

Chapter 38. Energy policy

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1. Introduction

The present chapter presents a comprehensive literature review on energy policy in Belgium, highlighting the country's complex and fragmented energy landscape, fraught with coordination challenges and ambivalent policies. Due to its particular institutional structure, Belgium is a rather unique case in the field of energy policy research. Indeed, the distribution of competences in Belgium – commonly referred to by commentators as an *institutional lasagna* – tends to complicate policy coherence. The country's energy sector exemplifies these challenges as energy policy responsibilities are shared between the Federal Government and the three Regions (see chapter 'Federalism' in this Handbook). As a result, the country has four energy ministers, each supported by their own administration. Federal competences include security of supply, nuclear energy, tariff regulation and electricity transport, and offshore wind in the North Sea (Van de Graaf et al. 2022). The Regions, in turn, are responsible for all competences not formally attributed to the federal level, including electricity and natural gas distribution and regulation, energy efficiency, renewable energy (except offshore wind), recovery of waste energy from industry or other uses, and non-nuclear research and development (Laes and Verbruggen 2019).

Similarly, there are both federal and regional regulators: the Belgian Federal Commission for the Regulation of Electricity and Gas (CREG), the *Vlaamse Regulator voor Elektriciteit en Gas* (Flemish Regulator for Electricity and Gas – VREG), the *Commission Wallonne pour l'Énergie* (Walloon Commission for Energy – CWaPE); and *Brugel* in the Region of Brussels-Capital. The CREG ensures that transparency and competition are respected on the electricity and natural gas markets, approves transmission tariffs, looks after the interests of consumers, and balances the operation of the markets, the general interest, and the development of the energy policy framework in Belgium. Meanwhile, the regional regulators are responsible for

organizing and operating regional electricity and gas markets, controlling the effective application of energy decrees, and providing mediation services for consumers (Collard 2016).

Energy wise, Belgium is characterized by a corporatist structure, with electricity and gas production largely in the hands of private companies (Van de Graaf et al. 2022). Energy producers, suppliers, transmission system operators, distribution system operators, intermediaries, industrial and individual consumers pursue different interests and sometimes promote their own visions for the country's future energy landscape.

Belgium is a rather small, yet densely populated country with high energy intensity and limited indigenous primary energy resources. This peculiar configuration presents distinct challenges for the country's current and future energy policy orientations, particularly regarding energy security, diversification, and the transition toward sustainable energy sources. In 2022, Belgium was the third most nuclearized country in the EU after France and Slovakia. Its electricity mix was composed of nuclear energy (45.7%), natural gas (21.9%), renewables (mainly wind, solar, solid biomass: 25.5%) and, to a lesser extent, solid fossil fuels and steelmaking gases (2.4%), petroleum products (0.3%) and other sources (including pumped hydropower, recovered heat, non-renewable waste and others: 3.2%) (FPS Economy 2024). According to the Federal Public Service (FPS) Economy, renewable energy *production* has increased by 108.3% (+12.7 TWh) compared to 2013 levels. Concurrently, the use of petroleum products and solid fossil fuels has fallen by 8.5% and 55.1%, respectively (FPS Economy 2024, 26).

However, in 2022, the share of renewable energy sources in final energy *consumption* (13.76%) remained well below the EU average (23%) and that of neighbouring countries such as Germany (20.8%) and France (20.2%). Likewise, net energy imports remained high, mainly from oil products (61.7%) and natural gas (28.7%). Energy dependence – i.e., the ratio of net

imports to the sum of gross domestic consumption and energy supplied for international maritime transport – was 73.9%, 11 points above the EU average in 2022 (FPS Economy 2024, 37).

In what follows, we synthesize key insights from the existing literature on Belgium's past and current energy policy orientations. Specifically, we derive from the literature six dominant frames of reference that drive the country's energy policy orientations: energy security, energy diversification, energy efficiency, liberalization and access to energy, nuclear phase-out, and energy transition. Building on these insights, the third section outlines several avenues for future research on energy policy in Belgium, including citizen participation and policies related to exnovation, phase-out, and maintenance. We conclude by emphasizing Belgium's potential as a fertile ground for researchers conducting interdisciplinary and comparative energy policy studies, particularly on governance challenges and policy innovation within the context of energy transition.

2. State of the art: Main past and current energy policy orientations in Belgium

Since the end of World War II, several key frames of reference have durably oriented Belgian policymakers' energy policy choices. Although such frames are deeply interconnected, they convey a sense of policymakers' most enduring concerns regarding energy policy.

2.1 The security of energy supply

According to the literature, energy security has long been, and continues to be, a dominant frame of reference in Belgian energy governance. This is particularly apparent when considering the historical prominence of the coal industry and its significance in the country's strategy for industrial recovery in the aftermath of World War II. The loss of manpower after the conflict led to the so-called *coal battle*, a series of measures which notably promoted and

sponsored the use of immigrant workforce in the coal industry. However, coal extraction became uncompetitive in the 1960s and the last exploitation was closed in 1992 (Van de Graaf et al. 2022).

Policymakers' long-lasting concern over security of supply is also made apparent in the deployment of the Belgian nuclear sector. Belgium is widely recognized as one of the early pioneers in the field of nuclear research (Jaumotte 2003). The sector's early achievements – with the construction at the Belgian Nuclear Research Center (SCK-CEN) of Belgium's first experimental reactor (BR1) in 1956, and Europe's first pressurized water reactor (BR3) in 1962 – came in a context marked by a rapid growth of energy demand, rising costs of domestic coal extraction, and a growing dependence on imported oil and gas. This prompted Belgian authorities to opt for nuclear energy in 1968 as one of the country's main energy sources (Söderholm 1998). After the construction of the country's first power reactors in 1975 (Doel 1, Doel 2, and Tihange 1), the expansion of nuclear capacity was carried out with the commissioning of Doel 3 (1983), Tihange 2 (1983), Doel 4 and Tihange 3 (1985). Nuclear energy rapidly became prominent in the country's energy mix, cementing Belgium as one of the most nuclearized countries worldwide.

Current research indicates that energy security remains a dominant policy issue in Belgium. The country is heavily dependent on primary energy imports (Dallenes et al. 2023; Brown et al. 2014) because of limited indigenous primary energy resources and a very high degree of energy intensity (Faraji Abdolmaleki et al. 2023). Although Belgian authorities have deployed energy diversification and efficiency measures to improve energy security (e.g., Brown et al. 2014), concerns over possible capacity shortages for a period situated between 2025 and 2030 remain important due to the nuclear phase-out policy initiated in 2003 (Vandorpe 2022).

In light of these concerns, federal authorities have urgently developed new capacity mechanisms under the form of a strategic reserve (SR) and a future capacity tendering process (Vandorpe 2022). In 2014, the SR was introduced to offset possible energy shortages during winter months. Based on annual security of supply forecasts that consider generation capacity, demand, and interconnectivity, the SR mechanism requires plants which are mothballed or scheduled for closure to remain available for activation via state tendering (Vandorpe 2022). Elia, the Belgian transmission system operator, negotiates remuneration with plant operators. In 2021, the Federal Government also adopted a Capacity Remuneration Mechanism (CRM) to ensure the availability of adequate capacity from the winter of 2025-2026 onwards and to stimulate long-term investment in new capacity (Mastropietro et al. 2024). Contrary to the SR, which focuses on solving urgent capacity deficits, the CRM is a market-based mechanism providing support for any type of new capacity (production, storage, demand management) that ensures security of supply (Vandorpe 2022).

Recently, the war in Ukraine threatened the energy supply of several member states (Rokicki et al. 2023) and brought into sharp focus the European Union's (EU) vulnerability regarding energy security. Belgium was particularly affected due to its structural dependency on energy imports (CREG 2023). This led the Federal Government to postpone the shutdown of two of its nuclear reactors and further accelerate energy transition projects.

2.2 Energy diversification

Ever since the 1973 oil crisis, Belgian policymakers have sought to diversify the sources and geographical origin of energy. This concern is illustrated by the continuous use of coal for electricity generation throughout the 1970s and 1980s. Indeed, despite the addition of nuclear energy in the mid-1970s, coal's share in the electricity mix still rose between 1973 and 1991 due to a decision to promote multi-fuel capacity and to convert old oil-fired plants to burn coal

(Söderholm 1998). Nowadays, energy diversification remains key to guarantee security of supply, as unanticipated disruptions may affect the energy imports on which the country is heavily dependent (Gusbin 2015).

In past decades, Belgium's strategy for diversifying primary energy imports has focused on "switching from the Middle East to the North Sea (Norway and the United Kingdom [UK]) and the former Soviet Union as the main crude oil suppliers" (Brown et al. 2014, 73). In the 1990s, Belgium also diversified natural gas imports, which gradually replaced coal for electricity generation. By the early 2000s, most natural gas imports originated from the Netherlands, Norway, Algeria, and the UK (Shenk 2008). Since 2019, the gradual phase-out of the Groningen gas field in the Netherlands led to an increase in Liquefied Natural Gas (LNG) imports from Russia to the Zeebrugge terminal (IEA 2022). Before the war in Ukraine, and despite its enduring dependence on energy imports, Belgium had achieved high import diversification and security performance due to its robust "natural gas infrastructure and (...) gas market indicators" (Streimikiene et al. 2023, 10).

Belgium's diversification strategy also aligns with the EU's energy union, which seeks to ensure energy security through diversification, decarbonization, an integrated energy market, as well as solidarity and cooperation between EU countries (COM/2015/080). Over the years, the country achieved greater cross-border interconnections with neighbouring countries' high voltage grids. In 2022, as a result from a gradual integration to the EU energy market and its well-developed gas infrastructure, Belgium was favourably positioned to attract and redistribute natural gas flows to North-Western European markets (CREG 2023).

In past decades, Belgium has also increased the share of renewables as part of the EU 2020 (2009/28/EC) and 2030 (EU/2023/2413) targets to reduce EU-wide greenhouse gas (GHG) emissions. This mainly resulted from increased solar and wind capacity supported by federal

and regional public subsidies (Boccard and Gauthier 2021; Delbeke et al. 2023). Offshore wind-based production, in particular, is set to gain in prominence. In 2021, federal authorities have agreed to the development of an additional 281 km² wind zone in the North Sea in view of expanding total offshore wind capacity to 5.4-5.8 GW by 2030 (Penneman et al. 2023). In 2023, the Federal Government also approved the second phase of the Modular Offshore Grid (MOG) project to improve interconnection with other offshore wind projects in the North Sea.

2.3 Energy efficiency

Along with energy diversification, the literature stresses how Belgian policymakers have also actively endorsed energy efficiency measures. Initially aimed at addressing energy security risks, energy efficiency gradually became a key strategy for achieving cuts in GHG emissions as part of a general effort towards energy transition (Shenk 2008). Currently, efficiency measures are largely driven by EU requirements (Van de Graaf et al. 2022), such as the 2012 Energy Efficiency Directive (2012/27/EU), which required member states to set a series of indicative targets contributing to the collective EU goal of a 20% reduction in energy consumption by 2020, and its 2023 revision (EU/2023/1791), which sets an additional 11.7% target reduction by 2030.

In Belgium, the responsibility for energy efficiency primarily rests with regional governments. The Federal Government is generally restricted to a coordination role through the ENOVER/CONCERE working group – which gathers regional and federal energy cabinets delegates since 1991 – and to the overseeing of energy efficiency in domains such as federal buildings, eco-design, passive house design (Kapedani et al. 2019) and energy labelling. Despite recent progress, Belgium's energy intensity remains significantly higher than the EU average. This low energy efficiency performance (Lu and Lu 2019) is often attributed to an

ageing, inefficient building stock (e.g., Coppens et al. 2022) that consumed “almost 40% more energy than the European average” in 2017 (Van de Graaf et al. 2022, 514).

In recent years, Belgium has set ambitious goals to reduce energy consumption. Energy efficiency is a key component of the 2021-2030 National Energy and Climate Plan (NECP), which sets a 32.5% contribution to the European target by 2030 (NECP 2019). As such, the Federal and Regional Governments have taken measures to improve the energy efficiency of residential buildings, such as minimal requirements for roof insulation in Flanders, or financial incentives to promote residential building stock efficiency, as only “half of the homeownership households are capable of financing the necessary renovation” (Albrecht and Hamels 2021, 11). In practice, several authors emphasize that energy-saving practices remain strongly related to individual cultural and socio-economic status (Bartiaux et al. 2016; Albrecht and Hamels 2021; Dallenés et al. 2023).

Measures were also taken to reduce energy consumption in the transport sector, which remains one of Belgium's most energy-intensive sectors (IEA 2022). Significant improvements were achieved, notably through the implementation of support policies for electric passenger cars (Dolge et al. 2023). Although e-mobility remains marginal amid increased road traffic (Van de Graaf et al. 2022), electric vehicle registrations grew up to 3.1% of the passenger car fleet (IEA 2022). Regional Governments also aim to improve industrial energy efficiency through voluntary energy agreements with energy-intensive industrial companies. In 2020, over 90% of such companies agreed to engage in such voluntary processes (IEA 2022).

2.4 Energy market liberalization and households' access to energy

Another key frame of reference in Belgian energy policy concerns household's ability to access energy at a reasonable price. Initially, policymakers favoured the liberalization of the energy market to drive down prices by enhancing competition. To reduce the market dominance of

historical players such as the energy supplier Electrabel (Collard 2023), the 1999 Electricity Act “unbundled the distribution and transmission segments from the generation and supply segments” (Tõnurist et al. 2015, 93). This reform led to the creation of the national Transmission System Operator (Elia) in 2002. However, these reforms yielded mixed results according to Tõnurist and colleagues: Electrabel's dominant position remained largely unchallenged, and regional disparities in market opening rates persisted, with Wallonia and Brussels-Capital lagging behind Flanders (2015).

Despite Electrabel's acquisition by Suez in 2007 and its merger with GDF to form Engie in 2015, the market still shows signs of oligarchic control (Collard 2023). Liberalization efforts have also arguably failed to promote cost-efficiency and lower market prices (Tõnurist et al. 2015). Instead, it is now argued that these measures have worsened energy access for some populations, contributing to higher energy poverty levels (Meyer et al. 2018).

While there is no official definition of energy poverty in Belgium, studies stress that its prevalence is high and varies considerably according to the Regions (Bartiaux et al. 2021; Meyer et al. 2018). In 2021, about 10% of Belgian households spent over 10% of their income on maintaining comfortable indoor temperatures (Antunes et al. 2023). Beyond energy market liberalization, authors highlight ageing building stock as a major factor to energy poverty in Belgium, with poor insulation and suboptimal energy performance driving high energy costs (Bartiaux et al. 2021). This issue, now worsened by soaring energy prices, is especially pronounced in Brussels-Capital and Wallonia, where most dwellings predate 1981 (Bartiaux et al. 2021).

Growing awareness led policymakers to enact a series of measures aimed at trying to alleviate energy poverty. Regional governments have focused on improving energy efficiency, by subsidizing home renovations (Coppens et al. 2022; Albrecht and Hamels 2021), while

successive federal governments have taken measures to contain untenable energy price fluctuations through energy diversification and energy security measures, including the delayed phase-out of the Doel 3 and Tihange 4 nuclear reactors. Amidst soaring energy prices, the Federal Government also promptly decided to provide financial support to low-income households in 2021 through a range of temporary subsidies, VAT reductions, tax and fiscal reforms on energy bills, which were subsequently extended on several occasions.

2.5 Nuclear Phase-Out

Following the 1973 oil crisis, a series of accidents (Three Mile Island in 1979 and Chernobyl in 1989) and local scandals (i.e., the 1987 Transnuklear affair) fuelled the antinuclear sentiment in Belgium: first among Green parties, then later among trade unions and other parties (Eggermont et al. 2007). The participation of Green parties in the 1999 federal government marked a significant political shift. The coalition agreement included a gradual nuclear phase-out plan, justified by a commitment to environmental sustainability and energy diversification (Dumont and De Winter 1999). In January 2003, a law was enacted to gradually phase-out nuclear energy for electricity generation by 2025. This law set a shutdown timeline and prohibited the construction and operation of new nuclear power plants. According to the schedule, all reactors were to shut down 40 years after their commissioning date. However, the law also authorized the extended operation of nuclear reactors should the country's energy security be jeopardized. This paved the way to a prolonged period of fluctuations in Belgium's commitment to nuclear phase-out (Vandorpe 2022).

Belgium's phase-out policy saw various revisions in the following decades. Although initially endorsed by the next government, it faced strong opposition from pro-nuclear initiatives and centre right-wing parties (Verbruggen 2013). In December 2013, the adoption of a new national energy plan postponed the shutdown of Tihange 1 by 10 years, while the rest of the schedule

remained unchanged. Until 2015, a series of forced shutdowns reduced the availability of nuclear power plants due to the detection of micro-fissures in the pressure vessels of Doel 3 and Tihange 2 and a cooling issue in Doel 4's steam turbine (IEA 2022). Yet, in June 2015, amid fears of an electricity supply shortage, the government postponed the shutdown of Doel 1 and 2 reactors by ten years (de Frutos Cachorro et al. 2019). This revision of the 2003 law resulted in an ambitious phase-out timetable, with seven reactors scheduled to shut down between 2022 and 2025. Still, in line with the phase-out plan, Doel 3 and Tihange 2 were shut down in October 2022 and February 2023, respectively.

In 2022, following the COVID-19 pandemic and the energy crisis in Europe – exacerbated by the war in Ukraine and the end of Russian gas imports – the Belgian Government announced its inclination to further mitigate the risk of power outages by extending the operating life of Doel 4 and Tihange 3. In December 2023, an agreement with Engie was reached to keep Doel 4 and Tihange 3 operational for ten years beyond their planned closure in 2025, requiring an investment of 1.6 to 2 billion euros (ENGIE 2023). The final extension agreement remains subject to European Commission approval and legislative amendments.

According to many observers, the nuclear phase-out evidently presents a serious dilemma for Belgium's current and future energy policy. While the shutdown of Doel 4 and Tihange 3 will likely be postponed, the planned closure of three nuclear reactors in 2025 raises concerns about compensating for the loss of 3866 MW of nuclear baseload capacity (Mentens et al. 2024). Ultimately, successive governments' decisions to extend the operational life of reactor units in 2013, 2015, and 2022 illustrate a form of nuclear lock-in (Verbruggen 2013) stemming from the challenge of balancing an ambitious phase-out policy with ensuring the practicalities of ensuring a reliable energy supply all the while reducing primary energy use, maintaining affordable prices, and committing to energy transition (Laveyne et al. 2020).

2.6 Energy Transition

Since the late 1990s, energy security, diversification, efficiency, and affordability are also tied to a general commitment to a low-carbon energy transition. In 1996, Belgium ratified the Kyoto Protocol, committing to reduce GHG emissions for the 2008-2012 period (Shenk 2008). Over the following decades, several EU Directives significantly shaped the country's energy transition policy. In 2009, the European Climate and Energy package set ambitious EU-wide targets, with a 20% GHG emission reduction, a 20% share of renewables, and a 20% energy efficiency improvement by 2020. In 2023, following the 2015 Paris agreement and as part of the 2019 Green Deal to attain climate neutrality by 2050, the EU updated its 2030 objectives to a 47% reduction in GHG emissions (COM/2021/550) and a 42.5% share of renewables in overall energy consumption (EU/2023/2413).

In the early 2010s, Belgium saw a significant increase in renewable energy production, particularly in electricity generation. By 2015, renewables accounted for about 26% of total energy production, a performance praised by some (Gökgöz and Güvercin 2018) for reflecting a strong governmental commitment to create incentives for renewable energy investments through subsidies (Ahmadov and van der Borg 2019). By 2019, Belgium, and especially Flanders, had the third-highest per capita use of photovoltaics (PV) in the EU (Wolniak et al. 2022). However, observers note that Belgium's renewables share in final energy consumption remains low, 13.8% in 2022, among the lowest in the EU (Dallenes et al. 2023). Others, such as Strunz et al. (2021), condemn an *ambition gap* exemplified by the unambitious Belgian NECP target of 17.5%¹ for renewables in final energy consumption by 2030.

¹ The NECP was updated in 2023 in accordance to the European Commission's new global strategies, such as *Fit for 55* and *RepowerEU*. As part of this revision, the target was increased to 21,7%.

Research on the drivers and constraints of energy transition in Belgium focuses on two main trends: the coordination challenges arising from the multiplicity of private and public actors involved, and the legal, technical, financial, and participatory instruments adopted for the energy transition.

First, scholars often highlight that, since 1988, the elaboration of energy transition policies has been complicated by fragmented competences between the Belgian federal and regional governments (Jay 2010). This complex articulation has led to a patchwork of policies and severe coordination issues (Happaerts 2015; Van Opstal and Smeets 2023) as evidenced by the six-year negotiation needed before reaching the 2020 EU renewables target agreement in 2015.

Over the years, the need for improved coordination gave rise to various intergovernmental initiatives, such as the ENOVER/CONCERE concertation platform and the National Climate Commission established in 2002 to ensure national coordination and the monitoring of climate commitments and policy. The 2017 inter-federal energy pact further exemplifies regional and federal ministers' desire to reach a concerted vision on energy transition considering 2030 and 2050 targets. Yet, despite these efforts, Regions still adopted different targets in the 2023 NECP revision, highlighting the persistent difficulty of aligning policies among the different entities.

At another level, energy transition efforts also target energy suppliers, intermediaries, commercial and residential sectors, and consumer behaviors. De Frutos Cachorro et al. (2019) note that nuclear phase-out uncertainties reduce supplier investments, while Jacquet et al. (2015) insist on valorising the commercial initiatives that promote circular economy. Decuypere et al. (2022) emphasize the importance of collaboration between intermediaries and homeowners for effective renovation practices. Researchers also demonstrate how inadequate bureaucratic and stigmatizing state social assistance practices (Bartiaux et al. 2018), and a

complex institutional structure (Bartiaux et al. 2021) can hinder changes in individual energy consumption behavior.

Second, many studies focus on the legal, technical, financial, and participatory instruments that are regularly adopted to sustain energy transition. In 2023 alone, Belgium reported a total of 241 single policies and measures addressing climate change (European Commission 2024). In Belgium, renewable electricity generation is primarily promoted through market-based instruments under the form of Tradable Green Certificates (TGCs) (Carton 2016). Belgium has four distinct TGC programs, emitted by relevant energy regulators: one for each regional government and one managed by the Federal Government to reward offshore wind generation. Renewable energy producers are only allowed to trade certificates inside their Region and all regional programs feature increasing quotas for certificates that electricity suppliers must secure annually, with penalties for non-compliance.

Although TGCs were intended to create a market favouring green energy solutions (Van de Graaf et al. 2022), they have sparked controversies in Belgium. TGCs initially favoured cheaper, environmentally questionable energy sources such as imported bioenergy (e.g., palm oil), which reaped significant rents from certificate money and diverted resources from alternative technologies (Carton 2016; Verbruggen and Laes 2021). Meanwhile, PV developments lagged due to high costs relative to TGC ceiling prices, with significant PV adoption only beginning in 2006 after the introduction of generous PV premium support (Tõnurist et al. 2015). However, these overgenerous subsidies created financial strain on the Regions, leading to reduced PV premiums (De Groote et al. 2016), and a perverse *rebound effect* in energy consumption among PV owners (Boccard and Gauthier 2021). Additionally, some authors noted that this support scheme, financed by direct and indirect taxes on all

citizens, has increased social inequalities as only those with greater financial resources could afford PV panels (Bartiaux et al. 2016).

Although TGCs remain a cornerstone to Belgium's energy transition policy, other schemes are employed at regional and federal levels. Besides public subsidies and taxes, Belgium innovates with the introduction of *regulatory sandboxes* to boost experimental energy transition innovations (e.g., local energy, flexible participation in electricity markets, distribution network tariffs) and regulatory learning through derogations (Beckstedde et al. 2023).

Many energy transition instruments focus on integrating the final energy consumer, or prosumer, into the process. Key issues include understanding consumers' behaviour and their degree of *consciousness* (Van de Velde 2009) as well as their capacity to change their behaviour accordingly, moving from passive to active citizens (Campos et al. 2020). In Belgium, social class significantly influences individual renewable energy consumption (Bartiaux et al., 2021). Vulnerable groups, with limited access to economic and cultural resources (Dallenes et al. 2023), also suffer from energy inequality and experience structural barriers to the adoption of green energy practices. In other words, it is harder for these groups to adopt energy saving practices (Bartiaux et al. 2016), to make renovation investments (Albrecht and Hamels 2021), or to oppose fossil fuels and nuclear energy (Dallenes et al. 2023).

Federal and regional authorities are currently exploring several ways to involve the public and stakeholders in energy transitions, particularly in wind energy development. Scholars have underlined strategies such as, to name a few, working on *familiarization* and experience sharing to reduce negative attitudes (Penneman et al. 2023; Van Opstal and Smeets 2023); developing *collective storytelling* to preserve diversity and inspire initiatives (Mourik et al. 2021); negotiating over acceptable solutions instead of fixed proposals (Pepermans and Loots 2013); creating more inclusive procedural conditions (Rossignol et al. 2017); and nurturing the *art of*

diplomacy (Mélard and Stassart 2018) to enable co-creation between citizens and authorities or experts (Manktelow et al. 2023), and to implement community-based management.

One of the most studied participatory instruments in Belgium are the *(renewable) energy communities* (REC) (Bauwens 2019; Bonfert 2024; Conradie et al. 2021), also known as *community-driven energy* (Van Summeren et al. 2020), or *collective action initiatives* (Gregg et al. 2023). These initiatives are seen as key energy transition drivers (Van Summeren et al. 2020; Bauwens and Devine-Wright 2018) which introduce “logics of proximity, spatial selectivity and collectivity” (Juwet 2019, 1902) essential for the creation of *transition cities* and to build resilient local communities (Kenis and Mathijs 2014). REC initiatives are also expected to raise public awareness and engagement, diversify market actors and risks, reduce dependence on large corporations, increase local autonomy, and respect local identities (Gregg et al. 2023).

Belgian regional authorities have also integrated RECs into their legal frameworks and issued subsidies for these initiatives. Intention to participate in energy communities is usually associated with a set of attitudes and subjective norms which suggest a strong influence of family, friends and neighbours’ opinions (Conradie et al. 2021). Economic incentives, social factors, self-identity, and attachment to democratic governance are also influential (Bauwens 2019; Conradie et al. 2021). However, energy communities face challenges in coordination and recognition with other energy actors. They “lack the authority and means to scale up innovations” (Bonfert 2024, 1) and must rely on other actors while complying with the incumbent energy system and its constraints (Van Summeren et al. 2020).

3. Avenues for future research

In addition to the evaluation of public instruments to support energy transitions and efforts to coordinate and integrate stakeholders in these transitions, we identify four avenues for interdisciplinary research.

3.1 Towards a holistic approach of Belgian energy history?

Belgium's energy transition plan prioritizes reducing GHG emissions, but what this *energy transition* actually entails and its multiple governance pathways remain topics of debate, as they can justify ambivalent policies in a fragmented energy landscape (Aykut et al. 2017). Given that energy sources tend to accumulate rather than replace one another, intertwined energy production and consumption dynamics should be studied holistically rather than as separate, competing entities. Hence, drawing on authors like Fresso (2024) should allow to avoid pitfalls in assessing Belgium's energy history and future energy projections. For example, revisiting the history of entanglement and interdependence of imported fossil fuels (e.g., Ahmadov and van der Borg 2019) or nuclear energy (e.g., Verbruggen 2013), alongside the inertia of the energy distribution system (Juwet and Deruytter 2021), should help identify key barriers to decarbonization in Belgium.

3.2 From energy innovation to energy exnovation

As illustrated in this chapter, the promotion of innovation – both technical and regulatory – frames the energy transition as a race for decarbonization as well as an opportunity for economic growth. The development of, and expectations associated with, innovative energy technologies such as small modular reactors (SMRs), transmutation of high-level radioactive waste, green hydrogen, cross-border offshore hybrid hubs, and their socio-technical

consequences for energy systems, should deserve a closer attention to understand future energy policy orientations.

For instance, the Federal Government recently allocated €100 million to SCK-CEN to conduct research on SMRs in the 2023-2028 period. While technical complexities and uncertainties around large-scale deployment persist (Böse et al. 2024), SMRs are touted as a flexible, reliable, and decarbonized solution for future energy networks. Similarly, strong federal and regional support exists for green hydrogen development (Sapnken et al. 2023), which, despite its nascent stage, is featured among policy priorities. Cross-border hybrid hubs – with plans to transform the North Sea in the “green power plant of Europe” (De Croo 2023) integrating renewables, hydrogen and carbon capture, utilization and storage (CCUS) – are also purported as key to simultaneously addressing energy transition, security, diversification and accessibility. Whether if and how these expectations will be realized remains uncertain.

In contrast, some authors argue that “disruptive or ‘breakthrough’ technologies” (Coppens et al. 2022, 11) are not needed to achieve mitigation objectives. They suggest *doing without, doing with less* as new innovation horizons (Goulet and Vinck 2022), introducing exnovation - the natural flipside of innovation - as the purposive termination of existing energy infrastructures and practices (David and Gross 2019). For example, the study of Brussels' Low Emission Zone (Fossati et al. 2022) is one of the first to focus on exnovation as a policy instrument. The purposive phase-out of existing energy (infra)structures, technologies, and practices will likely generate new networks with different rationales worth examining by *transition studies*.

3.3 Focusing on the multiple transformations of energy infrastructures

Innovation and exnovation policies face material constraints, particularly considering the constant and mundane changes that affect the materiality of ageing Belgian energy infrastructures. Both maintenance, when infrastructures wear out and deteriorate, and

decommissioning, when it is decided to scrap them, require policy choices and an adaptation of socio-technical practices. These are critical considerations for a country marked by phases of de-industrialization and a legacy of ageing or disused energy infrastructures.

First, *maintenance and repair studies* emphasize the importance of maintenance and repair policies and practices in the management of infrastructures before breakdowns occur. Roads, railways, electricity grids, and power turbines are infrastructures that often escape attention and recognition despite requiring considerable – yet also backgrounded – investment and daily care. In Belgium, special attention should be given to the extension of nuclear reactor operation, as both material and human factors (e.g., micro-fissure monitoring, maintenance staff recruitment and retention) are essential for ensuring safe operations.

Second, organizing the phase-out and decommissioning of energy infrastructures presents significant social, economic, and technical challenges (Hoti et al. 2021), such as ensuring public and stakeholder involvement in the process, anticipating long-term waste management, and hosting site planning. The (scheduled) phasing-out of several Belgian nuclear reactors further emphasizes that decommissioning was often overlooked in the design and financial planning of current facilities, making it vital to draw lessons to *systematically* anticipate and assess discontinuation policies for current and future infrastructures, including renewables. Indeed, end-of-life strategies for wind farms (Goethals and Maes 2023), PV panels (Van Opstal and Smeets 2023), and the associated waste management remain key governance blind spots in Belgium.

Third, energy transition entails transforming, repurposing, and revalorizing existing infrastructures. Retrofitting policies favour a particular form of repair over substitution, challenging conventional views of energy transition with practices that move beyond merely discarding the old or fully embracing the new. In Belgium, besides urban renovation and home

energy efficiency efforts (e.g., Decuypere et al. 2022; Bartiaux et al. 2016), retrofitting has also been proposed for reusing parts of the existing gas network for hydrogen transport (Dejonghe et al. 2023), positioning the country as a major CO₂ transit hub, and repurposing abandoned mines for geothermal energy or excess renewable electricity production storage.

3.4 Fostering inclusive and coordinated energy governance

Finally, and more broadly, the various avenues for future research developed above call into question the primary objective of energy transition: what is a *desirable* transition(s)? What kind of energy innovations do Belgians *want*? Such normative questions call for a systematic inclusion of publics and stakeholders throughout the process (from conception to assessment), as well as overcoming recurrent inequalities.

Numerous contributions to *participation studies* highlight that there is no single approach to integrating or consulting the public and stakeholders. Some of the practices discussed in this chapter reflect this diversity. In Belgium, there is still a need to comprehensively map and compare public engagement with energy and net zero. This ranges from "dominant practices" (e.g., public surveys viewing the public as consumers) to the formation of *diverse participation collectives* (such as energy communities), and *emergent and overflow* forms of participation (e.g., digital and mundane publics) (Chilvers and Longhurst, 2016). In the energy and environmental sectors, despite coordination and knowledge integration challenges in an already fragmented policy landscape (Manktelow et al. 2023), Chilvers and Longhurst (2016) emphasize the implementation of multiple, entangled, and interrelated forms of participation for robust energy system futures.

4. Conclusion

This chapter summarized scientific contributions on Belgium's past and current energy policy orientations, highlighting key frames of reference guiding policymakers' energy policy choices and their interconnections. Research emphasizes that energy security remains a primary concern in Belgian energy governance, driving both energy diversification and energy efficiency measures. Other key frames of reference underscored by the literature include the internal energy market (energy poverty, market integration), uncertain nuclear energy trajectories, and the EU climate policy agenda targeting a low-carbon economy by 2050. Scholars also point to historical legacies and path dependencies in the energy sector, which can create lock-ins and impede transformative energy transition policies.

Over the last decades, and consistent with other EU countries, most energy policies in Belgium reflect a general commitment towards energy transition and decarbonisation. This aspect, extensively covered in the literature, can be divided into two main trends. On the one hand, some scholars examine the governance issues arising from the complex coordination between numerous public (e.g., federal and regional levels) and/or private actors involved in energy transition. On the other hand, many contributions explore the innovative institutional attempts at improving decision support systems with a better integration of final energy consumers (or prosumers) through the development of energy communities, or the adoption of regulatory sandboxes for instance. As such, we argue that Belgium constitutes a compelling and illustrative case for comparative researchers interested in examining governance issues and policy innovation within the context of energy transition.

Finally, from the Belgian case, we identify four promising avenues for international researchers pursuing interdisciplinary studies on energy policy issues. First, the Belgian case illustrates that future research should contemplate the symbiotic dynamics of energy production and

consumption to critically assess and compare how different countries approach energy transition. Second, going against the usual focus on innovation in transition studies, we call for comparative studies investigating exnovation policies and the purposive phase-out of existing technologies. Third, studies should comprehensively examine the policy choices – from maintenance to retrofit and decommissioning – which concern many existing energy infrastructures in Belgium and beyond. This should provide valuable insights for the management of current and future energy infrastructures. Finally, future research should investigate, and assess, the inclusion of various publics through multiple forms of participation, as this appears crucial for establishing sound energy policies in the future.

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