Beudels, Estelle Cantillon, Pierre Henneaux, Mohammad Moradzadeh, Leticia Pieraerts García de la Cuadra, Emmanuel Slautsky, Elise Viadere

Brussels, October 2023

Table of content

Acronyms

CEC	Citizen Energy Community
CPP	Critical-peak pricing
DHW	Domestic Hot Water
DLC	Direct Load Control
DR	Demand Response
DSO	Distribution System Operator
EMS	Energy Management System
EV	Electric Vehicle
HP	Heat Pump
IEMD	Internal Electricity Market Directive (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))
IEMR	Internal Electricity Market Regulation (Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast))
LEC	Local Energy Community
NRA	National Regulatory Authority
REC	Renewable Energy Community
RTP	Real-time pricing
SME	Small and Medium-sized Enterprise
TSO	Transmission System Operator
ToU	Time of Use
V2G	Vehicle-to-Grid
VPP	Virtual Power Plant

1. Introduction

The overarching objective of the DemandFlex project is to study the legal, economic and technical obstacles to the full exploitation of the flexibility potential of electricity demand focusing on the Belgian electricity market. Technological advances, improved business models and market designs, and a clear and supportive regulatory framework can serve as enablers and/or facilitators to unlock the full potential of demand-side flexibility.

DemandFlex project is constructed on a common foundation (WP1) built on the aforementioned three disciplinary pillars (WP2, WP3, WP4). WP1 of the DemandFlex project aims to define a common framework for the project, which is multidisciplinary in nature. This is essential for a common understanding of the various notions involved in the project. The first Deliverable of the DemandFlex project was devoted to identifying the legal, economic, and technical barriers that could hamper the full exploitation of demand flexibility in Belgium, and to proposing our own definition of flexibility in the framework of the DemandFlex project.[1] The present Deliverable aims to define the common case studies that will be further analyzed, from a legal point of view in WP2, from an economic perspective in WP3, and from a technical angle in WP4 of the project.

Among other potential candidates such as heat pumps, district heating systems and vehicle to grid technology, **energy communities** and **retail tariffs** have been selected as the two case studies to serve as the common foundation for the specialized WPs of the Demandflex project.

This choice relies on a number of reasons, which are related to the role that energy communities and retail tariffs can play as key enablers in unleashing the potential of demand flexibility in Belgium and, in particular, in unleashing the potential of demand-side flexibility provision that comes from low and medium voltage consumers. As illustrated in Fig. 1, in 2021, 24% of the final electricity consumption in Belgium came from residential use and 25% from commerce and public services. Consequently, the combined retail sector, accounted for a big chunk of Belgium's overall electricity consumption in 2021. Yet, these consumers have so far remained largely passive in providing such flexibility as they face high information and electricity market understanding costs. They form therefore one of the main untapped potentials for demand-side flexibility provision.[2]

---

[1] https://demandflex.polytech.ulb.be/en/publications/identification-of-the-legal-economic-and-technical-aspects-of-the-demand-flexibility-in-belgium

[2] Hortaçsu, A., Madanizadeh, S. A., & Puller, S. L. (2017). Power to choose? An analysis of consumer inertia in the residential electricity market. American Economic Journal: Economic Policy, 9(4), 192-226.

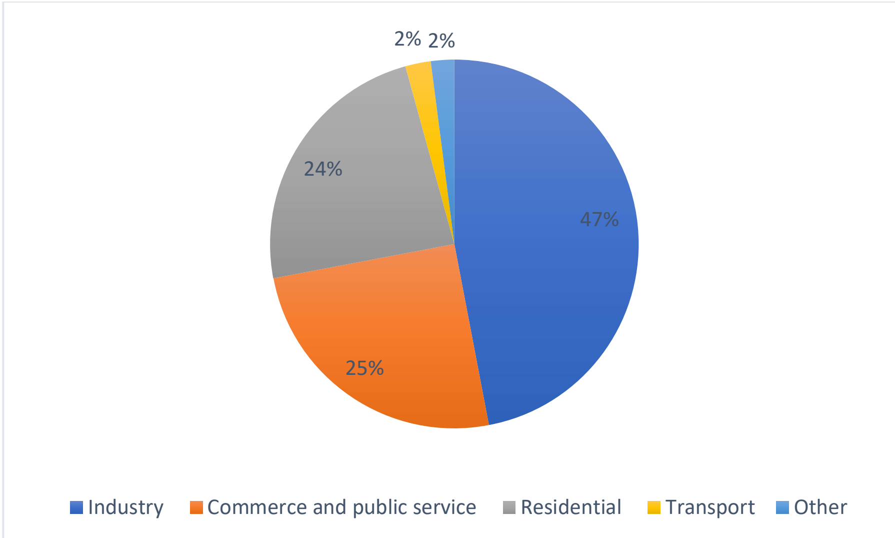


Figure 1: Belgium final electricity consumption by sector in 2021 [3]

More precisely, on the one hand, energy communities, as citizen-driven entities, aim at empowering end-consumers to collectively engage in energy-related decision-makings and join forces to implement collective energy practices such as local electricity generation, energy sharing, and Demand Response (DR). Energy communities' collective dimension, scaling effect and active consumers governance are the main arguments to study them as potential end-consumers' DR enablers.

On the other hand, retail tariffs can play a crucial role in incentivizing and facilitating implicit demand flexibility. By implementing differentiated retail tariffs that incorporate both energy prices and network tariffs, retail customers are encouraged to optimize their consumption patterns in response to price signals. Yet, traditionally, LV household consumers were seen as unresponsive to price incentives due to their inelastic electricity usage. However, this perception is changing due to rising energy conservation awareness, increased environmental consciousness, and the rise of automation in residential demand-side management. This shift presents significant untapped DR potential. This report will discuss retail tariffs as a 2nd case study.

Discussing the potential of energy communities and retail tariffs as enablers of demand side flexibility will further lead us to reconsider and revisit some of the barriers to the implementation of demand response that were identified in our first deliverable, such as the lack of smart meters, the lack of convincing business models and regulatory hurdles.[4]

The remainder of this report is organized as follows.

Chapter 2 delves into the details of the 1st case study, emphasizing the potential of flexibility within energy communities through energy sharing, which creates price-based incentives for demand-side flexibility. This chapter explores and dissects the legal, economic, and technical aspects of such flexibility potential, accompanied by the presentation of survey results from energy communities in Belgium.

---

[3] Source : StatBel - Energie Statistiques de consommation - Electricité 2021. Link : https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?view=df86fdc0-b000-4166-8783-aa4ef302f3a3

[4] https://demandflex.polytech.ulb.be/en/publications/identification-of-the-legal-economic-and-technical-aspects-of-the-demand-flexibility-in-belgium

The details of the 2nd case study are presented in **Chapter 3**. It analyses the component of retail tariffs, which includes, broadly speaking the commodity price, the network charges and the taxes. It then studies the considerations to which the commodity price and the network charges are responding. It then explores how using retail tariffs as a flexibility signal, under the form of variable energy prices and network charges, constitute a balancing exercise amongst several interest and objectives such as promoting RES, ensuring fairness in the allocation of network charges and ensuring the security and adequacy of the grid.

This report is concluded by **Chapter 4** in which the implications of these case studies on the specialized WPs will be discussed.

2. Case study 1: Energy Communities: A lever for retail demand-response? [5]

Energy communities are non-commercial legal entities, based on the open and voluntary participation of members and set up to share investment, production, and consumption of locally produced electricity. They are seen as an important vector to drive investment in renewables and social and technological innovations around the energy transition.[6]

Energy communities are important from a demand-side flexibility perspective because their regulatory framework makes it possible to share energy among community members. These communities can then encourage members to align their consumption to the level of local production (Box 1).[7]

This case study describes the regulatory framework for energy communities and the current landscape for energy communities in Belgium, with a focus on their potential to contribute to demand response.

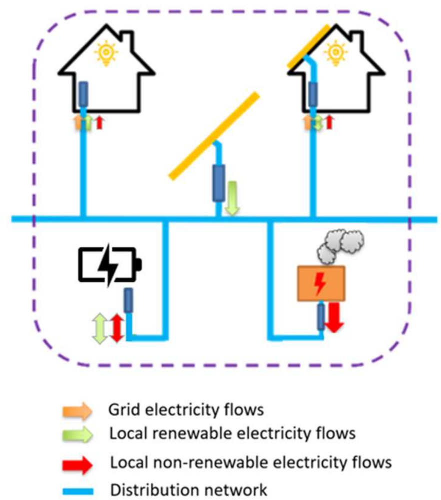
2.1. Legal and regulatory framework

The legal framework for energy communities comes from EU law and has been transposed into Belgian law.

2.1.1. EU regulatory framework

As part of the *Clean Energy for all Europeans* package adopted in 2019, the European Union adopted a legal framework for Renewable Energy Communities (RECs) and a broader definition of Citizen Energy Communities (CECs).[8] This regulatory framework establishes the specific conditions under which the traditional paradigm of electricity supply

Box 1: Energy sharing



Source: Adapted from Wallonie énergie SPW

Energy sharing refers to legal and economic arrangements that allocate the electricity production of one generation unit to different electricity users. It makes it possible to invoice local electricity production consumed locally (green and red arrows in the above figure) at a different price than electricity taken from the distribution network (orange arrow). Because local electricity will typically be cheaper than electricity purchased from traditional energy suppliers, energy sharing promotes self-consumption: the consumption of electricity produced locally at the time it is produced.

---

[5] This case study has benefitted from discussions with several stakeholders as part of the DemandFlex project, including Bruxelles Environnement, Energie Commune, RESCoop, Next Kraftwerke, FlexSys, Axpo, Centrica Business Solutions, Synergrid, Sibelga, RESA, Elia, SmartEn, DG Energy. However the views expressed here may not represent theirs.

[6] See e.g https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

[7] Many observers consider that energy communities are likely to be superior instruments to encourage demand response (over e.g. simple real-time or any other electricity retail pricing that depend on the state of the grid) thanks to the expected higher level of awareness and engagement of consumers involved in an energy community.

[8] See respectively the Directive (EU) 2018/2011 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) (hereafter "RED II") and the 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) (hereafter the "IEMD").

can be partially overturned to facilitate the implementation of energy sharing.

Renewable and Citizen Energy Communities have different objectives. RECs were introduced by the Renewable Energy Directive (RED II) of 2018 and seek to encourage renewable energy resources **acceptance and deployment**. CECs, on the other hand, were introduced by the Internal Market for Electricity Directive (IEMD) and seek to **attract private investment** in the energy transition by **making energy communities market actors**. These differences in objectives explain the differences in the definition of these energy communities as described in Table 1.

Table 1: Differences between renewable and citizen energy communities [9]

	Renewable Energy Community (REC)	**Citizen Energy Community (CEC)**
Generation technologies	Renewable technologies only	No restriction on technology
Membership	Can only include small entities	Can additionally integrate large companies if their primary activity is not energy-related
Authorized activities	- Produce, consume, store, sell, and share locally produced renewable energy - Access all suitable energy markets both directly or through aggregators	- Produce, consume, store, sell, and share locally produced energy - Participate in flexibility schemes and energy efficiency schemes - Own, establish, autonomously manage, purchase, or lease distribution networks
Geographical scope	Participants effectively controlling the community must be in the proximity of the renewable projects	No geographical restriction

2.1.2. Transposition in Belgium

In Belgium, the three Regions have transposed the legal framework for energy communities in, respectively, 2021 (Flanders) and 2022 (Wallonia and Brussels-Capital Region).[10]

In their transpositions, the regions have departed from the RED II and IEMD regarding the conditions on ownership of generation capacity and introduced an obligation of notification for energy communities.

Conditions on ownership: The directives require energy communities to own the production units used for energy sharing within the community.[11] All three regions have relaxed this condition that restricted third-party financing and the inclusion of existing production units. Specifically:

[9] Sources: Author's compilation based on Art. 2, 16 and 22 RED II and Art. 16 IEMD.

[10] Flanders: Decree of the Flemish Region of 2 April 2021 amending the Energy Decree of 8 May 2009 partially transposing EU Directive 2018/2001 and transposing EU Directive 2019/944; Wallonia**:** Decree of the Walloon Region of 5 May 2022 amending various provisions on energy in the context of the partial transposition of EU Directives 2019/944 and 2018/2001; Brussels: Ordinance of the Brussels-Capital Region of 17 March 2022 amending the ordinance of 19 July 2001 on the organization of the electricity market in the Brussels-Capital Region, ordinance of 1 April 2004 on the organization of the gas market in the Brussels-Capital Region, ordinance of 19 July 2001 on the organization of the electricity market in the Brussels-Capital Region and ordinance of 12 December 1991.

[11] See art. 22.2.b) of RED II for REC and art. 16.3.e) of the IEMD for CEC

- For CECs only, the Flemish Energy Decree allows energy sharing if the community owns the production unit *or* has a right to use the production units.
- The Walloon Electricity Decree allows energy sharing within the community (both CECs and RECs) when it owns or has a right to use the production units, or if the members of the community own those units.[12]
- The Brussels Electricity Ordinance has kept the ownership requirement for both CECs and RECs but created a third type of energy community: the Local Energy Community (LEC).[13] LECs are similar to the RECs except that energy sharing is possible if the community or one or more of its members own or have a right of use over the production facilities that the community uses to share electricity from renewable energy sources.[14]

This departure from the European directives was already found in the early (sandbox) initiatives and pilot projects. For instance, the initiatives *Enduro Assenede* in Flanders, *Nos Bambins* and *Marius Renard* in Brussels' Capital region have third-party investors owning their local production units.

Notification or authorisation obligations: The directives are silent with respect to the creation or recognition of energy communities. Members States therefore retain autonomy in this regard. All three regions have introduced a notification or authorisation procedure. Notifications differ from an authorisation in that there is no control nor verification of the conditions for energy communities.

- In the Walloon region, energy communities must notify their creation to the Walloon regulator, CWaPE, and must receive an authorisation before sharing energy.[15] A recent governmental decree (*arrêté gouvernemental*) specifies the notification procedure. [16] As the governmental decree was only published in the Belgian State Gazette on 28 September 2023, at the time of writing, no energy community benefited from the official status of energy community in the Walloon Region as of today. All existing initiatives were developed in the context of regulatory sandboxes.
- In the Brussels Region, energy communities must be authorised by the Brussels regulator, Brugel. Such authorisation is valid for 10 years and can be filed online.[17] At the time of writing, only two local energy communities had been authorized.[18]
- In Flanders, energy communities must notify the Flemish regulator, the VREG, online.[19]

Proximity criterion: The RED II requires RECs to be "effectively controlled by shareholders or members that are *located in the proximity* of the renewable energy projects that are owned and developed by

---

[12] Art. 35undecies, para 1, 4° of the Walloon Electricity Decree. Translation of " l'électricité produite, soit par les installations dont elle est propriétaire, soit par les installations sur lesquelles elle dispose d'un droit de jouissance susceptible de lui conférer le statut de producteur, soit par les installations en autoproduction détenues par ses membres et injectée sur le réseau ».

[13] See art. 28ter, para 2 of the Brussels electricity Ordinance for CEC and art. 28quinquies, para 2 of the Brussels electricity Ordinance for REC.

[14] Art. 28septies, para 1 of the Brussels Electricity Ordinance.

[15] Art. 35terdecies, para 1 and Art. 35quaterdecies, para 3 of the Walloon Electricity Decree.

[16] Governmental decree of 17 March 2023 on energy communities and energy sharing, art. 15-17.

[17] https://energysharing.brugel.brussels/energysharing/formulaire-535.

[18] See https://www.brugel.brussels/documents/decisions/rechercher?search_text=communaut%C3%A9 (accessed September 18, 2023).

[19] See https://dv.formulieren.vlaanderen.be/content/forms/af/vlaamse-overheid/vlaamse-regulator-van-de-elektriciteits--en-gasmarkt/Energiegemeenschap.html. At this stage, it is worth noting that the VREG has recently criticised this notification procedure as it leaves room for a lot of errors such as natural person registering as ECs (which is normally not possible) and the VREG is not in state to control that all requirements to be an energy community are met. See CREG, report of 22 December 2022 on energy communities, energy share and peer-to-peer trading of green power in 2022, available at https://www.vreg.be/sites/default/files/document/rapp-2022-23.pdf.

that legal entity" but it does not specify how proximity is measured.[20] All three regions have clarified this aspect by, essentially, requiring energy communities to indicate how proximity will be measured in their projects:

- Under the Walloon Electricity Decree, both the effective control of a REC and the sharing of energy is limited to a proximity criterion.[21] According to a governmental decree which further details the content of this criterion, it is considered met if the production assets and the participants of the REC are located within the territory of one municipality or connected under the same HV transformer station.[22] RECs are also required to specify, in their articles of association, how this proximity criterion will be assessed for establishing which members may have effective control of the community.[23]
- In the Brussels Region, energy communities must communicate in their articles of association how they will assess this proximity criteria.[24]
- Under the Flemish energy decree, the proximity criterium applies to all members of a REC (and not only those holding effective control of the REC).[25] The Flemish Decree specifies that proximity can be technical or geographical but does not provide more information on how to assess such proximity. The RECs must provide this information when they notify their creation to the VREG.[26]

Beyond these variations in the way the two directives have been transposed, it is worthwhile to highlight two other differences. First, while the EU, the Brussels Region and the Flemish Region have separate provisions for RECs and CECs (and LECs), the Walloon Region framework is, in most aspects, common to both RECs and CECs.[27] Second, quite surprisingly the Flemish framework specifies that electricity sharing must be free of charge even when it is taking place within an energy community.[28] The goal of the Flemish legislator was to differentiate energy sharing from the sale of energy.[29] Yet, in doing so, the Flemish legislator deprives energy communities from one of their main sources of revenue. While the energy communities may not have profit as a first goal, they are, under the European framework, allowed to raise revenues, for instance for investing in new generation units.

2.1.3. Regulatory sandboxes

Between the adoption of the EU directives on energy communities and their transposition into regional law, all regional regulators provided derogations to pilot projects; some of the pilot projects are still ongoing. The goal of these derogations was to ease the development of experimental projects to test different market models and technical solutions (e.g. smart grids, microgrids, Energy Management Systems (EMSs)) for energy communities, and evaluate their wider benefits, such as demand response

[20] Art. 2. 16) of RED II.
[21] Art. 35quinquiesdecies of the Walloon Electricity Decree.
[22] Governmental decree of 17 March 2023 on energy communities and energy sharing, art. 24.
[23] Art. 35duodecies of the Walloon Electricity Decree.
[24] Art. 28tredecies of the Brussels Electricity Ordinance.
[25] Art. 4.8.2, para. 1 of the Flemish Energy Decree.
[26] Art. 4.8.3 of the Flemish Energy Decree.
[27] Art. 35quindecies of the Walloon Electricity Decree.
[28] Art. 1.1.3, 38°/1 of the Flemish Energy Decree.
[29] See the parliamentary work of the Decree of the Flemish Region of 2 April 2021 amending the Energy Decree of 8 May 2009 partially transposing EU Directive 2018/2001 and transposing EU Directive 2019/944 (document 663 (2020-2021) – nr 1, p. 49).

or reduction of energy poverty. Most existing energy communities evaluated for this case study fall under this derogatory regime.[30]

2.2. The current energy communities' landscape in Belgium

We collected information on all existing and associated energy communities in Belgium using as primary source the European Commission Energy Communities Repository and the websites of energy regulators.[31] We then went through the list to verify that the listed projects were indeed energy communities (using the project's website or information on other websites). This resulted in 90 valid energy communities.

This full sample provides us with a first picture of the energy community landscape in Belgium as of March 2023. 47% of Belgian energy communities operate in Flanders, 34% in Wallonia and 19% in Brussels (Figure 2). The most popular legal status for energy communities is the cooperative legal status (61% of energy communities), followed by limited responsibility company (10%), non-profit organization (9%) and public company (2%) (the legal status was not available for 18% of the sample).

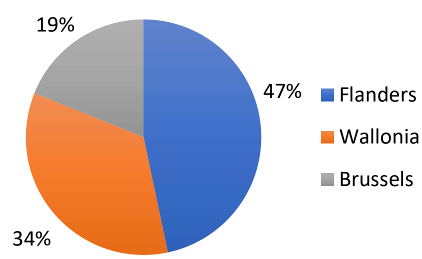


Figure *2*: Geographical location of Belgian energy communities (March 2023)

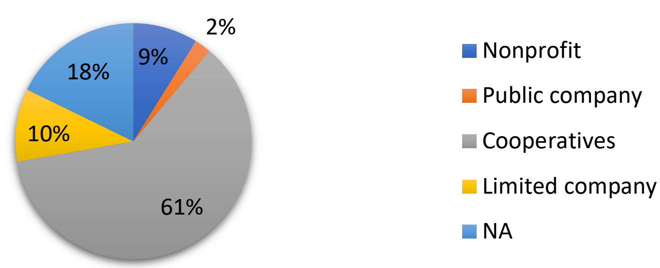


Figure 3: Legal status of Belgian energy communities (March 2023)

[30] See also Frippiat, Jean (2022), Projets pilotes bruxellois de partage d'électricité, Bruxelles Environnement, https://environnement.brussels/sites/default/files/user_files/pres_20220509_3_projetspilotes_fr.pdf (accessed June 30, 2023).

[31] https://energy-communities-repository.ec.europa.eu/index_en. In Brussels, energy communities must be authorized. In Flanders, energy communities are notified to the regulator, hence the information is not as reliable. In Wallonia, the regulatory framework for energy communities is not operative as of September 2023.

Notes: For nonprofit legal status in Belgium, the French acronym is ASBL (Association Sans But Lucratif), and the Dutch acronym is VZW (Vereniging Zonder Winstoogmerk). For cooperatives legal status in Belgium, the French acronym is SC (Société Coopérative), and the Dutch acronym is CV (Coöperatieve Vennootschap). For limited company status in Belgium, the French acronym is SRL (Société à Responsabilité Limitée), and the Dutch acronym is BV (Besloten Vennootschap). For public company status in Belgium, the French acronym is SA (Société Anonyme), and the Dutch acronym is NV (Naamloze Venootschap).

To get a more in-depth picture of existing energy communities, we complemented the analysis of the data in the repository with an in-depth analysis of 17 energy communities (based on the data available on Brugel's website or on online interviews; see Appendix 1 for the questions).

Table 2 provides a description of these 17 energy communities. They constitute our main sample going forward.

The table illustrates the large diversity of energy communities, be it in terms of size (from a few members to almost 1,000), types of participants (households, Small and Medium-sized Enterprises (SMEs), local authorities), technological choices (solar, wind, hydro, combined heat and power, storage), and installed capacity (from a few kW to more than 1 MW).

Most of the energy communities in our sample report falling under one of the three existing legal frameworks, even if not all have gone through the formal notification or authorization process. The column "production units' ownership" confirms that ownership often differs from the restrictive conditions of the EU directive and takes advantage of the flexibility introduced by the regional transpositions. For instance, the HospiGREEN project falls under the REC definition, but the production units are owned by a third-party investor. Thirteen of the 17 energy communities interviewed implement some form of energy sharing.

Lastly, as part of our investigation, we sought to identify whether existing energy communities benefitted from any network tariff adjustments. Network adjustments may involve lower distribution or transmission charges on the volumes of electricity shared from local production within energy sharing schemes. These adjustments further increase the financial incentives for energy sharing on top of the energy component of the shared tariff. Nine out of the 17 energy communities in our sample benefited from network tariff adjustments. All of them were also actively implementing energy sharing.

Initially, these tariff adjustments were granted as part of a derogatory regime. In 2022, the Brussels energy regulator, Brugel, published a new network tariff schedule for energy sharing. The new tariff schedule provides favorable financial conditions for energy sharing inside the same building, for meters connected to the same substation in the distribution grid and, to a lesser extent, for energy sharing between meters located at different substations.[32]

[32] As of September 2023, neither the Walloon region nor the Flemish region offered favorable network tariffs for energy communities or energy sharing outside of their respective existing derogatory regimes.

Table 2: Main characteristics of interviewed energy communities

Name (Region)	Legal status	Applicable EU regulation	Households	Other participants	Production units' ownership	Production technology	Installed power	Energy sharing	Network tariff adjustment
Allons en Vent (W)	Cooperative	n/a	950	None	All initiative's members	Wind	800 kW	No	No
AltERcoop (W)	Cooperative	n/a	430	SMEs	All initiative's members	CHP	1350 kWe	No	No
BocagEn (W)	Cooperative	REC	450	Local authorities, SMEs	All initiative's members	Solar PV, Hydro power	300 kWp, 240 kW	No	No
Brupower (BC)	Cooperative	CEC	10	Local authorities, SMEs	All initiative's members	Solar PV	0 (obj. 1,5 MWp in 2024)	No	No
Courant Alternatif (BC)	Nonprofit	LEC	15	Local authorities, SMEs	Third-party investor	Solar PV	100 kWp	Yes	Yes
Coléco (W)	Cooperative	REC	150	Local authorities, School, SMEs	Prosumers	Solar PV	450 kWp	Yes	No
Enduro Assenede (F)	Nonprofit	REC	20	Local authorities	Third-party investor	Solar PV	18 kWp	Yes	Yes
Energ'Ittre (W)	Cooperative	REC	12	None	Third-party investor	Solar PV	18 kWp	Yes	No
Greenbizz (BC)	Public company	n/a	0	SMEs	Prosumers	Solar PV	240 kWp	Yes	Yes
HospiGREEN (W)	Nonprofit	REC	0	Local authorities, SMEs	Third-party investor	Solar PV, Wind	200 kWp, 2.2 MW	Yes	Yes
Illuminous notre quartier (BC)	Non profit	LEC	3	None	Prosumers	Solar PV	NA	NA	NA
Marius Renard (BC)	Nonprofit	n/a	150	Local authorities	Third-party investor for cogeneration	CHP, Wind	72 kW (expected)	Yes (CHP only)	Yes
Noordlitch (F)	Cooperative	REC	350	None	All initiative's members	Solar PV, Hydro power	230 kWp	Yes	No
Nos Bambins (BC)	Nonprofit	LEC	10	Local authorities, School, SMEs	Third party investor and prosumers	Solar PV	44 kWp	Yes	Yes
Strommvloed (F)	Cooperative	REC	530	Local authorities	All initiative's members	Wind	NA	Yes	No
Sunsud (BC)	Nonprofit	n/a	35	Local authorities, SISP	All initiative's members	Solar PV	35 kWp	Yes	Yes
ZuidtrAnt (F)	Cooperative	REC	750	Local authorities, School, SMEs	All initiative's members	Solar PV, Storage	1 MWp	Yes	Yes

Notes: Authors' compilation from online interviews and projects' authorisation information from Brussels-Capital regional energy regulator Brugel. *Applicable EU regulation*: energy community status derived from EU regulatory framework (self-reported information). Projects with energy sharing within a single building such as Greenbizz, Marius Renard and Sunsud do not fit into the EU regulatory framework. Allons en Vent and AltERcoop did not report a specific energy community status in the online survey. In fact, these cooperatives existed as energy cooperative before the creation of the energy community's status and did not bother up to now to seek authorization as a REC or CEC. *Households*: number of residential electricity consumer households participating to the energy community; *Other participants*: list of other participants to the energy community by category; *Production units' ownership*: ownership structure of the production units within each energy community; *Production technology*: specific technologies employed by each energy community for energy generation. The acronym CHP stands for Combined Heat and Power, also known as cogeneration; *Installed capacity*: power generation capacity installed in the energy community; *Energy sharing*: indicates whether the energy community implements energy sharing; *Network tariff adjustment*: indicates whether the energy community benefits from special adjustment mechanism related to distribution or transmission network charges imposed by the electricity grid operators.

2.3. A typology of energy communities

When it comes to contribution to demand response, we can distinguish three distinct business models for energy communities: energy communities without energy sharing, energy communities with energy sharing, and energy communities actively bidding their flexibility on wholesale markets.

2.3.1. Energy communities without energy sharing

Energy communities without energy sharing focus solely on electricity generation and supply. Changes in consumption, and thus demand response, are never incentivized.

Because energy sharing was not allowed until the RED-II and the IEMD directives, this business model was the dominant business model for energy communities, also known as energy cooperatives. As of March 2023, several energy communities, including *Allons en Vent*, *AltERcoop*, *BocagEn*, *Brupower*, *Noordlicht*, and *Stroomvloed*, operated under this model.

2.3.2. Energy communities with energy sharing

The introduction of the RED-II and IEMD directives have removed the regulatory barriers to energy sharing, and technological advances in digital metering have further facilitated the emergence of energy communities with energy sharing. In this model, members share locally produced energy and face lower electricity prices when they consume locally produced electricity. In other words, members are financially incentivized to prioritize electricity consumption when it is locally abundant.

Energy communities such as *Coléco*, *Sunsud*, *Nos Bambins*, *Marius Renard*, *Enduro Assenede*, *Greenbizz*, and *Energ'Ittre* in Belgium operated under this business model as of March 2023. For example, *Sunsud*, initially a pilot project in the Brussels region, consists of 35 households equipped with digital meters, who collectively own 35 kWc of solar PV production units. A fixed percentage of the total locally produced energy is allocated to each member. Members who consume the allocated electricity when it is produced are invoiced at an attractive rate lower than 0.1 EUR/kWh.

In principle, the energy sharing model enables energy communities to optimize local energy usage and self-balance their energy production and consumption. Whether these benefits actually materialize or, in other words, to what extent energy sharing actually impacts consumption behavior, relative to a situation where the electricity produced is simply sold back to the grid (energy communities without energy sharing), remains an open question. The presence of self-consumption is not in itself evidence that members of the energy community change their behavior. Preliminary evidence from detailed data from the HospiGREEN energy community suggests very little, if any, changes in consumption, despite the presence of financial incentives. [33]

2.3.3. Energy communities providing explicit demand response

A third possible business model for energy communities is to provide flexibility in the wholesale market. This model is enabled by behind-the-meter demand-control technologies, including EMS and Direct Load Controllers (DLC).

As of March 2023, no energy community project in Belgium had actively engaged in explicit demand-side flexibility provision, though one energy community, ZuidtrAnt, was involved in offering supply-side flexibility through large-scale storage and production units to the balancing market.

While this situation may evolve in the future, regulatory and economic barriers limit the adoption of this model in the short run. First, existing rules impose a minimum size requirement of 1 MW to participate in the balancing market. As *Table 2* illustrates, only two energy communities among the 15 interviewed meet this requirement. Second, participation in the balancing market involves sophisticated hedging and optimization strategies for which small energy communities lack expertise. Third, participation in the balancing market requires the use of expensive demand-control technologies and energy optimization systems. This may explain why, as of today, no energy community directly participates in the balancing market.

2.4. Energy communities as technological accelerators for end-consumers' demand-response

While energy communities may not, as of today, contribute much to demand-side flexibility, they serve as an accelerator for the deployment of technologies that will help tap into the flexibility potential of end consumers at large.

Specifically, energy communities contribute to the deployment of smart meters, an area where Belgium lags behind European objectives.[34] Furthermore, our survey responses suggest that the regulatory sandboxes that were developed for energy communities have enabled experimentation with diverse technologies such as collective storage, microgrids, HPs, and shared EVs, which all contribute to flexibility. For instance, the MIRaCCLE project experimented with a microgrid. ZuidtrAnt and Stroomvloed have integrated EVs and EV chargers as part of the assets managed by the community. Other projects such as Nos Bambins, Marius Renard, Energ'Ittre, and Stroomvloed adopted HPs, showcasing a commitment to sustainable heating practices.

Looking forward, energy communities are also emerging as grassroots pioneers of smart grids, actively exploring advanced energy system management tools and remote-control technologies. In a smart grid, EMS play a pivotal role in optimizing local production and consumption automatically. These technologies hold potential for local grid demand-side flexibility. MeryGrid is one such example. The project involves the construction of a microgrid at the industrial site of Mery in Esneux, along the Ourthe River. The project aims to study the profitability, technical feasibility, and operation of a

---

[33] Comprehensive results will be discussed in a separate research paper by Elise Viadere as part of the DEMANDFLEX project.

[34] According to the 17th annual report of Berg Insight on smart metering in Europe, only 13% of electricity meters were digital in 2021. This is to be compared with the initial European ambition of an 80% coverage by 2020 (Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC).

microgrid, which features hydroelectric and PV power generation capabilities, alongside an energy storage unit controlled in real-time by the EMS and remote controllers.

2.5. Takeaways from the case study and avenues for further research

Energy communities are recent actors in the electricity retail market. They are seen in Europe as an important actor of the energy transition and are credited for many potential benefits, including activating demand-side flexibility.

Our review of existing energy communities suggests that many are at the experimental stage. There is very little evidence at this stage that energy communities are major contributors to demand-side flexibility, either because they do not involve energy sharing in the first place, because the technical characteristics of the assets operated by the community limit the potential for flexibility, or because members do not respond to financial incentives. Energy communities do contribute to other goals of the energy transition, however, including investment in renewables, environmental awareness and inclusivity, and deployment of key technologies (EVs, digital meters, …) for the transition.

Within the DemandFlex project, further research on the impact of retail tariffs will be conducted. For instance, task 3.3 (WP3) aims to explore the potential of Time-Of-Use pricing in stimulating demand-side flexibility within the retail market. This research will comprehensively evaluate the effectiveness of implicit demand-response incentives offered to energy communities and their impact on grid-related benefits. Furthermore, team members are currently conducting research based on the analysis of the Walloon pilot project HospiGREEN and seek to delve deeper into the characterization of energy sharing incentives and effects.[35] Finally, simple, user-friendly but nevertheless efficient automatic management techniques accounting for technical characteristics of related assets will be developed within WP4 to harness the DR potential of energy communities.

[35] This research paper, authored by Elise Viadere, is currently in the final stages of preparation at the time of this document's publication. The definitive version, complete with results and in-depth analysis, will be made available through the DemandFlex website and various other communication channels. Please refer to the official publication for the comprehensive findings and insights.

3. Case study 2: Retail Tariffs

This case study explores the potential of retail tariffs to foster demand response from households. In 2021, residential and commercial sectors account for 24% and 25% of Belgium's final electricity consumption, respectively.[36] These consumers are often considered as passive and therefore not a significant source of demand response.[37] This is changing. First, there is a growing level of awareness among consumers of the need to conserve energy and use it efficiently, particularly in the wake of the 2022 energy crisis and heightened environmental consciousness. Second, increased automation in residential demand-side management makes it easier for consumers to adapt their consumption.

Retail tariffs – the overall price that consumers pay for their electricity - play an important role in activating this flexibility potential. They have three components: the price paid for electricity consumption (commodity component), network charges, and taxes. The supplier sets the commodity price as a function of its costs. Network charges are set by the network operators and approved by the relevant regulators (in Belgium: CREG for the transmission charges, and the regional regulators for the distribution charges). Taxes mostly apply proportionally to the sum of the network tariffs and the price of electricity.

While it is the sum of the commodity price, the network charges and taxes that determine the financial incentives of retail consumers, each component responds to different considerations. We review these in turn.[38]

3.1. Network tariffs

Network operators are responsible for the development, operation, and maintenance of public electricity transmission and distribution networks. Network charges enable them to cover the cost of these responsibilities. For residential consumers and small businesses, network tariffs are typically billed by the network operator to the electricity suppliers. These suppliers, in turn, pass on the corresponding

Box 2: Electricity retail tariff structures

Commodity and network tariffs may be structured on energy, power, or subscription basis. Existing tariffs range from fixed annual rates to hourly variations tied to wholesale prices.

•**Fixed tariff**: the tariff expressed in kWh, kW or periods, is the same over a given period.

•**Time-of-use (ToU) tariffs**: electricity prices vary based on time, considering factors like peak/off-peak, seasons, and specific hours. They come in two main types: energy-based (€/kWh during set periods) and power-based (€/kW during specific times). In Belgium, there are typically two rates: day (7 am - 10 pm) and night (10 pm - 7 am). However, more complex variations and formulas can be found in ToU tariffs.

•**Real-time pricing (RTP)**: consumption is billed reflecting wholesale market prices. Energy economists have long endorsed this approach to incentivize demand adjustments based on market conditions.

•**Critical-peak pricing (CPP):** a pricing model that dynamically adjusts electricity charges during critical peak periods when electricity is in high demand and scarce. Consumers receive advance notice of these scarcity events to make informed electricity usage decisions.

•**Peak time rebates:** reward consumers for using less electricity during peak periods, promoting grid reliability and efficiency.

---

[36] Statbel (2023) Statistiques sur l'utilisation d'énergie. Données disponibles en ligne: https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?view=df86fdc0-b000-4166-8783-aa4ef302f3a3

[37] Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? Energy efficiency, 1(1):79–104 ; Allcott, H. (2011). Consumers' perceptions and misperceptions of energy costs. American Economic Review, 101(3):98–104.; Ito, K. (2014). Do consumers respond to marginal or average price? evidence from nonlinear electricity pricing. American Economic Review, 104(2):537–563; Fabra, N., Rapson, D., Reguant, M., and Wang, J. (2021). Estimating the elasticity to real-time pricing: evidence from the Spanish electricity market. American Economic Association volume 111, pages 425–429.

[38] Taxes are proportional to their bases and while the VAT rate has changed over time, they do not play a role for flexibility.

amounts to their customers as part of a single bill. The monthly invoice received by residential consumers and small businesses includes, on top of the commodity component and the associated taxes, a portion related to network transmission and distribution costs.

3.1.1. Legal considerations

From a legal point of view, network tariffs are the compensation to which network operators are entitled in return for implementing a third-party access system. Indeed, as per article 6 of the Internal Electricity Market Directive of 2019 (IEMD), "Member States shall ensure the implementation of a system of third-party access to the transmission and distribution systems based on published tariffs, applicable to all customers and applied objectively and without discrimination between system users".

In the process of setting these network tariffs, the role of National Regulatory Authorities (NRAs) is crucial. They have the duty of "fixing or approving, in accordance with transparent criteria, transmission or distribution tariffs or their methodologies, or both".[39] NRAs must, at a minimum, approve the methodology to determine the network tariffs. In practice, these methodologies include information about which costs are recoverable for the network operator and how these costs are allocated to different network users.

The Internal Electricity Market Regulation (IEMR) defines further criteria which network charges and methodologies must fulfil. They must, by way of example, be cost-reflective, transparent, take into account the need for network security and flexibility, reflect the actual costs incurred (insofar as they correspond to those of an efficient and structurally comparable network operator) and be non-discriminatory.[40] Regarding this last criterion, it is further specified that network charges may not discriminate positively or negatively between production connected at the distribution or transmission level or against energy storage or aggregation.[41]

3.1.2. Tariff cascade

Another important aspect of network tariffs is the so-called "tariff cascade". Cost cascading refers to the allocation of the costs associated with a specific voltage level among users connected at a lower voltage.[42] In practice, there are two types of cascades: the cascade between transmission and distribution, and the cascade within transmission and/or distribution. First, the transmission network operator will charge its tariffs to the users connected at the transmission level, including the distribution network operators. The DSO will then charge the transmission and the distribution network charges to its users. In Belgium, such billing takes place through the suppliers (if any), who are the debtors of the network charges to the DSO and must collect the amounts from consumers. This means that part of the methodology for distribution network tariffs relates to how the transmission charges are allocated to the distribution network users.

Second, the (distribution or transmission) network tariffs methodologies will have different costs allocation calculations depending on the voltage level of the network user. The costs cascade thus denotes the allocation of the costs associated with a specific voltage level among users connected at the lower voltage level. This means that the end-users connected at the lowest voltage level will bear the costs related to each superior voltage level.

---

[39] Art. 59.1.(a) of the IEMD.
[40] Art. 18.1 of the IEMR.
[41] Art. 18.1 of the IEMR.
[42] ACER - Report on Electricity Transmission and Distribution Tariff Methodologies in Europe - January 2023 - https://www.acer.europa.eu/Publications/ACER_electricity_network_tariff_report.pdf

3.1.3. Economic considerations

Due to their large fixed costs and the resulting economies of scale, network operators (TSO and DSOs) are considered natural monopolies: from a cost efficiency perspective, it makes sense to have only one network rather than duplicate networks.[43] But monopolies raise concerns too, such as the potential abuse of market power and under-provision of quality.[44] These provide an economic rationale for regulating network tariffs.

First, network tariffs should ensure that network operators recover the cost incurred in the performance of their duties (cost-recovery principle). Costs incurred by network operators include the system-wide costs of development, operations and maintenance of the network, as well as fixed individual costs such as a new connection to the distribution grid.

Second, from an efficiency perspective, network users should ideally pay according to the costs they cause to the network (cost reflectivity principle). Nodal tariffs – where electricity prices are specific to a location and therefore reflect transmission losses and local congestion – provides an example of a pricing structure that exactly seeks to reflect the network costs more closely. Nodal pricing is used in some jurisdictions, but not in Europe. Real-time or dynamic tariffs– where the network charges reflect the real time conditions on the grid - provides another example. Less variable structures such as Time-of-Use (ToU) or Critical Peak Pricing (CPP) can achieve adequate cost reflectivity while being simpler for end-consumers.[45] Tariffs that encourage flexibility fit in this category. Indeed, demand-side flexibility can reduce the need for grid expansion and reduce maintenance costs.[46]

3.2. Commodity price

3.2.1. Pricing structures

The commodity component of the electricity retail tariff is the rate at which electricity (i.e., the energy) is invoiced by the supplier to the end-consumer. Suppliers have the freedom to set the commodity price, generally without regulatory constraints. Electricity tariffs come in diverse structures and formats (Box 2). When examining the commodity price component closely, we observe differences in tariff characteristics, driven by factors such as the number of time periods constrained by the meter, and market conditions. *Table 3* summarizes the main tariff characteristics.

Table 3: Commodity component electricity tariff characteristics

		Time periods	
		1	1+
Rates	Non-market dependent	Fixed-fee	ToU
	Market dependent		RTP, CPP

One noteworthy structure is the Time-of-Use (ToU) tariff, which sets a fixed price over pre-specified time periods, which can vary across days and seasons, subject to the technical constraints of the meter.

43 Sharkey, W. W. (1983). The theory of natural monopoly. *Cambridge Books*.
44 Laffont, J. J., & Tirole, J. (1993). A theory of incentives in procurement and regulation. MIT press.
45 Astier, N. (2021). Second-best pricing for incomplete market segments: Application to electricity pricing. *Journal of Public Economic Theory*, *23*(6), 1287-1311.
46 Bartusch, C., & Alvehag, K. (2014). Further exploring the potential of residential demand response programs in electricity distribution. *Applied Energy*, *125*, 39-59.

For example, a common ToU structure in Belgium is a day and night tariff during weekdays and a weekend tariff. This tariff was historically designed to synchronize with nuclear capacity operating as baseload during the night and to encourage night-time consumption. However, this tariff structure no longer effectively signals demand-side flexibility due to its alignment with an outdated energy mix. Ideally, ToU tariffs should aim to replicate the typical daily price variations on the wholesale market while providing consumers predictability and protection from exceptionally high peak price events. *Figure 4* shows, based on wholesale day-ahead market data from the 1st of February 2023, that a two-band tariff structure (night and day) is too coarse to sufficiently follow the real time prices, and that 6-bands would be better.

One should note that the implementation of tariff structure of the kind described in Box 2 depends on the type of meter installed at the end-consumer's connection, making the meter itself a technological barrier. So, for example, a 6-band pricing structure as illustrated in *Figure 4* is not feasible with the existing old meters and would require a smart meter (Box 3).

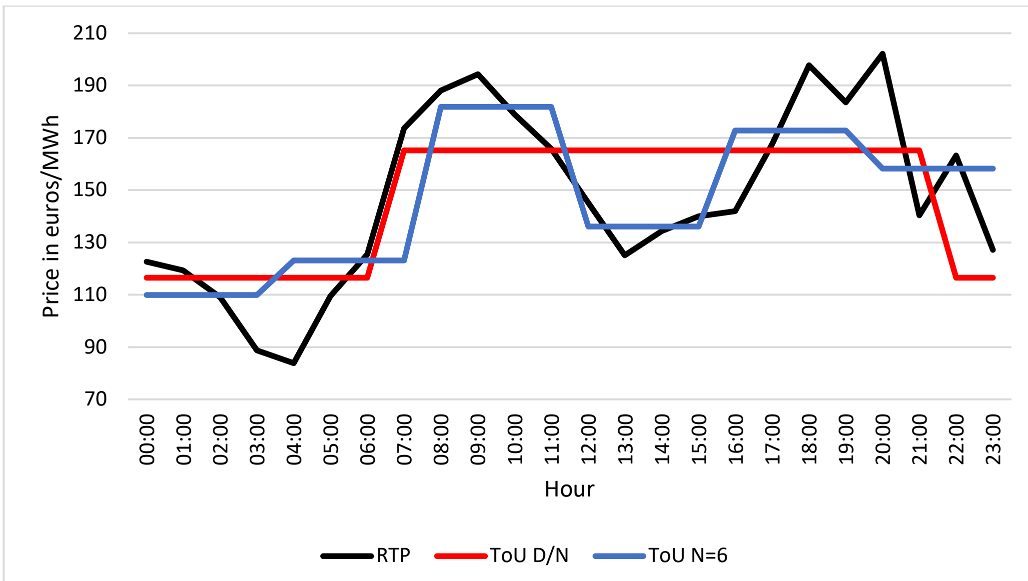


Figure 4: Comparison between real-time wholesale prices and 2-bands (night and day) and 6-bands tariff structure [47]

3.2.2. What type of contracts do suppliers offer and consumers choose?

Most of retail commodity prices are non-market dependent fixed-rate pricing schemes which protect retail consumers against the volatility of wholesale prices.[48] In exchange for a fixed-rate price, suppliers bear the volume and price risks (respectively, the risk that the amount consumed by a household differs from the amount procured, and the risk of price spikes on the wholesale market). A retail company can also own generation capacity, which it can use to serve its consumers or to adjust to short-term changes in consumption.

[47] Sources: Single Day Ahead Coupling for Belgium on the 01/02/2023 from Elia published Day Ahead reference price in euros/MWh (https://www.elia.be/en/grid-data/transmission/day-ahead-reference-price)

[48] Celebi, E., & Fuller, J. D. (2012). Time-of-use pricing in electricity markets under different market structures. *IEEE Transactions on Power Systems*, *27*(3), 1170-1181.

Even though market-dependent pricing schemes are considered as the most efficient tariff structure, they are rarely observed in practice. From a supplier perspective, four issues could explain this:

(i) Suppliers can procure significant volumes of electricity a long time before actual delivery and can hedge themselves against real time price volatility. Day-ahead prices might therefore not reflect the true procurement cost of serving their consumers.
(ii) Suppliers that participate in the wholesale market are contractually obliged to have a balanced portfolio for every quarter-hour of the day. This means that they must buy or produce exactly the same amount they sell to their consumers. Providing incentives to consumers to react to prices increases the risk of imbalance for suppliers.
(iii) Suppliers with generation assets have no incentives to decrease wholesale prices. Any generation not used can be sold on the wholesale market at a higher price in times of tight supply and high demand. If consumers were exposed to wholesale prices, demand-response would lower prices during critical periods and lower the revenue of vertically integrated firms.
(iv) Lastly, using publicly available wholesale prices makes retail pricing more transparent to consumers and the regulator. Hence retail companies with market power are not able to exercise market power as with fixed-tariffs or time-of-use contracts.

Figure 5 describes the mix of contracts offered by suppliers in Flanders since July 2022. The most selected contracts in Flanders are indexed contracts, confusingly called "variable contracts". These contracts involve periodic tariff updates based on wholesale market prices, typically occurring every three months. Fixed contracts, locks consumers into agreed-upon rates for a fixed term of 2 to 3 years. Following the IEMD, suppliers must now also offer a "dynamic electricity price contract" namely a contract that "reflects the price variation in the spot markets, including in the day-ahead and intraday markets, at intervals at least equal to the market settlement frequency",[49] promoting the adoption of dynamic pricing options.[50] These contracts enhance consumer flexibility and encourage exploration of alternative contract structures beyond traditional variable rates.

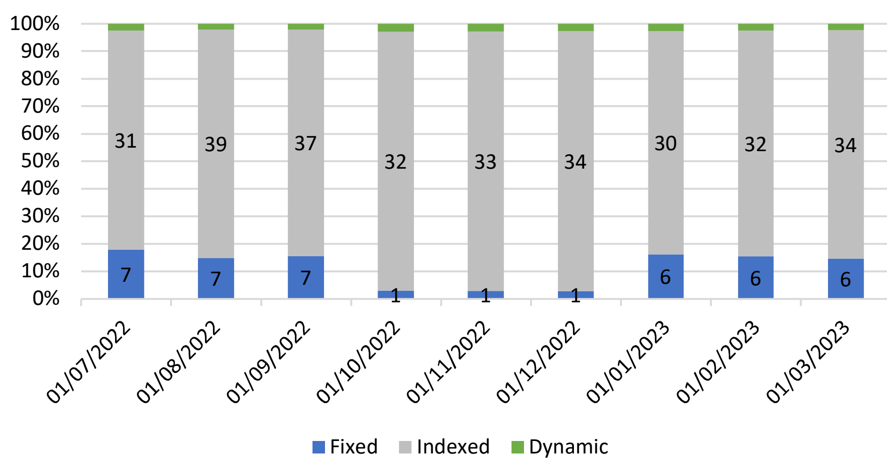


Figure 5: Residential supply contract offer in Flanders [51]

[49] Art. 2(15) IEMD.
[50] Art 11 IEMD. However, these contracts are currently only available in Flanders and only depend on the availability of real-time consumption data.
[51] Source: Author's compilation of VREG dashboard's data on electricity market in Flanders. Consultation on 30/08/2023: https://dashboard.vreg.be/report/DMR_MarktaanbodE.html

Figure 6 shows the market penetration of the different contract types. Since the end of 2021, we observe a reduction in the selection of fixed rate contracts. The transition towards indexed contracts accelerates throughout 2022, reaching 68% by January 2023. This is likely driven by suppliers unwilling or unable to bear the price risk of the energy crisis that took place throughout 2022 and excluding the possibility to renew consumers' fixed contracts for the following year.[52]

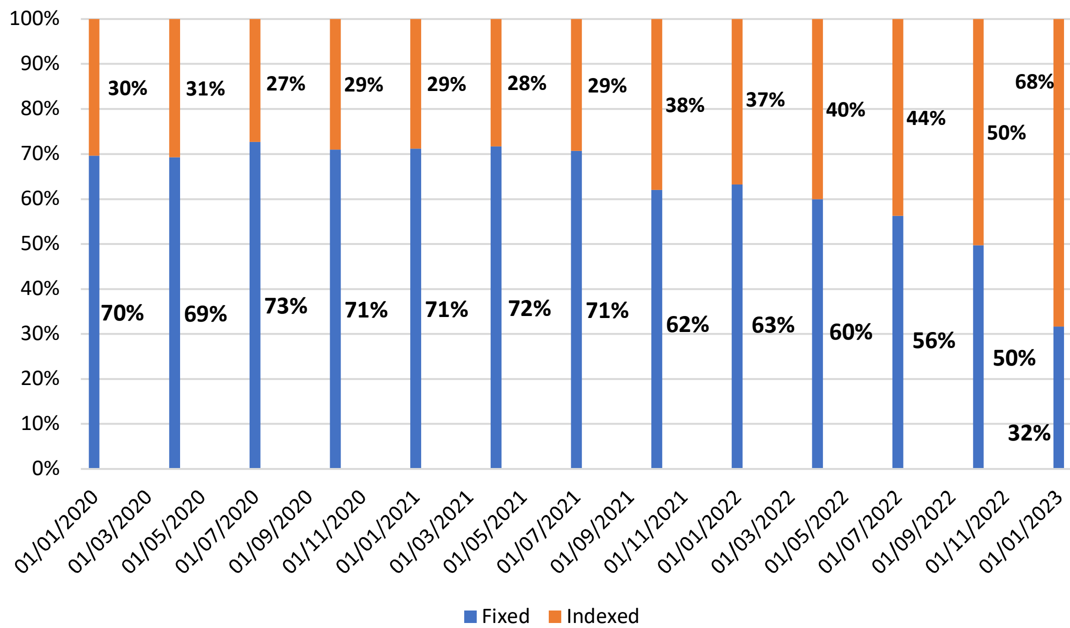


Figure 6: Share of fixed and variable electricity supply contract selected by residential consumer in Flanders [53]

[52] CREG (2023) Study 2289 on the increase in electricity and gas prices in Belgium.

[53] Source: Author's compilation of VREG dashboard's data on electricity market in Flanders. Consultation on 30/08/2023: https://dashboard.vreg.be/report/DMR_MarktaanbodE.html

3.3. Retail tariff as a flexibility driver

Retail tariffs that integrate information about the state of the market can in principle encourage end-consumers to adapt their consumption to market conditions. This section first summarizes what we know about demand response when consumers are faced with time-varying prices (section 3.3.1). Second, it explores how early tariff structures favouring the deployment of RES in Belgium have in fact discouraged demand response (section 3.3.2). Finally, it analyses recent developments in Belgium showing that there is a momentum towards the use of retail tariffs as flexibility driver (section 3.3.3).

3.3.1. What do we know about the role of retail tariffs to elicit demand-side flexibility?

In theory real-time pricing is the most efficient retail pricing design. It accurately reflects scarcity during peak hours.[54] Furthermore, RTP achieves market efficiency.[55]

Empirically, however, studies typically show limited demand responses by consumers. Consumers do not pay much attention to the price and struggle to understand and predict how much they will pay.[56] Ito (2014) analysis of California utility data highlights that residential consumers tend to be more responsive to average prices rather than marginal or expected marginal prices. Essentially, consumers focus on the broader context of average prices, overlooking finer price fluctuations. Furthermore, Fabra et al. (2021) examination of the first large-scale deployment of RTP in Spain in 2015 underscores this issue. Their findings indicate that households subject to RTP exhibited an average price elasticity of zero. This suggests that, despite significant price variations throughout the day and access to pricing information through various channels, consumers showed minimal responsiveness to price signals. However, it appears that the challenge extends beyond mere price reactions and extends to consumers' willingness to take action to shift their consumption behaviour.

> **Box 3: State of the play of the deployment of smart meters in Belgium**
>
> Commodity and network tariffs depend the access to detailed consumption data and, thereby, on the deployment of smart meter. This deployment takes place at regional level:
>
> •**Brussels**: Deployment rules are segmented for various scenarios, including new prosumers, electric vehicle owners, energy sharing, modernization by Sibelga, major renovations, new connections, and customer requests. As of October 2022, around 35,000 smart electricity meters are installed, about 5% of total meters.
>
> •**Wallonia**: Deployment rules are segmented. Starting January 1, 2023, smart meters are installed for prepayment activation, replacements, new connections, and user requests. From January 1, 2024, new installations below 10 kVA capacity also get smart meters. By December 31, 2029, the goal is 80% smart meters for users with consumption over 6,000 kWh, electricity production setups, and public charging points.
>
> •**Flanders**: around 1,100,000 smart meters have been installed for both electricity and gas, covering approximately 40% of the total meter population for each.

---

[54] Borenstein, S., & Holland, S. P. (2003). On the efficiency of competitive electricity markets with time-invariant retail prices.; Borenstein, S. (2005). The long-run efficiency of real-time electricity pricing. The Energy Journal, 26(3).; Fabra, N., Rapson, D., Reguant, M., & Wang, J. (2021, May). Estimating the elasticity to real-time pricing: evidence from the Spanish electricity market. In AEA Papers and Proceedings (Vol. 111, pp. 425-429). 2014 Broadway, Suite 305, Nashville, TN 37203: American Economic Association.

[55] Borenstein, S., Bushnell, J. B., & Wolak, F. A. (2002). Measuring market inefficiencies in California's restructured wholesale electricity market. American Economic Review, 92(5), 1376-1405.; Joskow, P., & Tirole, J. (2007). Reliability and competitive electricity markets. The RAND Journal of Economics, 38(1), 60-84.

[56] Reiss, P. C., & White, M. W. (2005). Household electricity demand, revisited. The Review of Economic Studies, 72(3), 853-883.; Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy?. Energy efficiency, 1(1), 79-104.; Allcott, H. (2011). Rethinking real-time electricity pricing. Resource and energy economics, 33(4), 820-842.

Research findings from Bailey et al. (2023) demonstrate that even minor consumer actions, such as pressing a button on a mobile app versus automated centralized demand-response can result in substantial differences in demand-response behavior. Therefore, implementing retail pricing as a lever for demand-response may require leveraging centralized demand control technologies.

3.3.2. Early tariff structure in favor of the deployment of renewables disincentivized demand response

Until recently, prosumers, namely residential end-consumers owning RES (mostly solar PV), used to pay only for their net withdrawal from the network, both for the commodity price and network charges. This means that what they had injected into the network was deducted from their withdrawal from the network, making the investment into RES economically attractive. In Wallonia and Flanders, it was implemented through a "going backwards meter" which would directly display the difference between the energy withdrawn from the network and the energy injected in the network. In Brussels, there is no "going backwards meter" but a compensation system is applicable, meaning that the amount injected in the grid is compensated from the amount withdrawn but the information on these amounts are also available.

Such net metering does not incite prosumers to align their consumption with their RES generation. The energy injected into the network must be handled by the network operator, which creates additional costs. Such a system of net metering is also not fair. While prosumers have double use of the network (for withdrawal and injection) they pay less (if not zero) network tariffs compared to other users. In addition, additional investment which need to be made to increase the capacity of the network facing decentralized RES generation are borne by all customers including those without RES. Net metering constitutes a double penalty for the end-customer who did not invest in RES.

3.3.3. Recent developments in Belgium: a momentum heading towards a better use of retail tariffs

Retail and network tariffs are not yet flexibility drivers, in some cases actually disincentivizing reasonable use of the network. However, there is momentum heading in this direction.

Firstly, regulators have realized that the network tariffs were not providing the right incentives. Yet, in Flanders and Wallonia, they were blocked by the fact that "going backwards meters" had been installed and provided only information about the net consumption. The first remedy was thus to apply the so-called "prosumer tariffs" with applies on an estimation of the amount of electricity injected in the grid, using available estimates on peak production capacity of solar PV, hours of sunshine and self-consumption rates. Yet, in doing so, prosumers are charged for the net consumption and for an estimation of their injection. In other words, an actual change in their consumption behavior to make it match with their solar production would not have an impact on the network charges paid. The second remedy is therefore to change the installed meter to a bidirectional or smart meter and not to offer a compensation mechanism. In doing so, prosumers would be encouraged to consume their production at the time of production. At this stage, this is applicable only in Flanders and Brussels. Indeed, until 31 December 2023, Wallonia still offers the compensation mechanism (with the prosumer network charge) and will keep on offering it to existing PV installation until 31 December 2030.

Secondly, new forms of network tariffs are being implemented, such as capacity tariffs in Flanders. The Flemish capacity tariff entered into force in January 2023. The Flemish regulator has decided to introduce a power-based network charge applied based on the average of the 12 monthly consumption peaks, with a minimum of 2.5 kW, in addition to the proportional fixed energy-based network tariff (per kWh).[57] By introducing a capacity tariff, the Flemish regulator encourages end users to spread their electricity consumption over time and not to have all (intensive) appliances running simultaneously.[58] Even though it is an improvement from the perspective of designing tariffs to induce flexibility, there are several limitations to this tariff design. The capacity tariff does not consider the alignment between peak consumption for end-users and on the distribution grid, which is the critical issue this tariff aimed to mitigate.

The example of the Flemish capacity therefore demonstrates a move towards network tariffs, which induce some form of implicit flexibility. Such initiative is the result of a balance between several interests, including the protection of the end-user through simple tariffs. It also balances incentives, spreading users' consumption over the day but not incentivizing them to shift consumption from (network) peak to off-peak periods.

3.4. Existing barriers to the use of retail tariffs as flexibility driver and avenues of further research

While recent developments in tariffs and technological deployment are supporting greater demand response, several questions remain open when it comes to the role of retail tariffs to promote flexibility. Some of them will be tackled in the framework of the DemandFlex project.

The first question relates to the right incentives that must be conveyed through retail tariffs. Yet, the answer to this question depends on the risk that demand-response aims to avoid. If demand-response is used for the purpose of the whole system (for instance for balancing purposes), retail tariffs would have to convey a different signal than if demand-response is used to avoid local grid issue (such as congestion leading to a need of network reinforcement). Such analysis will be the subject of the research performed under Task 3.3 of the DemandFlex project.

Second, the question raises to what extent network tariffs can be used as flexibility drivers. This will be analysed in the framework of Task 2.2 of the DemandFlex project. The use of network charges as an incentive instrument aiming at influencing the behavior of consumers also raises questions on the role and mission of the regulators. The role of NRA as leading authority in setting network tariffs, without parliamentary or governmental intervention has been designed with the view that network charges must simply ensure cost recovery for system operators and prevent them from abusing their natural monopoly. When network charges are used to encourage individual behavior, it entails political goals. The current (legal) role of the NRAs and, above all, the absence of intervention by a democratically elected body, could therefore be called into question. This question will be further analyzed in the framework of Task 2.1 of the DemandFlex project (power allocation between the regulatory and the legislator).

Third, it is not purely because network tariffs incentivize consumer to be flexible that the DR potential will be harvested in an efficient manner: simple energy management systems must be available for the end users such that the electricity consumption can be optimized in reaction to the tariffs. This will be investigated in the framework of WP4.

Yet, other questions will not be directly investigated in the framework of the DemandFlex project. By way of example and as explained above, retail tariffs are not unique, and its two main components (commodity price and network tariffs) are neither defined by the same agent nor do they answer to

---

[57] Tariefmethodologie voor distributie elektriciteit en aardgas gedurende de reguleringsperiode 2021-2024, p. 103.

[58] Consultatiedocument van de VREG van 5 september 2019 met betrekking tot de vaststelling van de tariefstructuur periodieke distributienettarieven elektriciteit voor klanten met kleinverbruiksmeetinrichting, p. 10.

the same considerations. It might be possible to have contradictory signals for each price component, cancelling out the incentives at the level of the final price. This raises the question of implementing compatible pricing signals to reach multiple objectives.

4. Conclusions and Perspectives

This report has identified two case studies that will serve as a common foundation for further studies in the rest of the DemandFlex project, namely: *Energy Communities* and *Retail Tariffs*.

Chapter 2 provides a comprehensive overview of energy communities in Belgium, highlighting their legal and regulatory framework, their current and evolving landscape, and their potential to contribute to demand response. This chapter sheds light on the complex landscape of energy communities, their diverse business models, and their role as technological accelerators.

It is discussed that energy communities in Belgium have evolved significantly in response to EU directives and regional transpositions. The legal and regulatory framework has been adapted to accommodate the unique characteristics of these communities, allowing for flexibility in ownership, proximity criteria, and notification procedures. These adaptations have given rise to a diverse array of energy communities, each with distinct legal statuses and operational models. While some focus solely on electricity generation and supply, others engage in energy sharing, incentivizing members to align their consumption with local production. However, it is argued that the full potential of energy communities in contributing to demand-side flexibility is yet to be realized.

In conclusion, chapter 2 has identified limited evidence of energy communities significantly tapping into the DR potential due to various factors, including the absence of energy sharing in some cases, technical limitations, and member response to financial incentives. Nevertheless, energy communities are playing a crucial role in other aspects of the energy transition, such as promoting renewable energy, environmental awareness, and the deployment of critical technologies for DR like smart meters.

Looking ahead, we will delve deeper into the effectiveness of incentives for implicit demand response provided to energy communities. This will help us further understand how energy sharing incentives can benefit the grid and potentially unlock greater demand-side flexibility within these communities. We will also ensure that simple but efficient automatic management techniques are available to the members of these energy communities to effectively harness the potential.

Chapter 3 discusses the evolving landscape of retail tariffs in Belgium and their potential to promote demand response and flexibility among Belgian households and commercial sectors. Retail tariffs consist of multiple components: the commodity price, network charges, and taxes. This combined signal plays an important role in shaping consumer behaviour and incentivizing efficient energy use, while each of its underlying components responds to different considerations. Regulatory shifts, such as the introduction of capacity tariffs in Flanders, are encouraging consumers to spread their electricity consumption over time. Despite the promising shift towards more dynamic tariff structures, significant questions and complexities still require further research.

Looking ahead, the evolving role of regulatory authorities in shaping retail tariffs and promoting flexibility should be further investigated. That includes questions about the division of power between regulators and legislators, especially in the context of using tariffs as means for consumers' behavioural change. Furthermore, the question of how to design the right tariffs model should be further studied, considering that this will depend on the network objective which is aimed to be achieved with time-varying retail tariffs. Finally, similarly to energy communities, simple but efficient management techniques must be available to end users such that incentives are converted into a concrete impact.

5. Appendices

Appendix 1: Enablers of retail demand response beyond energy communities

In the typology of business models described in section 2.3, energy sharing was the main instrument to activate, through financial incentives, demand response. But, of course, there is no reason for energy sharing to be limited to energy communities.

Peer-to-peer electricity trading refers to the direct exchange of electricity between consumers and producers who may not be located close to one another. Specifically, P2P platforms allow participating consumers to buy and sell energy from each other in real-time, often using decentralized and blockchain-based technologies to record and verify transactions.

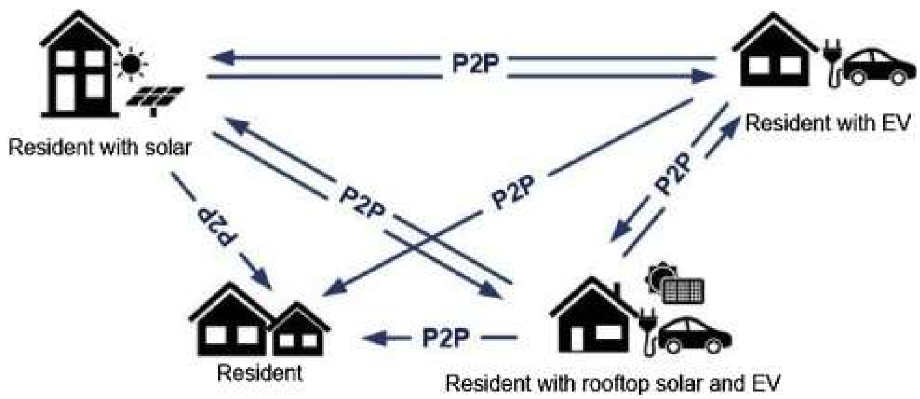


Figure 7: Peer-to-peer trading [59]

P2P trading leads to an optimization of both the supply side and the demand side of the local market. By implementing a more complex price signal than in the context of energy sharing - that aims to maximize collective self-consumption - P2P trading can help address the uneven distribution of renewable resources, manage the dynamic intermittence and fluctuations in renewable power supply, and bolster grid independence. Additionally, it has the potential to offer voltage/power stabilization services to local power grids.[60]

P2P electricity trading can also foster demand response and create viable business cases for energy storage and local energy management. Through P2P trading platforms, consumers can adjust their electricity consumption patterns based on real-time price signals, grid conditions, and their own energy needs.

[59] Source : Liu, Y., Wu, L., & Li, J. (2019). Peer-to-peer (P2P) electricity trading in distribution systems of the future. The Electricity Journal, 32(4), 2-6.

[60] Zhou, Y. (2022). Energy sharing and trading on a novel spatiotemporal energy network in Guangdong-Hong Kong-Macao Greater Bay Area. Applied Energy, 318, 119131.

Appendix 2: Questionnaires for online interviews

As part of this case study, a questionnaire was sent in March 2023 to all the energy community initiatives identified from the European Commision repository and the website of regional regulators. In the framework of this case study, several online interviews have been implemented to gather information about existing Energy communities in Belgium and to understand the existing diversity of Energy communities' design. These online interviews have been carried out towards a survey that has been sent to approximately 80 energy community initiatives in Belgium. The initiatives have been listed from a combination of sources including regional energy regulators, and the Energy Communities Repository.[61]

The questionnaire (available at: https://forms.office.com/e/JcVh9tih6N) asked for the following information:

- General information: initiative's name, objectives in order of importance, legal status, EU regulation energy community status.
- Design and technologies: members nature and number, ownership, and management right over the local production and storage units, solar, wind, hydro power, cogeneration and storage capacities, specific electrical appliances, energy sharing scheme if any, distribution key.
- Consumption behaviour and generation performance: total electricity consumption, production and surplus injection over the past year, self-consumption rate, aggregator contract existence and nature of DR services
- Optional - Economic gains and savings: energy tariff applied to electricity surplus injected in the network (euros/kWh), to shared electricity (euros/kWh) all taxes included, approximate energy bill reduction of initiative's members over the past year, and existence of any network tariff adjustment.
- Optional – Legal framework and barriers: description of the legal barriers initiative's members might have encountered during the initiative's establishment process (e.g., grid connection procedure, legal status), characterisation of the initiative as regulatory sandbox, a pilot project or not.

We received 15 responses. The following graphs and figures provide some information about the sample of respondents.

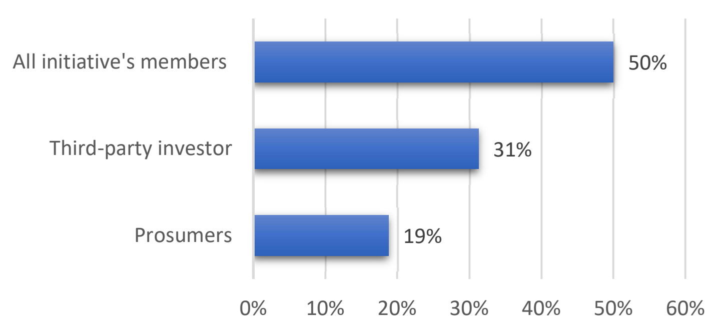


Figure 8: Ownership of local production units

[61] European Commission – Energy Communities Repository - https://energy-communities-repository.ec.europa.eu/energy-communities/energy-communities-map_en

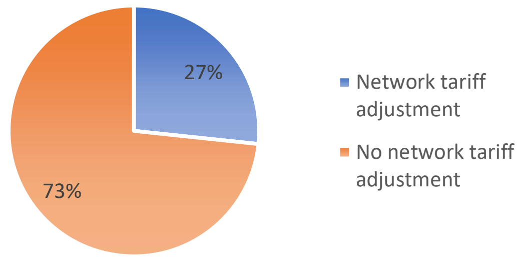


Figure 9: Network tariff conditions

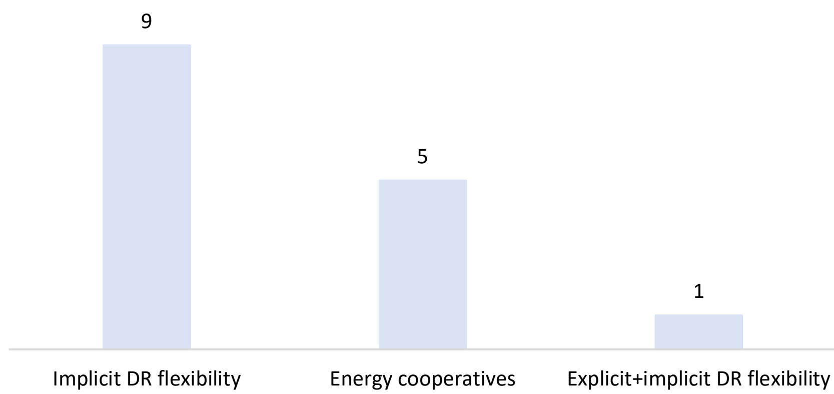


Figure 10: Demand-response business models