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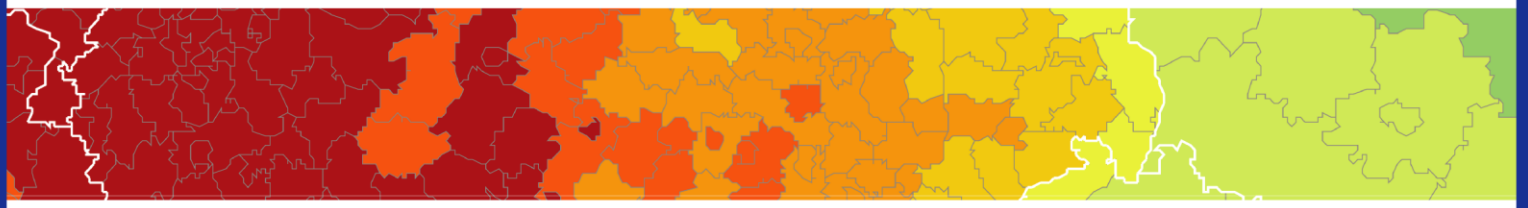

Cooperation perspectives for the Luxembourg Cross-border Functional Region

Thinking and planning in areas of territorial cooperation: ESPON ACTAREA spin-off

Final Report

Final Report

Cooperation perspectives for the Luxembourg Cross-border Functional Region

Version 13/10/2020

Disclaimer:
This document is a final report.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2020 Cooperation Programme.

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Abbreviations

COVID-19	Coronavirus Disease 2019
DATer	Luxembourgish Department of Spatial Planning
EC	European Commission
EGTC	European Grouping of Territorial Cooperation
ESPON	European Territorial Observatory Network
EU	European Union
FUA	Functional Urban Area
INSEE	Institut national de la statistique et des études économiques (France)
LISER	Luxembourg Institute of Socio-Economic Research
MosaHYc	Mosel Saar HYdrogen Conversion
NUTS	Nomenclature of Territorial Units for Statistics
STATEC	Institut national de la statistique et des études économiques du Grand-Duché de Luxembourg
VRE	Variable renewable energy

1 Introduction

The Luxembourg government is currently revising the Master Programme for Spatial Planning. This new version will include guidelines for the near- to medium-term future development of the Luxembourgish territory (time horizon 2035) and strategic orientations for its long-term future development (time horizon 2050). As a preparation and input for these strategic orientations, the government has launched the process of creating a vision for the cross-border functional area of Luxembourg until 2050 (called “Luxembourg in Transition”) based on the principles of carbon neutrality and resilience. This fits into the context of ongoing discussions in Luxembourg about an approach of co-development in the cross-border cooperation with its neighbours and the vision will eventually guide a soft territorial cooperation driven by the Luxembourg government in the context of the implementation of the Master Programme for Spatial Planning. The visioning process itself will run from October 2020 until December 2021 and will be supported by 10 expert teams, many of which neither come from Luxembourg nor from the Greater Region.

The present report is meant to offer different types of guidance to support the work of the expert groups. These inputs are based on two pillars:

- a precise overview of institutional frameworks of relevance for the balanced territorial development in and around Luxembourg; and
- descriptions of cross-border functional interdependencies in relation to themes and issues considered to be of strategic importance by the government of Luxembourg.

The objective is to provide contextual information for expert inputs. This contextual information is synthesised by using two types of graphic tools developed by the ACTAREA project: Mapshots and Institutional mappings.

It focuses on three themes, which have been selected in dialogue with the Luxembourgish Department of Spatial Planning (DATer):

- Labour markets, housing and transport;
- Energy production and provision;
- Food provision and associated value chains.

The following chapters successively address these three themes. Each section first reviews available evidence. Mapshots and Institutional mappings are presented in the final sub-sections. The final section of the report presents recommendations for a soft cross-border territorial cooperation strategy.

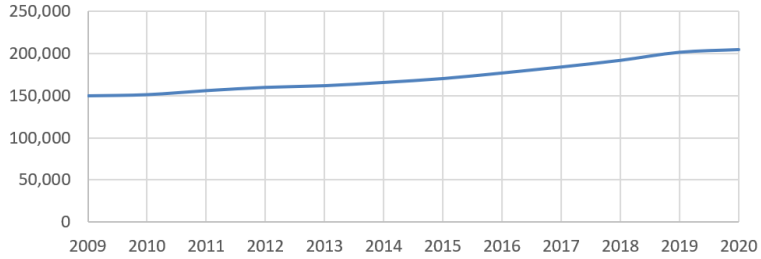
2 Labour, housing and transport

Access to jobs, affordable housing and the adequate provision of transport infrastructure and services are key concerns for the Luxembourg Cross-border Functional Region. The present chapter first describes the extent of cross border commuting (section 2.1) and its impact in terms of transport flows and congestion (section 2.2). Patterns and trends in the different labour markets around the Luxembourg Cross-border Functional Region are then described (section 2.3). Finally, available evidence on housing construction trends across these territories is compiled (section 2.4). On this basis, a delineation of the Luxembourg Cross-border Functional Region from the perspective of the labour market, housing and transport is presented (section 2.5). This forms the basis for the elaboration of a Mapshot (section 2.6) and an institutional mapping (section 2.7).

2.1 Cross border commuting

Cross-border workers account for 43 % of the employed population in Luxembourg, i.e. over 200,000 workers out of a total of 460,000 (Conseil économique et social, 2020). This proportion has been steadily increasing since 1986 (Figure 1). Since 2009, the number of cross-border workers has increased by 36 %.

Figure 1 Evolution of the number of cross-border workers



Source: Conseil économique et social (2020)

The countries of residence of cross-border workers are roughly 50 % France, 25 % Belgium and 25 % Germany (*Table 1*). These proportions have remained relatively constant since 2009. The proportion of cross-border workers residing in France is slowly increasing. Flows of commuters in direction of Luxembourg are considerably greater than any other flows observed in the Greater Region (Figure 2).

Cross-border commuter flows primarily target the City of Luxembourg. There are also significant flows from France in direction of Esch-Belval, and more diffuse short-distance flows across all the border (Figure 4). Judging from these 2017 data, the 2002 general representation of how out-commuting and in-commuting areas are organised geographically (Figure 5) remains valid. Cross-border commuters working in Luxembourg reside primarily along the Metz-Thionville axis, around Trier and Arlon, and in the vicinity of the southern border of Luxembourg (Figure 3).

Table 1 Proportions of cross-border workers in Luxembourg by country/region of residence

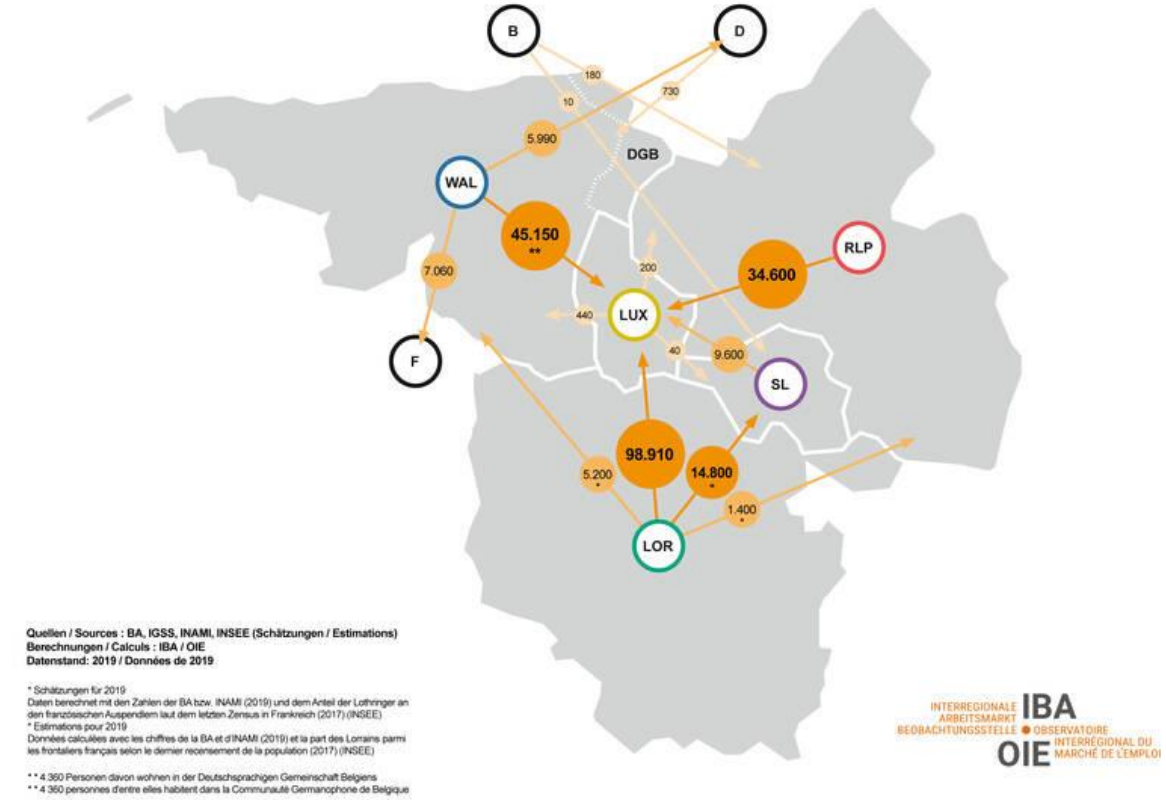
		2009	2010	2011	2012	2013	2014
Germany		25.1 %	25.2 %	25.3 %	25.3 %	25.3 %	25.3 %
	Rhineland-Palatinate	18.0 %	18.2 %	18.3 %	18.4 %	18.5 %	18.5 %
	Saarland	4.9 %	5.0 %	5.0 %	5.1 %	5.2 %	5.2 %
Belgium		25.7 %	25.6 %	25.5 %	25.4 %	25.5 %	25.5 %
	Province de Liège	4.6 %	4.6 %	4.6 %	4.6 %	4.6 %	4.6 %
	Province du Luxembourg	18.4 %	18.4 %	18.3 %	18.3 %	18.3 %	18.3 %
France		49.2 %	49.2 %	49.2 %	49.2 %	49.1 %	49.3 %
	Meurthe-et-Moselle	12.7 %	12.7 %	12.7 %	12.7 %	12.6 %	12.7 %
	Meuse	1.0 %	1.0 %	1.0 %	1.0 %	1.0 %	1.0 %
	Moselle	32.7 %	32.8 %	32.8 %	33.0 %	33.1 %	33.2 %

		2015	2016	2017	2018	2019	2020
Germany		25.2 %	24.9 %	24.5 %	24.3 %	24.0 %	24.4 %
	Rhineland-Palatinate	18.6 %	18.4 %	18.1 %	17.9 %	17.6 %	17.9 %
	Saarland	5.1 %	5.1 %	5.0 %	5.0 %	4.9 %	5.0 %
Belgium		25.3 %	25.1 %	24.8 %	24.6 %	24.2 %	24.1 %
	Province de Liège	4.6 %	4.5 %	4.5 %	4.4 %	4.3 %	4.3 %
	Province du Luxembourg	18.2 %	18.1 %	18.0 %	17.9 %	17.8 %	17.8 %
France		49.5 %	50.0 %	50.7 %	51.1 %	51.8 %	51.5 %
	Meurthe-et-Moselle	12.7 %	12.8 %	13.0 %	13.1 %	13.2 %	13.1 %
	Meuse	0.9 %	1.0 %	1.0 %	1.0 %	1.0 %	1.0 %
	Moselle	33.5 %	34.0 %	34.7 %	35.0 %	35.5 %	35.4 %

Source: Conseil économique et social (2020)

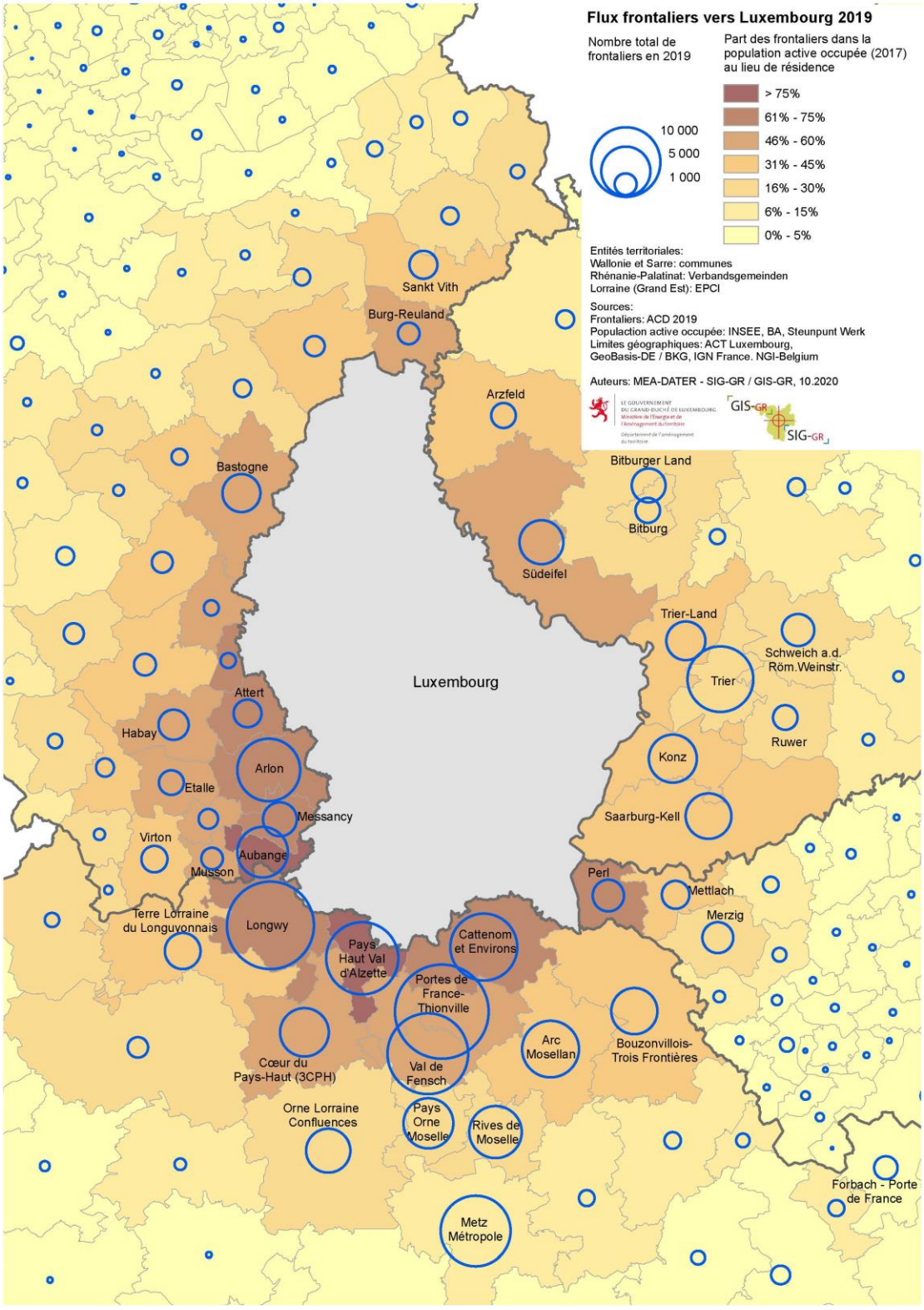
Raft

Figure 2 Volumes of cross-border commuter flows in the Greater Region



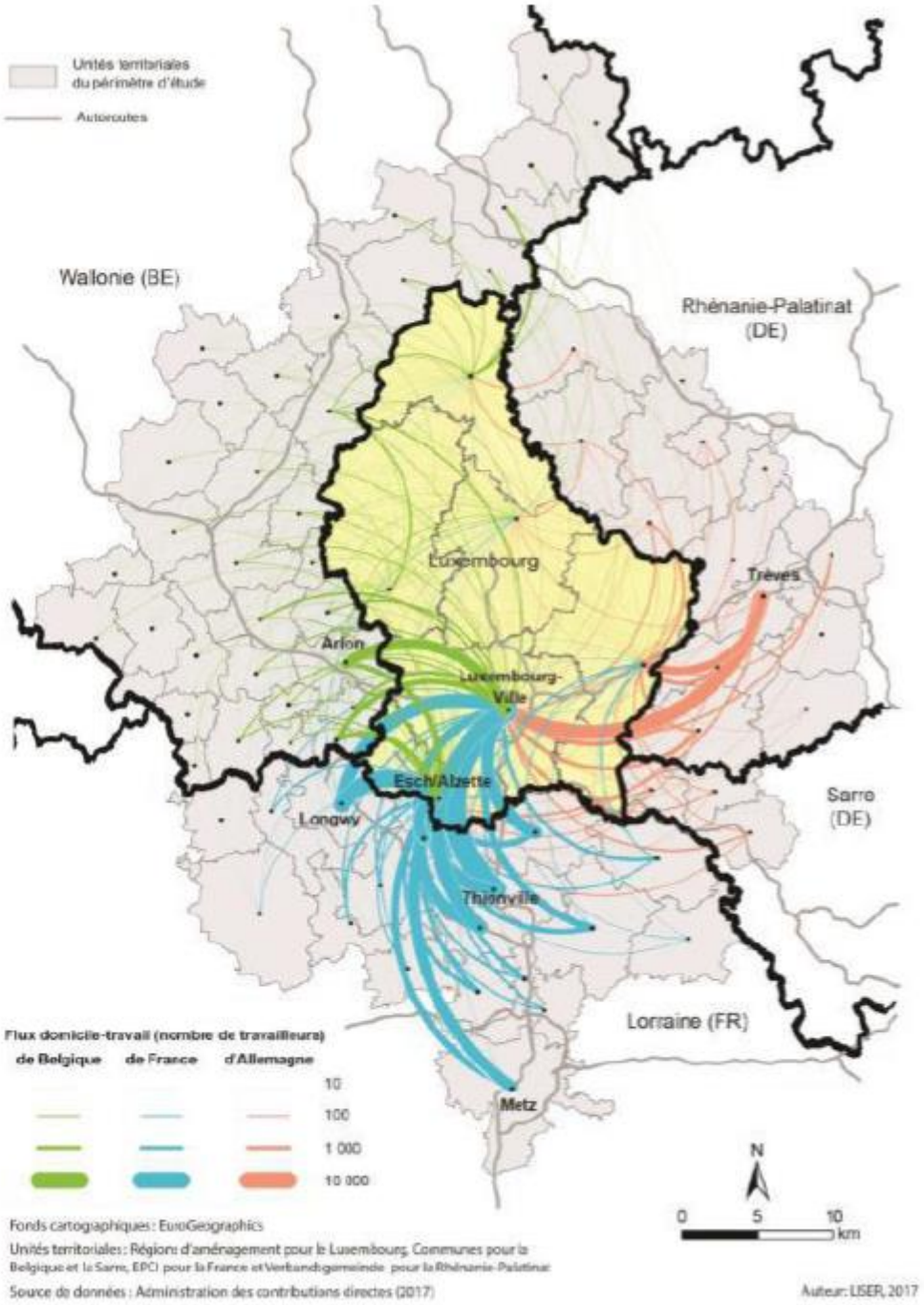
Source: IBA-OIE

Figure 3 Geographical distribution of cross-border commuters 2019



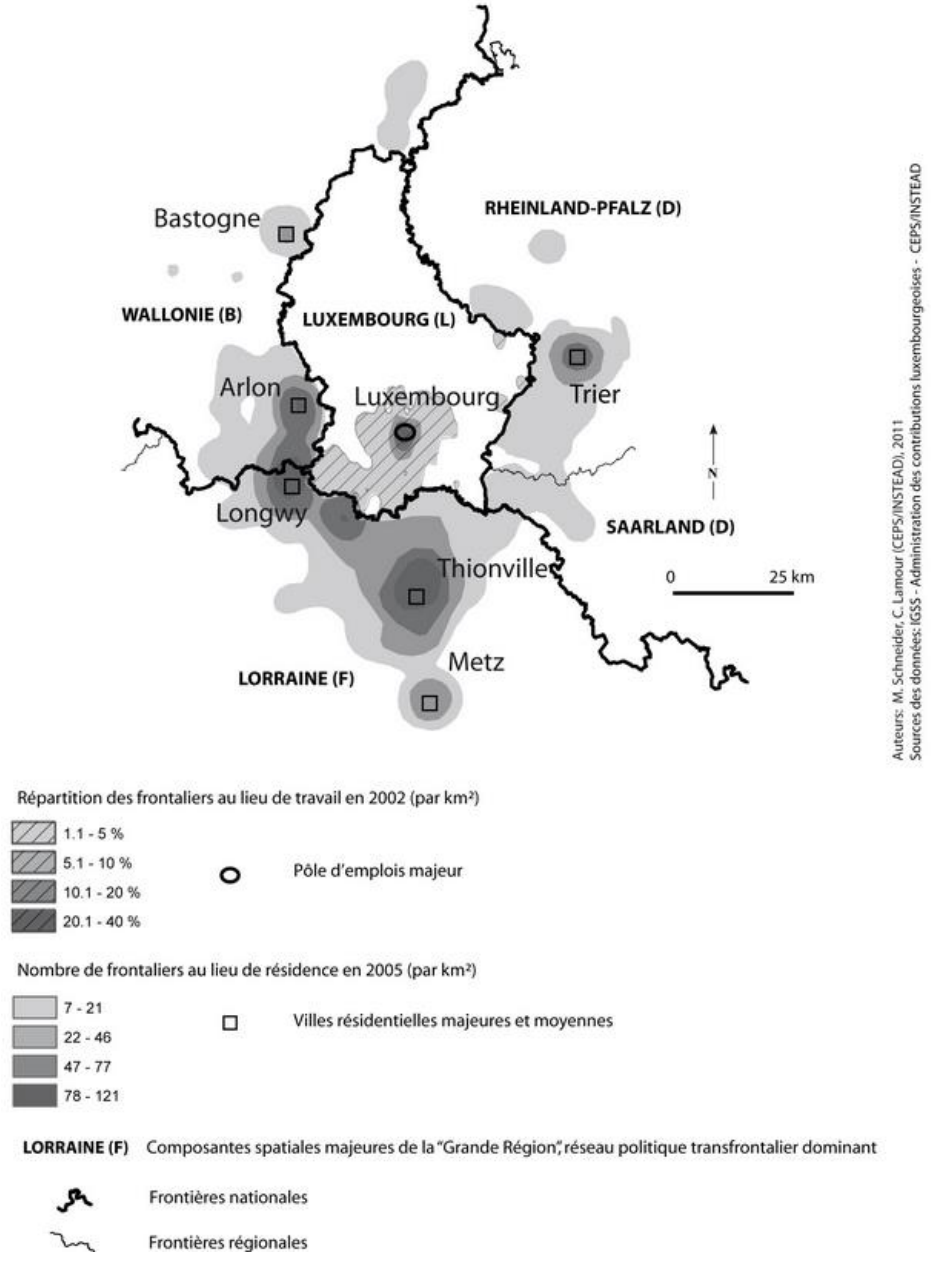
Source: SIG-GR

Figure 4 Cross border travel-to-work flows towards Luxembourg in 2017



Source: LISER (2017)

Figure 5 Area with a concentration of cross-border in- and out-commuters in 2002



Source: Diop and Lamour (2014)

2.2 Transport axes, modal distribution and congestion risks

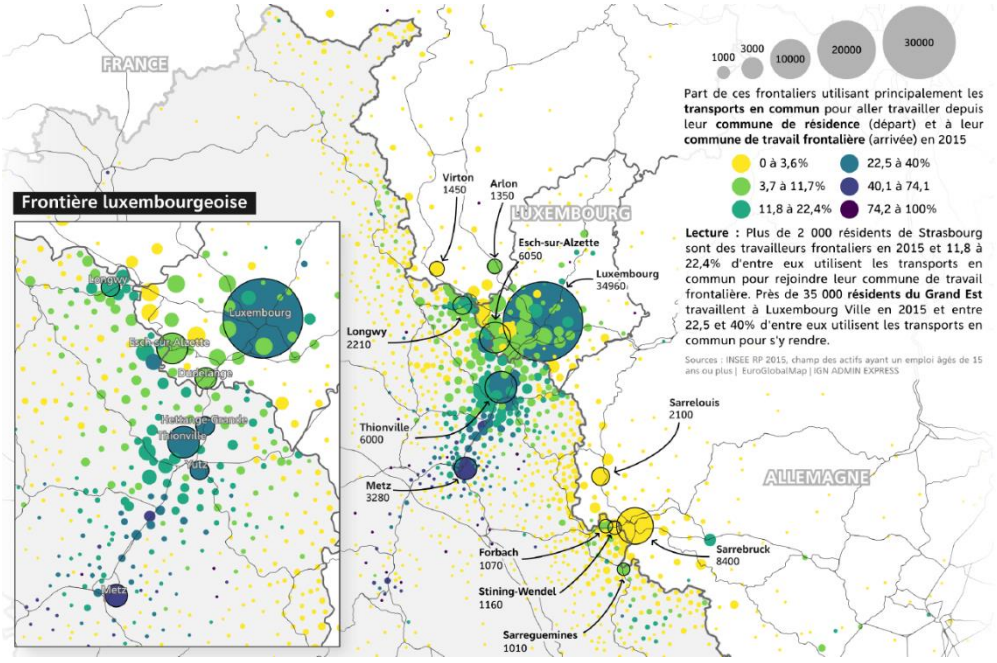
Latest identified available data on preferred modes of transportation among cross-border workers are from 2010. These data indicate that the vast majority of cross-border workers from Belgium and Germany use private cars (88-90 %). This also concerns 83 % of French cross-border workers (Table 2). According to French data, the situation has not evolved much between 2010 and 2015. Only 18 % of cross-border workers used public transportation to travel between the Grand-Est region and Luxembourg in 2015 (Préfet de la région Grand Est, 2018). These workers are concentrated along the rail axis between Luxembourg and Nancy (Figure 6).

Table 2 Modal distribution for cross-border workers in 2007, 2010 and 2017

	Individual car			Train			Bus, walking		
	2007	2010	2017	2007	2010	2017	2007	2010	2017
France	89 %	83 %	80,8 %	9,5 %	11,5 %	12,1 %	1,5 %	5,5 %	0,2 %
Belgium	95 %	90 %	88,1 %	8 %	9 %	8 %	2,5 %	3 %	0 %
Germany	95 %	90 %	89,7 %	1 %	2,5 %	3 %	4 %	7,5 %	0,3 %

Sources: 2007, 2010: Schmidt, Gerber (2012), 2017: Enquête LuxMobil, quoted by Conseil économique et social (2020)

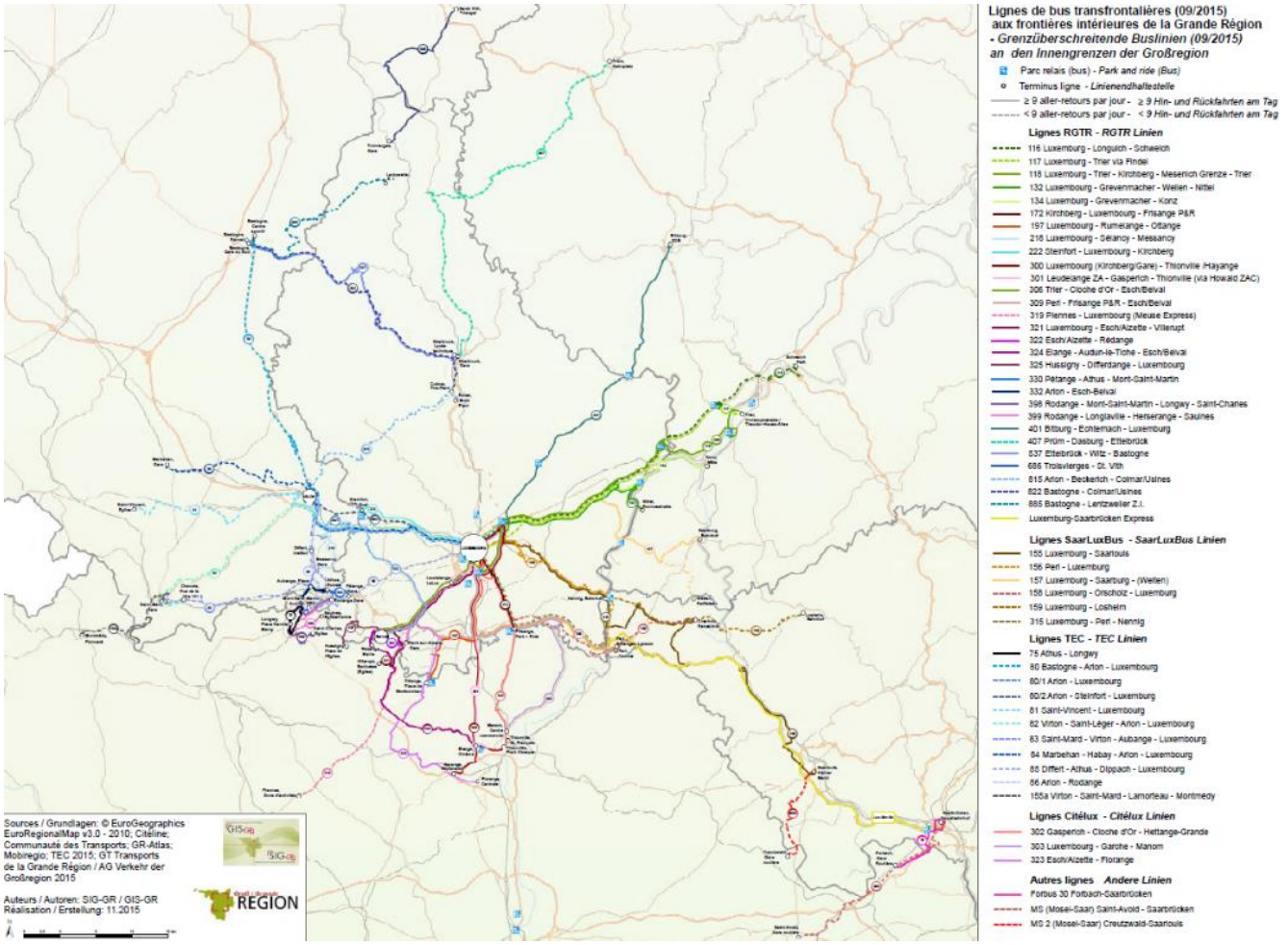
Figure 6 Geographical distribution of cross-border workers from Grand-Est region using public transportation



Source: Préfet de la Région Grand Est (2018)

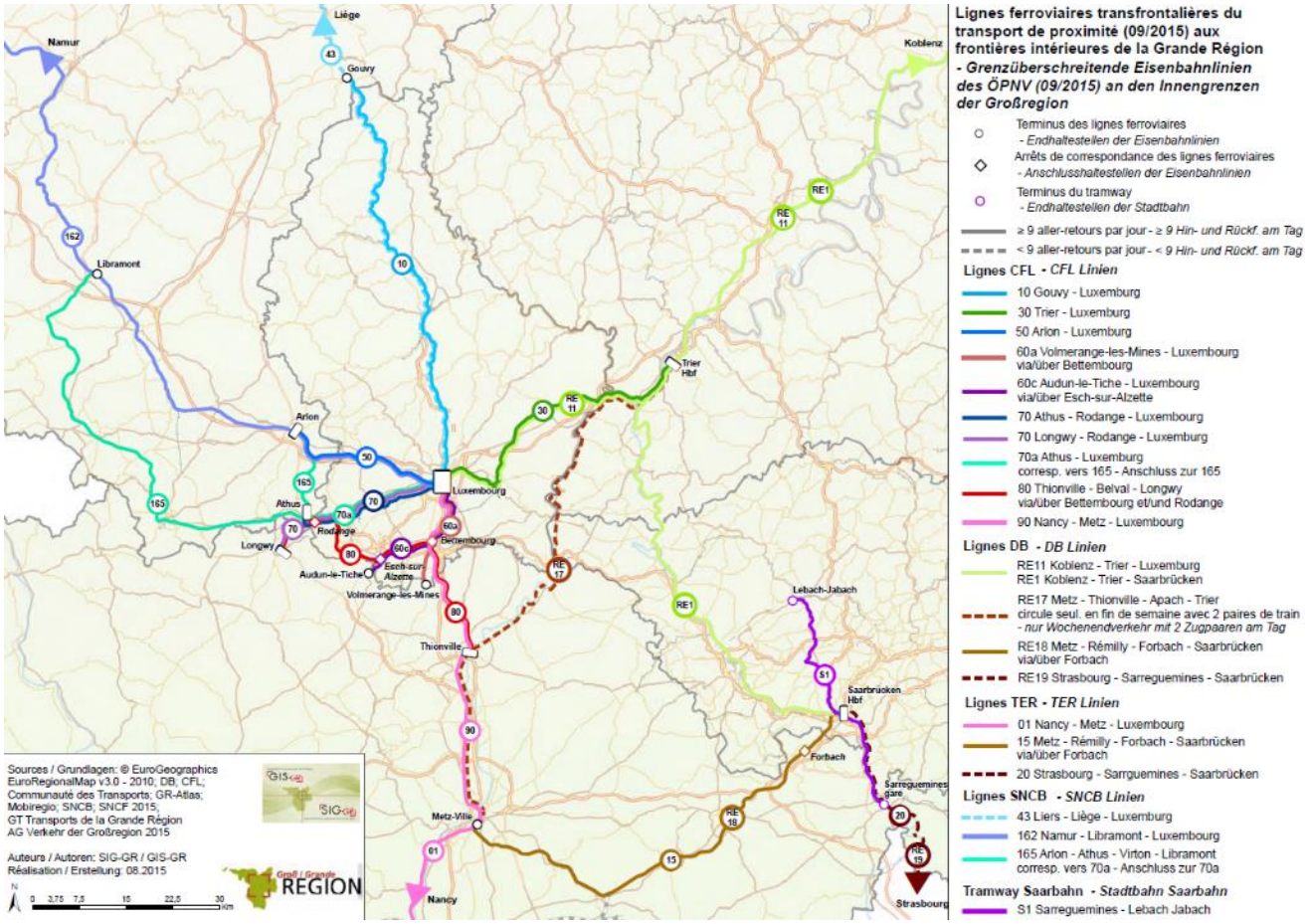
However, there is an extensive network of bus and rail services connecting neighbouring regions to Luxembourg (Figure 7 and Figure 8). Admittedly, these connections are centred on Luxembourg city-centre and Esch-sur-Alzette. Commuting to other destinations may be complicated, unless they are situated close to one of the stations along these lines. Furthermore, the speed and reliability of the different connections would need to be critically assessed. Despite the relatively higher proportion of commuters using public transportation, road traffic is the highest in direction of France (Figure 9).

Figure 7 Cross-border bus lines around Luxembourg



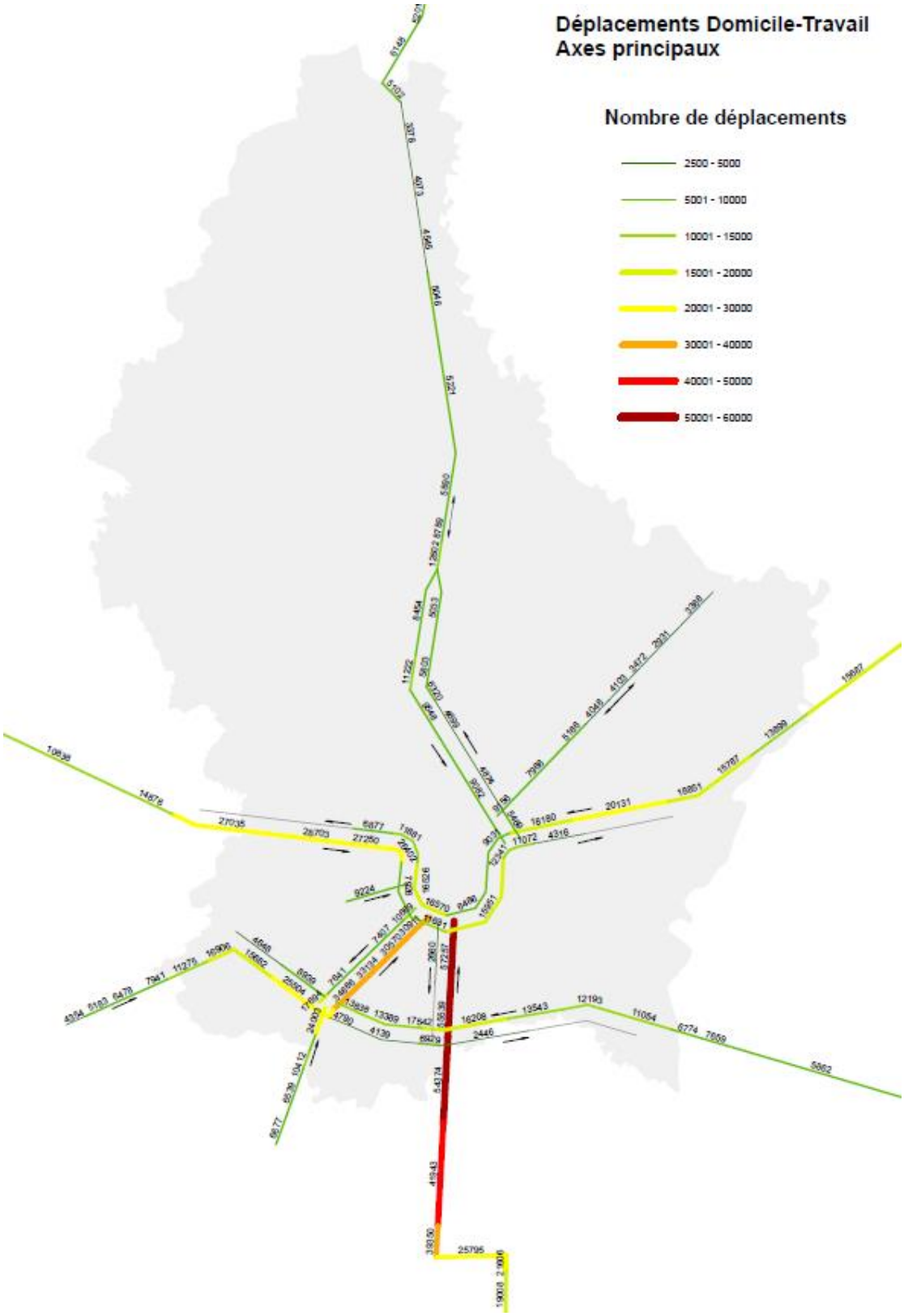
Source: SIG-GR

Figure 8 Cross-border railway connections around Luxembourg



Source: SIG-GR

Figure 9 Number of travel-to-work movements on main road section, 2017



Source: Administration des contributions directes 2019, MEA DATer, September 2020

2.3 Labour market dynamics

The change in the numbers of cross-border commuters over the coming years will be impacted by many factors, e.g. number and range of job opportunities in Luxembourg, differences between wages in Luxembourg and neighbouring regions, unemployment rates, and demographic change. The present sub-section explores a selection of these factors.

Luxembourg has a relatively lower employment rate compared to neighbouring regions, especially in Germany. Unemployment is significantly lower than in French neighbouring regions and Wallonia, but higher than in Rhineland-Palatinate. However, unemployment figures have risen significantly as a result of the COVID-19 crisis in Luxembourg[1], Saarland[2] and Rhineland Palatinate[3], while they have fallen in the Grand Est[4] and remained stable in Wallonia[5].

Over the last decades, employment and population have rapidly increased in Luxembourg-City and neighbouring municipalities with extensive cross-border commuting in direction of the city, and only weakly in remaining parts of the functional region in France, Belgium and Germany (Table 4 *and*
Figure 10). If we consider neighbouring regions as a whole (Tables 5 to 7):

- Saarland experiences significant population losses, especially in the working age population, but gains in employment. Population losses are decelerating.
- Grand Est experiences more limited, but also significant population losses in the working age population, accompanied by losses in employment. Population losses are accelerating.
- Wallonia experiences population gains and a stable working age population.

Table 3 Activity and unemployment rates

	Luxembourg	Grand Est	Saarland	Rhineland-Palatinate	Prov. Luxembourg	Prov. Liège	Wallonia
Employment rates (2019)*	67,9 %	65,5 %	73,6 %	76,5 %	65,3 %	59,0 %	59,2 %
Unemployment rate (2018)	5,6 %	8,9 %	3,6 %	3,1 %	5,4 %	8,2 %	8,5 %
Unemployment rate (2019)	5,6 %	8,0 %	3,7 %	2,8 %	5,4 %	6,7 %	7,2 %

**Ratio of full time equivalents to total population aged 15 to 64 years.*
Sources: Employment rates: Eurostat lfst_r_lfsd2pwc,
Unemployment rates: Eurostat lfst_r_lfu3rt

[1] Statistical Poral of the Grand Duchy of Luxembourg

[2] Statista

[3] Statista

[4] OREF Grand Est

[5] Statbel

Table 4 Population and employment growth

	Population totale 2017 (x1000)	Evolution 2007-2017	Emploi salarié 2015 (x1000)	Evolution 2005-2015
UE 28	511 370	+2,6%	193 519	+5,1%
Régions métropolitaines de l'UE 28	299 384	+4,7%	122 483	+6,4%
Luxembourg	590,7	+24%	406,1	+32%
*Territoires frontaliers (>15% de frontaliers) **	*747,8*	*+6%*	*186,5*	*+0%*
« Grand Luxembourg » (seuil à 15%)	1 338,5	+13%	592,6	+20%
*Territoires frontaliers (>10% de frontaliers) ***	*1 024,3*	*+5%*	*319,4*	*+3%*
« Grand Luxembourg » (seuil à 10%)	1 614,9	+11%	725,5	+17%
*Territoires frontaliers (>5% de frontaliers) ****	*1 883,9*	*+4%*	*605*	*-1%*
« Grand Luxembourg » (seuil à 5%)	2 474,5	+8%	1 011,1	+10%

* arrondissements d'Arlon, de Virton et de Bastogne (BE) + Landkreise de Trèves-Sarrebourg et Eifel-Bitburg-Prüm (DE) + zones d'emploi de Thionville et Longwy (FR)

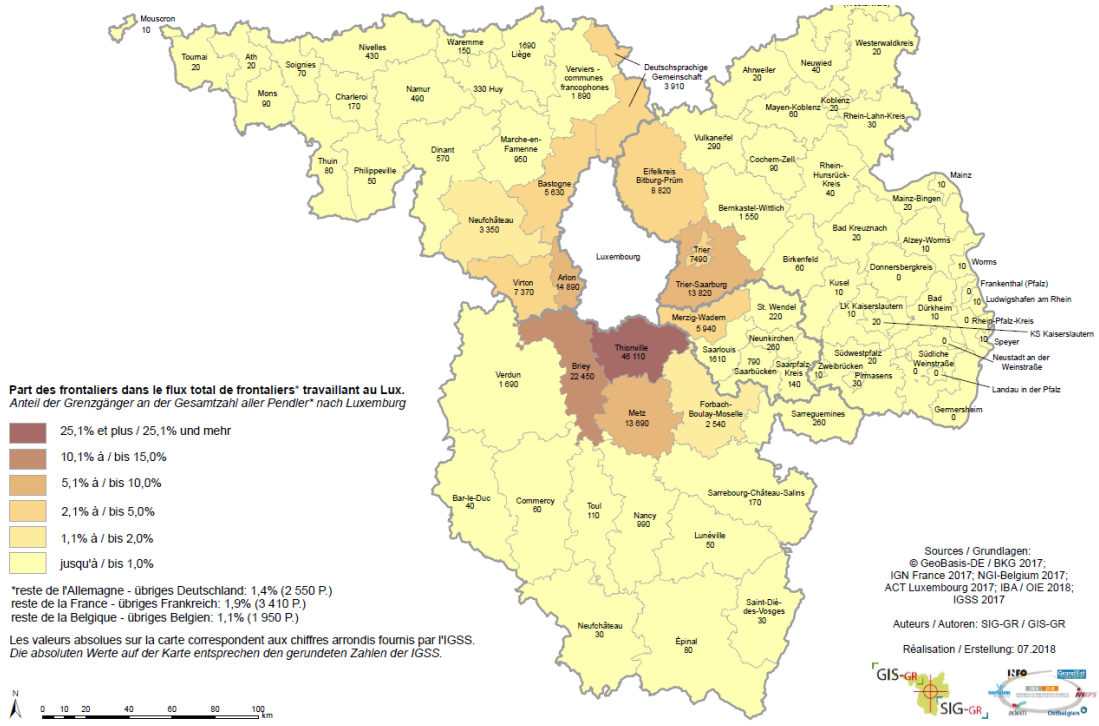
** : précédents (*) + arrondissement de Neufchateau (BE) + Stadtkreis de Trèves + Landkreis de Merzig-Wadern (DE)

*** : précédents (**) + arrondissement de Verviers (BE) + zone d'emploi de Metz (FR)

Sources : EUROSTAT, DESTATIS, INSEE, IWEPS, STATEC, calculs IDEA

Source: Hein (2019)

Figure 10 Ratio of cross-border commuters in direction of Luxembourg to total number of commuters



Source: SIG/GR

Table 5 Employment change

	Luxembourg	Lorraine*	Saarland	Rhineland-Palatinate	Wallonie
	Total	**Total**	**Total**	**Total**	**Total**
2000	264,000	875,151	517,600	1,808,000	n.d.
2010	359,400	851,920	519,400	1,905,000	1,201,475
2018	448,500	822,067	534,300	2,034,000	1,281,208
2019	465,000	:	534,200	2,046,700	n.d.
2000-2018	69,9 %	-6,1 %	3,2 %	12,5 %	n.d.
2010-2018	24,8 %	-3,5 %	2,9 %	6,8 %	6,6 %

** Départements of Meuse, Meurthe-et-Moselle, Moselle and Vosges*
Source: Portail statistique de la Grande Région

Table 6 Population change

	Luxembourg	Lorraine*	Saarland	Rhineland-Palatinate	Wallonie
	Total	**Total**	**Total**	**Total**	**Total**
2000	433,600	2,314,909	1,071,501	4,030,773	3,339,516
2010	502,066	2,350,920	1,022,585	4,012,675	3,498,484
2018	602,005	2,324,619	994,187	4,073,679	3,624,377
2019	613,894	2,316,183	990,509	4,084,844	3,633,795
2020	626,108	2,307,425	986,887	4,093,903	3,645,243
2000-2018	38,8 %	0,4 %	-7,2 %	1,1 %	8,5 %
2010-2018	19,9 %	-1,1 %	-2,8 %	1,5 %	3,6 %
2000-2019	41,6 %	0,1 %	-7,6 %	1,3 %	8,8 %
2010-2019	22,3 %	-1,5 %	-3,1 %	1,8 %	3,9 %

**Départements of Meuse, Meurthe-et-Moselle, Moselle and Vosges*
Source: Portail statistique de la Grande Région

Table 7 Working age population change (20 to 60 years old)

	Luxembourg	Lorraine*	Saarland	Rhineland-Palatinate	Wallonie
	Total	**Total**	**Total**	**Total**	**Total**
2000	246,056	1,244,792	585,868	2,195,711	1,792,859
2010	288,346	1,262,456	559,230	2,194,395	1,873,548
2018	353,232	1,166,429	520,801	2,170,285	1,892,858
2019	360,322	1,153,971	513,783	2,162,832	1,889,322
2020	367,438	1,140,997	506,092	2,149,334	1,885,640
2000-2018	43,6 %	-6,3 %	-11,1 %	-1,2 %	5,6 %
2010-2018	22,5 %	-7,6 %	-6,9 %	-1,1 %	1,0 %
2000-2019	46,4 %	-7,3 %	-12,3 %	-1,5 %	5,4 %
2010-2019	25,0 %	-8,6 %	-8,1 %	-1,4 %	0,8 %

**Départements of Meuse, Meurthe-et-Moselle, Moselle and Vosges*
Source: Portail statistique de la Grande Région

2.4 Housing

Since 2010, 2,891 new dwellings have been built on average every year in Luxembourg, while the number of households has increased by 5,390 (STATEC, 2019). Housing needs have been met thanks to the stock of available dwellings built before 2000.

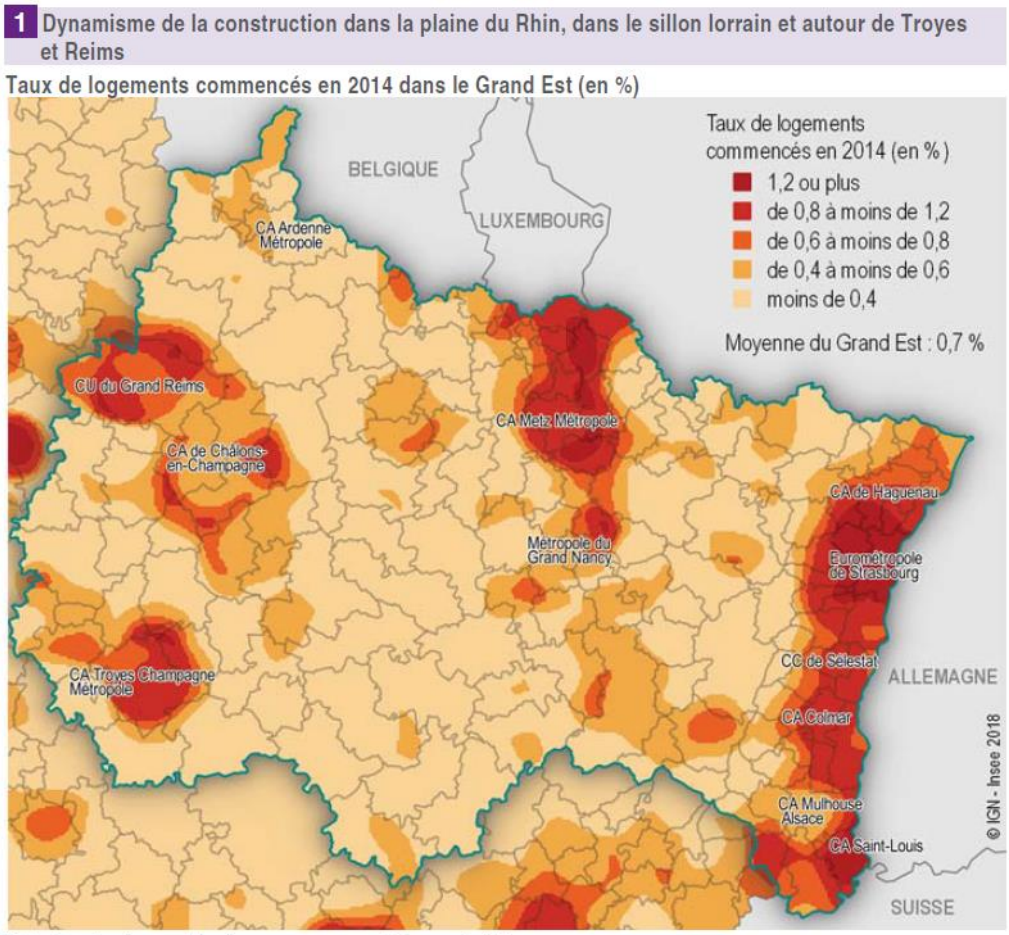
In the French part of the functional region, housing construction is relatively intense in spite of the demographic stagnation at the level of the entire region. Housing constructions appears specifically focused on the areas with high accessibility to Luxembourg (Figure 11). In Wallonia, the only visible impact of proximity to Luxembourg on residential building activity would be in the vicinity of Arlon (Figure 12). In Rhineland-Palatinate, some *Kreise* with more intense housing construction activities can be found in the vicinity of Luxembourg (*Figure 13*). In Saarland, Merzig-Wadern in the vicinity of Luxembourg has the highest intensity in construction activities of all *Kreise* (Table 8). Therefore, there is converging evidence of an impact of cross-border commuting to Luxembourg on building activities. However, causal connections remain to be identified.

Challenges related to the construction of new dwellings within the Grand Duchy of Luxembourg are linked to a concentration of land ownership in the hands of a limited number of primarily private actors (LISER - L'observatoire de l'habitat, 2019b). As prices on the real estate market keep rising (+6,1 % on average every year between 2010 and 2017 (LISER - L'observatoire de

l'habitat, 2019d)), a large proportion of these actors prefer to keep the land they possess, rather than sell it to developers (LISER - L'observatoire de l'habitat, 2019c). Luxembourg planning law makes it difficult to overcome this reluctance to sell land. In spite of efforts to expand existing constructions and to redevelop brownfields (LISER - L'observatoire de l'habitat, 2019a), the pressure on housing construction in the parts of Luxembourg located far from the main employment areas and in neighbouring countries is all the higher. This generates longer commuting distances, and high pressure on transport infrastructure.

In the cross-border functional region of Luxembourg, one may therefore identify two distinct types of spaces: on the one hand, a central area with structural constraints on residential building and a lack of available housing; on the other hand, different peripheral areas within commuting distance experiencing an acceleration of residential building activities. These peripheral areas include multiple territories in Luxembourg's neighbouring regions, but also some areas within Luxembourg (see Figure 14).

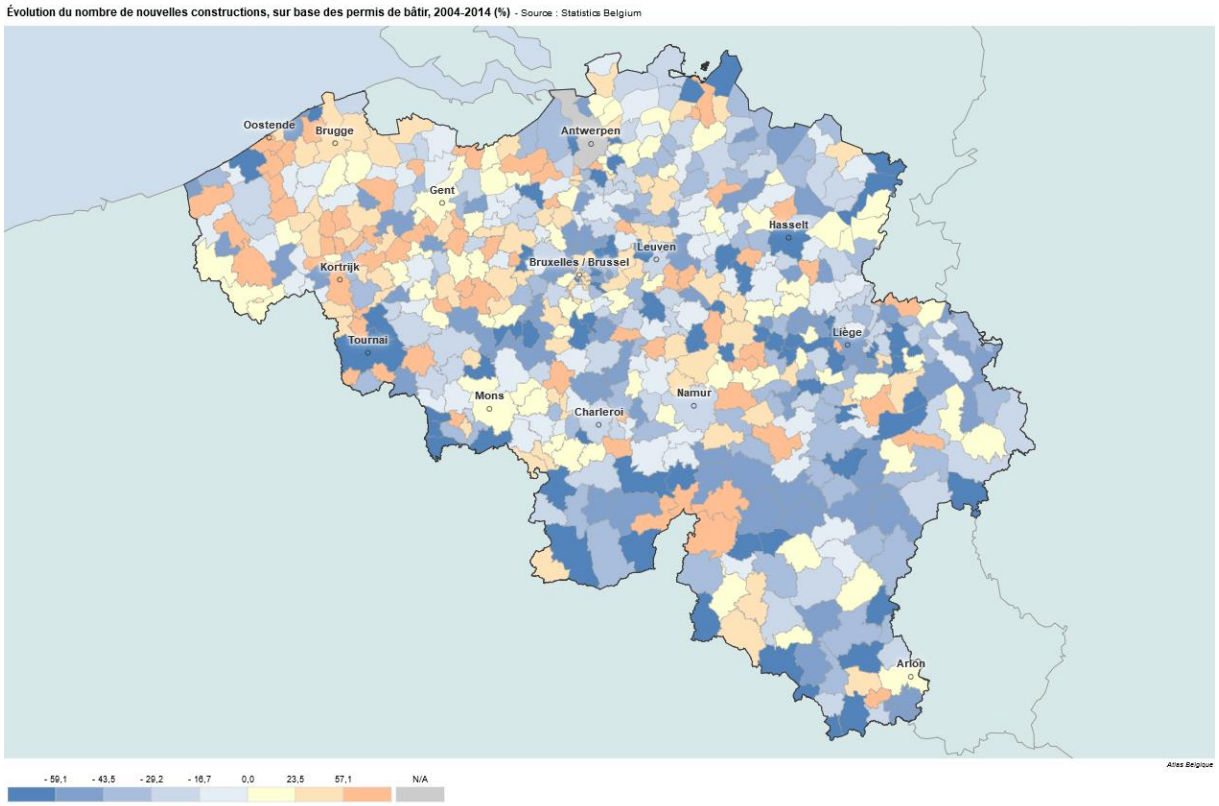
Figure 11 Spatial distribution of new dwellings in the Grand Est region (2014)



Note : les données sont lissées avec un rayon de lissage de 15 km.
Sources : SDES, Sit@del 2013, 2014 et 2015, données en date réelle arrêtées en décembre 2017 ; Insee, recensement de la population 2014.

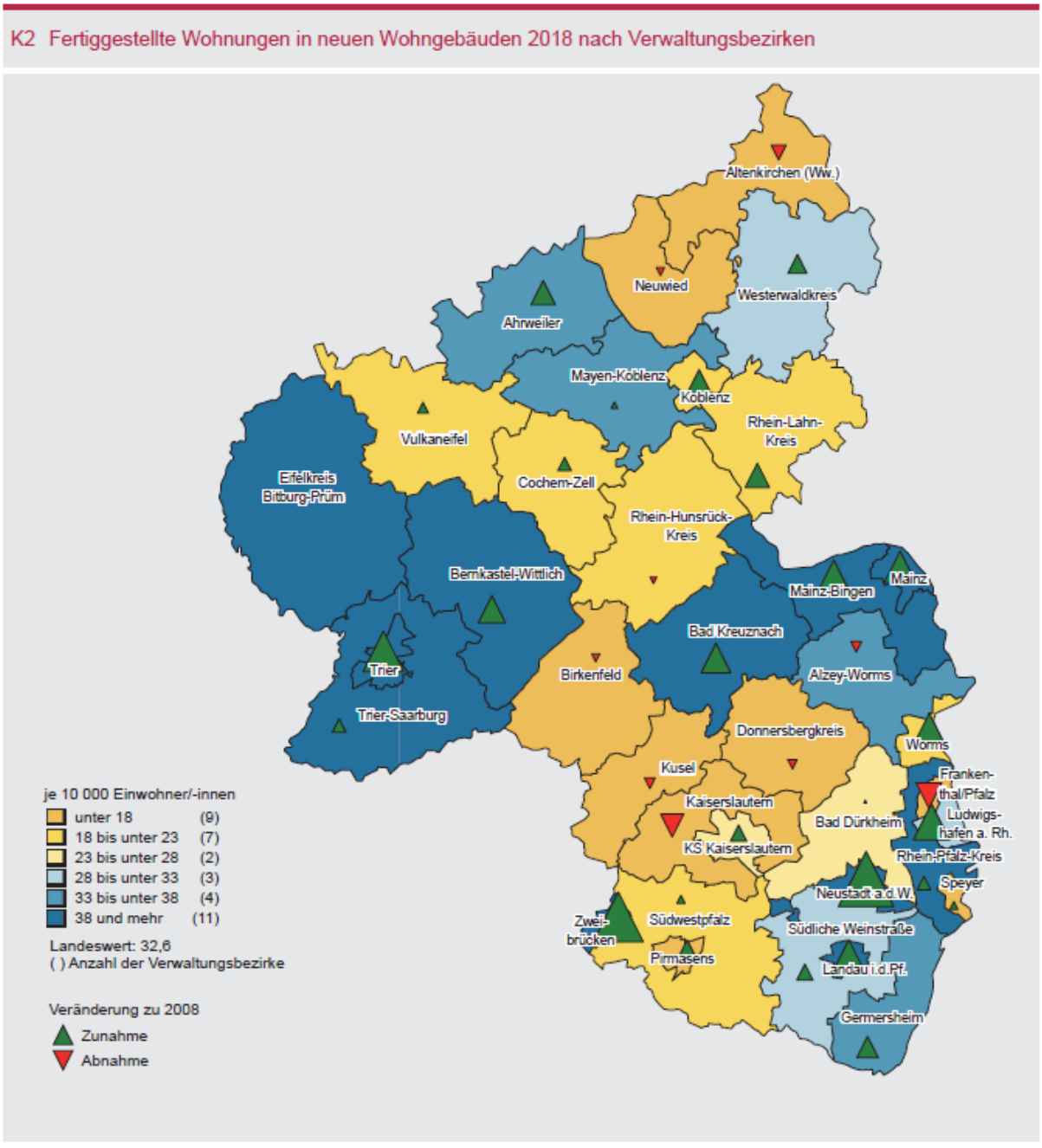
Source: INSEE (2019: 12)

Figure 12 Evolution of building permits in Belgium (2004-2014)



Source: Atlas de Belgique

Figure 13 Delivery of new residential buildings 2018 and trends 2008-2018



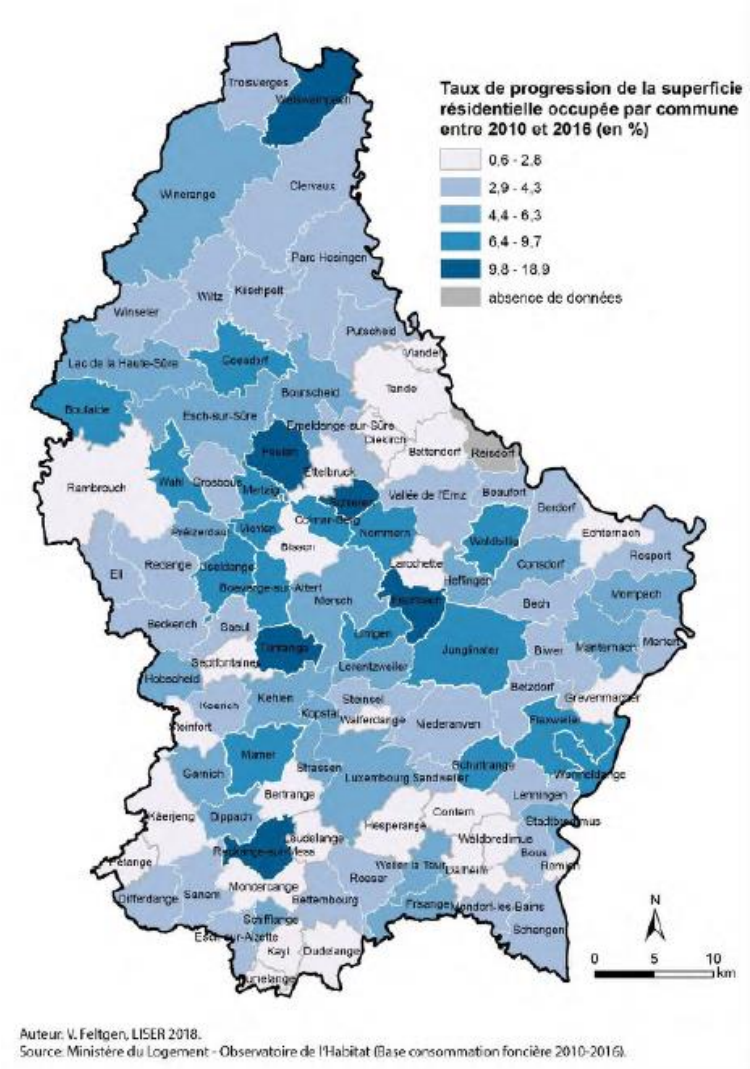
Source: Statistisches Landesamt Rhineland-Palatinate (2019)

Table 8 Number of new constructions per year per thousand inhabitants in Saarland (by NUTS3)

Kreis	2014	2015	2016	2017	2018	2019
Regionalverband Saarbrücken	0,45	0,41	0,85	0,47	0,51	0,73
Merzig-Wadern	1,40	1,41	1,40	1,44	1,74	1,55
Neunkirchen	0,68	0,67	0,76	0,72	0,80	0,81
Saarlouis	1,17	1,15	1,36	1,13	1,23	1,13
Saarpfalz-Kreis	1,09	0,79	1,00	0,78	1,00	0,77
St. Wendel	0,75	0,92	1,34	1,25	1,38	1,38
Saarland	**0,84**	**0,80**	**1,06**	**0,85**	**0,96**	**0,97**

Source: own calculations based on Eurostat (population) and Saarland Statistical Office

Figure 14 Growth in residential built-up area 2010-2016 in Luxembourg municipalities



Source: LISER – L'observatoire de l'habitat (2019a)

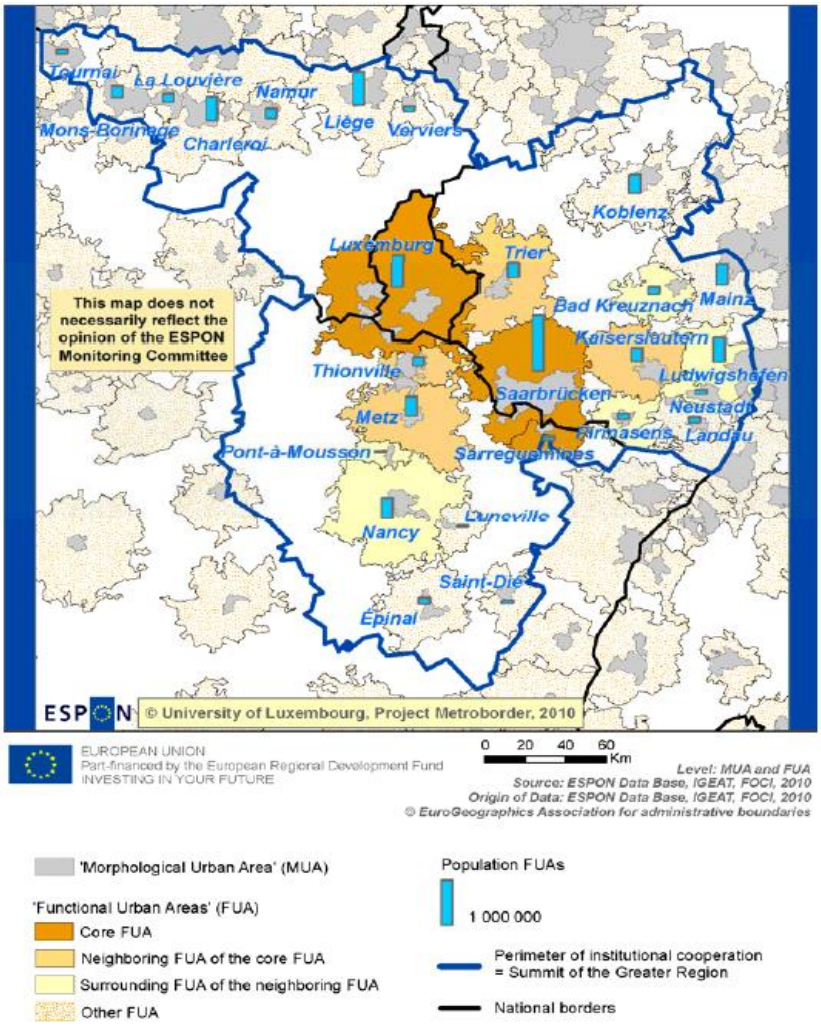
2.5 Delineation of the functional region

The cross-border functional region of Luxembourg for the labour market, housing and transport should include areas where commuting flows currently occur, and territories where such flows may emerge or could be encouraged.

It therefore includes the functional urban area (FUA) of Luxembourg as it was described by the ESPON METROBORDER project (see
Figure 15 below). However, as illustrated by the study area in Figure 4 p. 6, it also extends to the surroundings of Trier to the east and of Thionville and Metz to the south, in addition to a number of local administrative units contiguous to the border. The need to consider areas beyond the FUA identified by the METROBORDER project is also confirmed by Figure 5 p. 7.

It appears important to distinguish between the part of the cross-border functional area located within the Grand Duchy of Luxembourg, and the parts located in the different neighbouring regions.

Figure 15 Functional urban areas around Luxembourg



Source: ESPON METROBORDER final report, p. 23

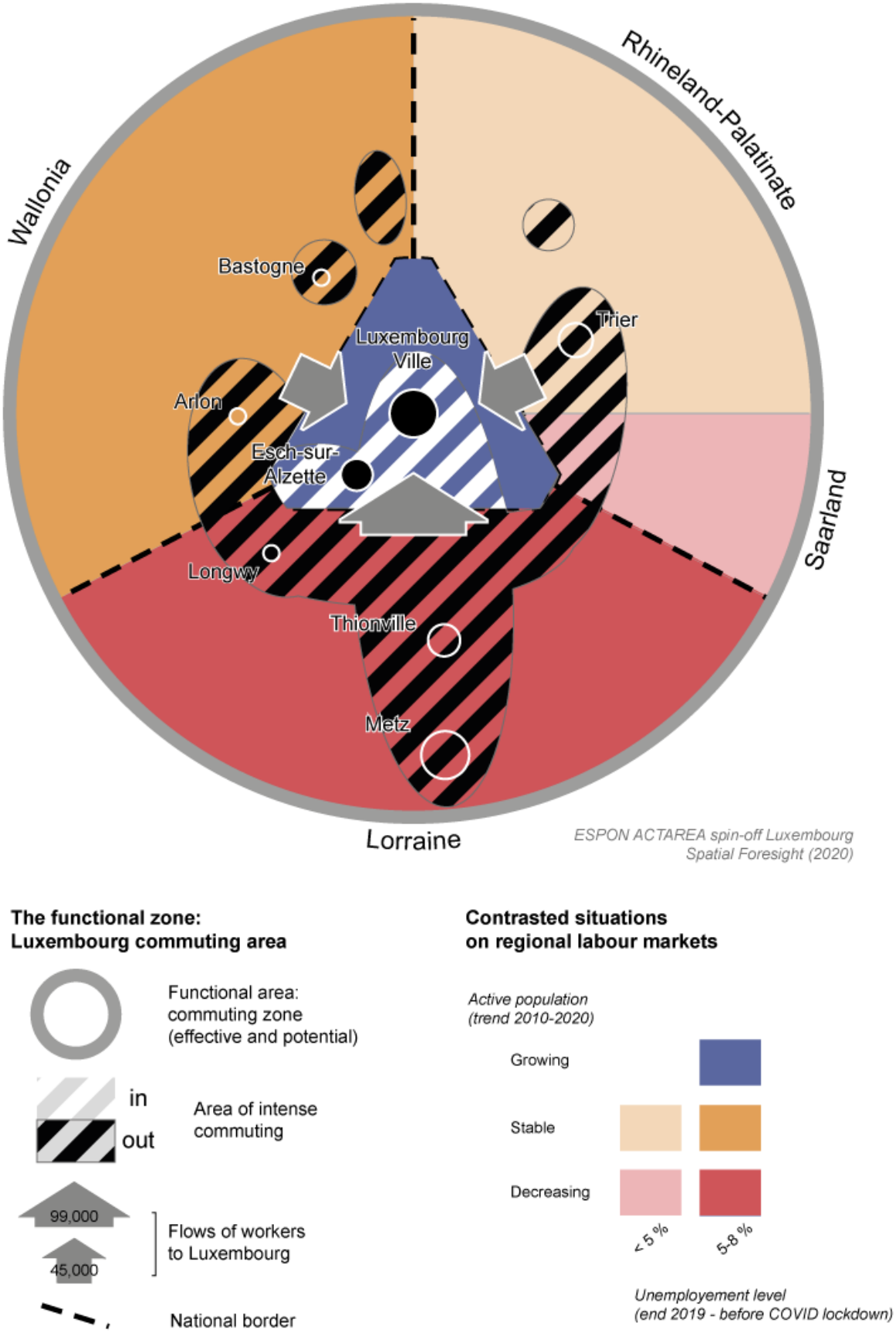
2.6 Mapshot

The Mapshot focuses on the following aspects:

- Current volumes of commuter flows from each of the three neighbouring countries in direction of Luxembourg (2019-2020);
- Delineation of the main area of out-commuting and in-commuting;
- Current unemployment levels (2019);
- Evolution of active population (growth, decline) (2010-2020);
- main urban nodes of in- and out-commuting areas.

The Mapshot describes the territorial organisation of some of the main driving forces of cross-border commuting. It also illustrates how commuting is organised territorially. Transport axes, congestion and tensions on the real estate market are not represented specifically. However, areas with more intense building activities (compared to regional values) correspond to areas with intense out-commuting (black hatches). Pressures on transportation systems are synthesised by the arrows showing volumes of commuters. The main urban nodes of in- and out-commuting areas are hubs around which multi-modal public transportation services can be organised.

Figure 16 Mapshot - thematic field "labour, transport and housing"



'Lorraine' in this context designates the three Départements Meuse, Meurthe-et-Moselle and Moselle.

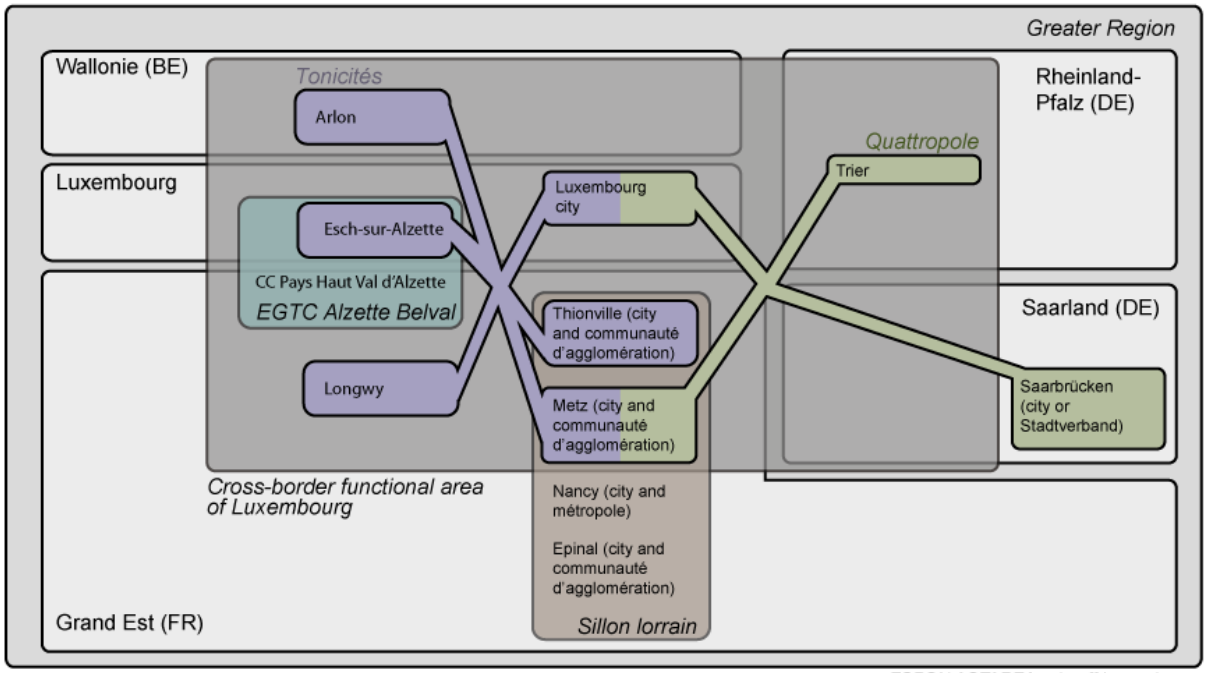
2.7 Institutional mapping

The Institutional mapping focuses on the description of overlaps between the cross-border functional region of Luxembourg and the three major urban networks in the area:

- 'Tonicité' is entirely included in the Cross-border functional area;
- 'Quattropole' is partly included, as Saarbrücken has its own functional area;
- Only the northern half of the 'Sillon Lorrain' is included in the functional area.

In addition, the European Grouping of Territorial Cooperation Alzette Belval organises the part of the cross-border functional region located between Esch-sur-Alzette and the Pays Haut Val d'Alzette intermunicipal cooperation area in France.

Figure 17 Institutional mapping - thematic field "labour, transport and housing"



3 Energy production and provision

The present chapter describes the main issues and cooperation potentials linked to energy production and provision in the Luxembourg Cross-border Functional Region. National and regional borders continue to play a major role in the implementation of energy policies. The chapter, therefore, first focuses on energy consumption and production within Luxembourg. Section 3.1 and 3.2 compare levels of consumption to other European countries, describe current electricity production from renewable sources and provide figures on the level of dependence on external providers of energy. Section 3.3 then focuses on infrastructure for energy transmission between Luxembourg and its neighbouring countries. In sections 3.4 and 3.5, data on electricity production and consumption in neighbouring regions is compiled. The objective is to provide an overview on the respective importance of different types of production, from renewable and non-renewable sources, and the respective importance of different types of electricity consumption (e.g. by households, manufacturing and service activities). This provides indications on constraints and opportunities for future energy policies. Section 3.7 provides synthetic reflections on how a functional area for energy production and provision for the cross-border functional region of Luxembourg may be circumscribed. Finally, a Mapshot and an Institutional Mapping for this theme are presented in sections 3.8 and 3.9.

3.1 Energy consumption in Luxembourg

Total energy consumption in Luxembourg is extensively influenced by the purchase of fossil fuels by non-residents. A significant number of inhabitants from neighbouring countries and transiting truck drivers choose to buy fuel in Luxembourg, benefitting from lower prices compared to neighbouring countries. This explains the high proportion of energy consumption in the transport sector (Table 9).

However, Luxembourgish households also have the highest final energy consumption per dwelling[6] (Figure 18). This is partly due to particularly high heating consumption by dwelling (Figure 19). 48.6 % of this energy consumption by dwellings was covered through imports of natural gas (Table 11). As a result, Luxembourg's electricity consumption per dwelling is just above the EU average (Figure 20).

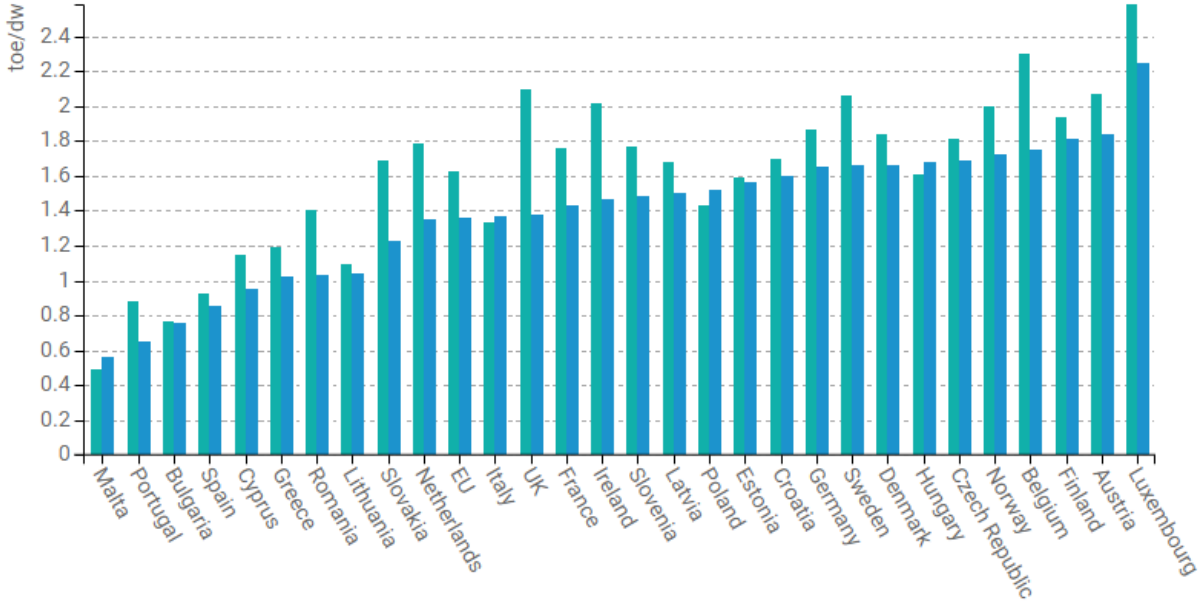
[6] Figures calculated considering household consumption only

Table 9 Energy consumption by category of use in Luxembourg – 2000-2018 (GWh)

Year	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	41,553	51,223	50,696	49,307	48,729	47,309	47,203	47,835	49,418	51,386
Manufacturing	8,775	9,181	8,833	8,278	7,875	7,996	7,847	8,203	7,587	7,693
Transports	22,483	30,587	31,718	30,194	29,745	29,186	28,281	28,305	29,733	31,750
Other	10,295	11,456	10,145	10,835	11,109	10,126	11,075	11,327	12,098	11,943
Services	4,677	5,116	4,211	4,776	4,945	4,336	4,787	4,826	5,429	5,697
Households	5,582	6,242	5,836	5,969	6,078	5,719	6,219	6,426	6,587	6,154
Agriculture	36	97	98	90	86	72	69	75	83	92

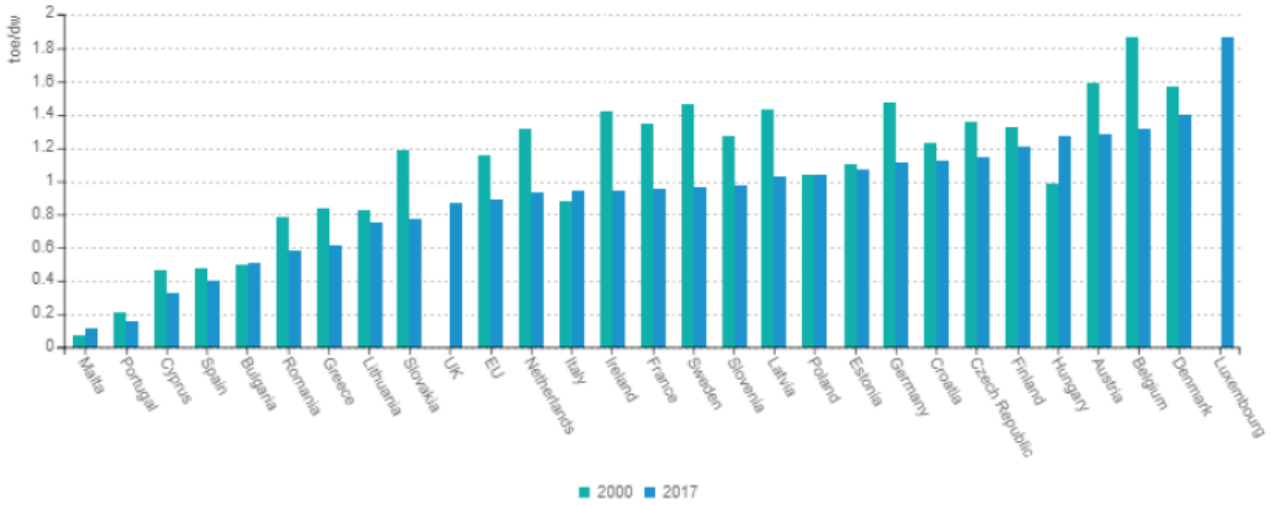
Source: Statistics portal of the Grand Duchy of Luxembourg

Figure 18 Final energy consumption per dwelling by country (2000 and 2017)



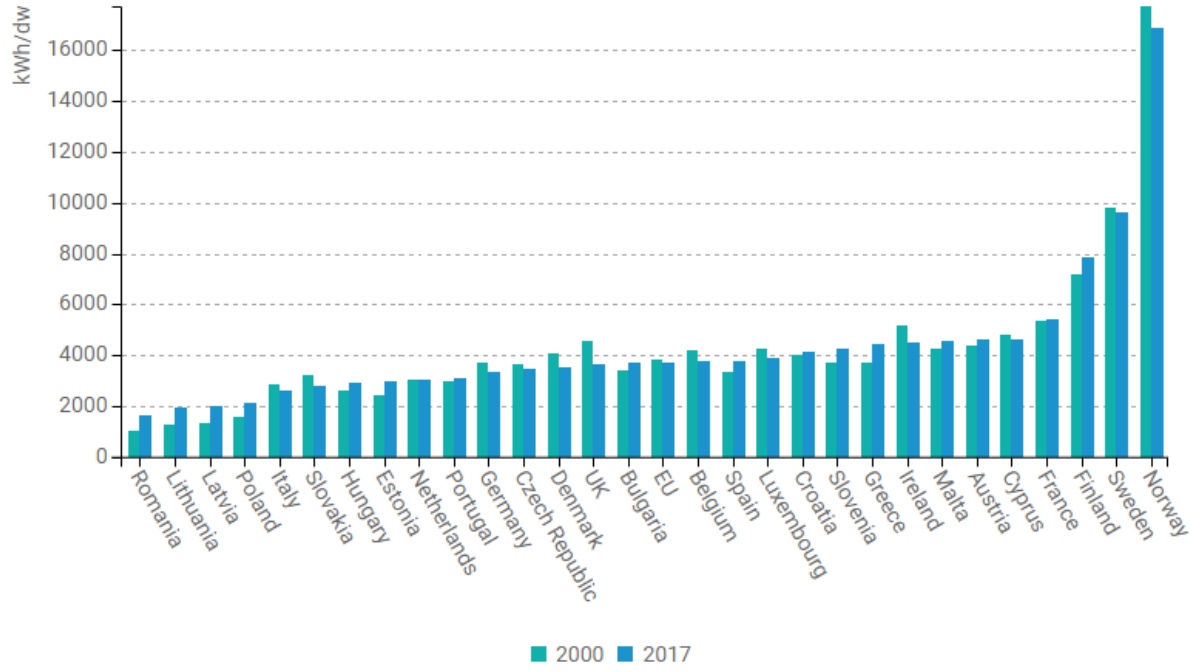
Source: Odysee-Mure

Figure 19 Energy consumption for heating per dwelling by country (2000 and 2017)



Source: Odysee-Mure

Figure 20 Electricity consumption per dwelling by country (2000 and 2017)



Source: Odysee Mure

If we consider electricity consumption only, we observe that 47 % is consumed by manufacturing industries, 35 % by service activities and 14.5 % by households (Table 10). Households, therefore, account for a relatively limited share of total electricity consumption.

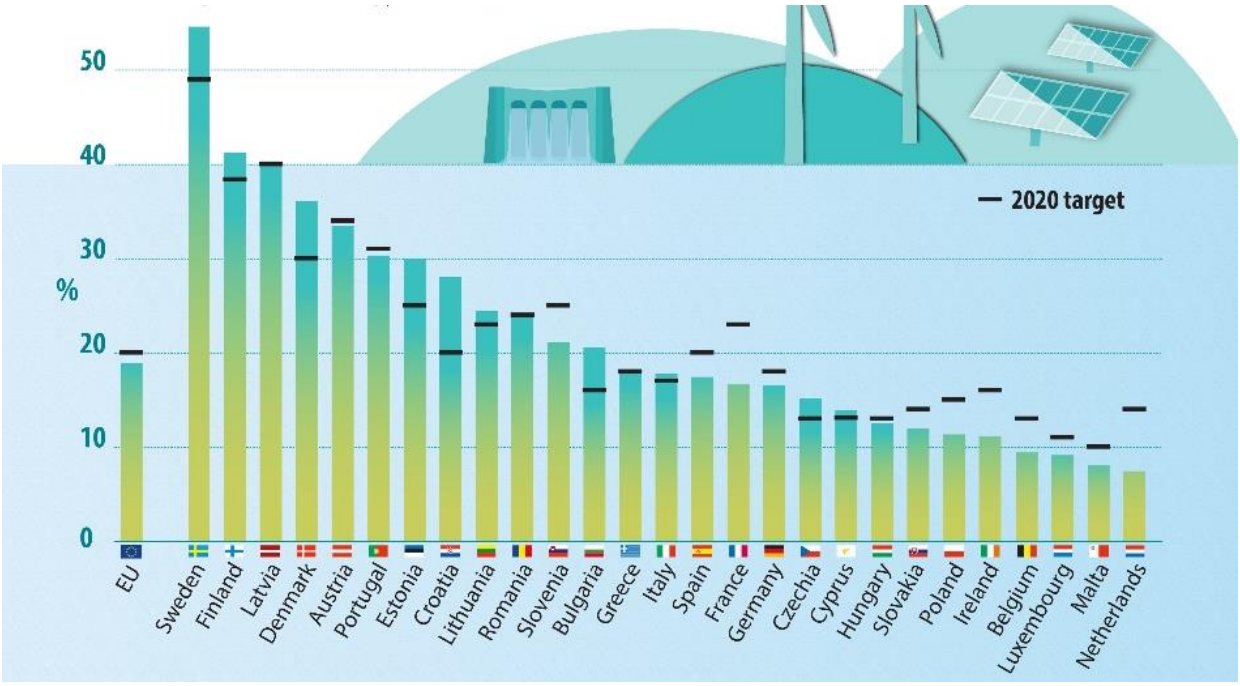
Table 10 Energy consumption (electricity) – 2000-2018 (GWh)

Année	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	5,775	6,593	6,484	6,236	6,199	6,182	6,224	6,367	6,393	6,422
Manu-facturing	3,242	3,625	3,576	3,207	3,051	3,077	3,146	3,432	3,004	3,062
Transport	60	120	129	129	129	123	131	130	134	136
Services	1,647	1,994	1,881	1,946	1,999	1,932	1,921	1,794	2,252	2,262
Households	792	815	852	917	980	1,011	990	977	970	930
Agriculture	34	39	46	38	40	39	37	34	33	33

Source: *Statistics portal of the Grand Duchy of Luxembourg*

Overall, the share of renewable energies in Luxembourg's total energy consumption is just above 9% (Figure 21). This is the third lowest rate in the EU, above Malta and the Netherlands.

Figure 21 Share of energy from renewable sources in gross final energy consumption, by country (2018)



Source: Eurostat (nrg_ind_ren)

Table 11 Share of fuels in the final energy consumption in the residential sector (2017)

	Electricity	Derived Heat	Gas	Solid fuels	Oil & petroleum products	Renewables and Wastes
EU - 27	**24.7**	**8.7**	**32.1**	**3.4**	**11.6**	**19.5**
EU - 28	**24.6**	**7.6**	**36.2**	**3.1**	**10.8**	**17.6**
Belgium	19.6	0.2	41.0	0.9	30.3	8.1
Bulgaria	42.3	14.5	3.5	5.1	1.0	33.6
Czechia	18.4	14.2	26.7	11.2	0.7	28.9
Denmark	18.4	36.3	13.4	0.0	4.8	27.0
Germany	19.9	6.6	40.3	0.9	18.5	13.7
Estonia	17.0	34.3	5.8	0.1	0.9	41.9
Ireland	25.3	0.0	21.7	11.7	38.9	2.5
Greece	36.8	1.3	8.5	0.1	26.5	26.8
Spain	43.0	0.0	18.3	0.5	18.6	19.7
France	34.9	3.3	27.3	0.1	12.1	22.4
Croatia	23.2	4.9	20.3	0.1	5.2	46.3
Italy	17.5	3.9	51.5	0.0	6.9	20.3
Cyprus	43.1	0.0	0.0	0.0	28.6	28.3
Latvia	11.7	30.1	9.7	0.5	4.4	43.6
Lithuania	17.2	31.6	11.0	4.0	3.8	32.3
Luxembourg	15.9	0.0	48.6	0.0	29.1	6.4
Hungary	16.8	8.0	48.6	1.6	1.3	23.6
Malta	69.5	0.0	0.0	0.0	16.3	14.2
Netherlands	20.5	3.1	70.9	0.0	0.4	5.1
Austria	23.5	11.8	20.8	0.3	14.3	29.4
Poland	13.0	19.4	18.4	31.9	3.3	13.9
Portugal	38.9	0.0	9.4	0.0	14.4	37.3
Romania	14.1	10.1	32.7	0.4	3.8	38.9
Slovenia	27.2	7.0	10.4	0.0	11.7	43.7
Slovakia	21.3	20.3	54.4	1.5	0.4	2.2
Finland	34.3	28.3	0.4	0.1	5.8	31.1
Sweden	51.7	34.4	0.5	0.0	2.5	10.9
United Kingdom	23.8	0.7	62.7	1.3	6.2	5.3
Iceland	14.4	82.7	0.0	0.0	0.5	2.4
Norway	75.2	2.4	0.1	0.0	1.2	21.2
Montenegro	44.1	0.0	0.0	0.9	0.7	54.4
North Macedonia	53.3	7.0	0.0	0.2	2.3	37.2
Albania	53.0	0.0	0.0	0.0	21.5	25.5
Serbia	40.6	14.2	6.8	7.3	1.3	29.6
Turkey	22.8	0.0	50.9	8.4	1.1	16.8
Bosnia and Herzegovina	23.4	5.5	2.1	4.5	1.5	63.0
Kosovo*	35.3	1.7	0.0	0.4	1.9	60.6
Moldova	10.4	9.0	19.0	2.7	4.6	54.3
Ukraine	19.3	14.2	53.0	1.8	0.5	11.3
Georgia	17.4	0.0	58.9	0.0	1.5	22.2

Source: Eurostat

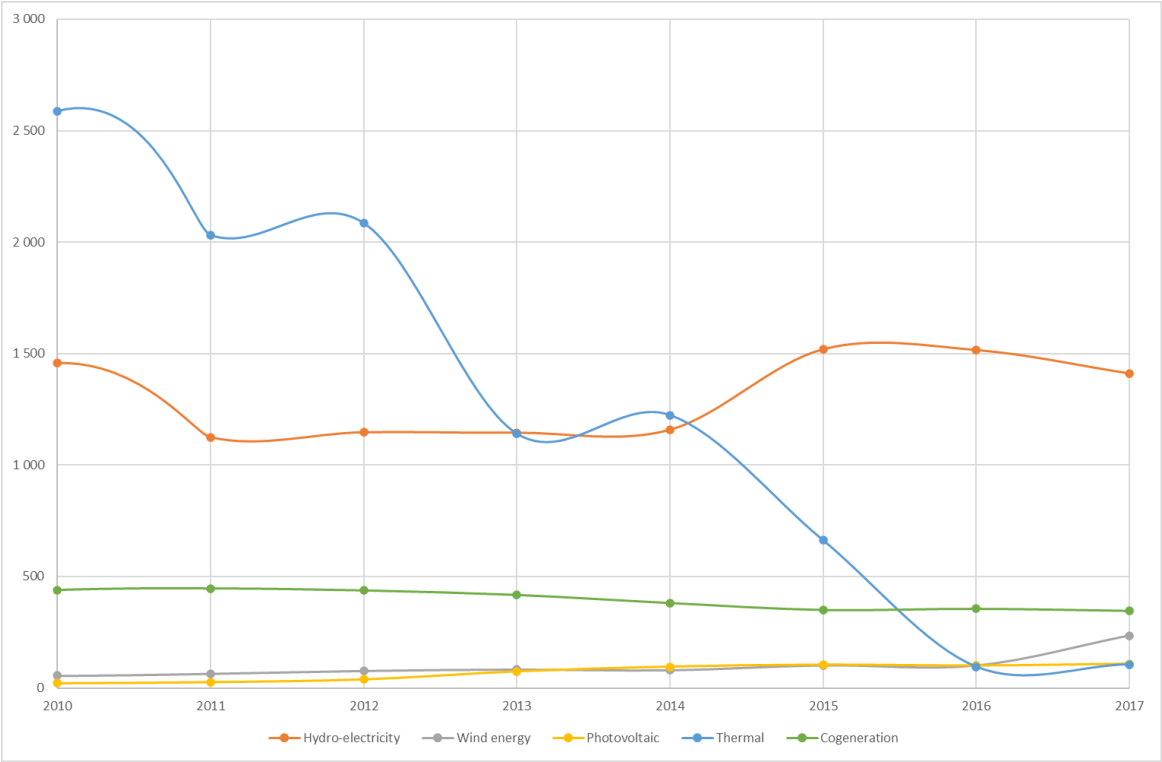
3.2 Electricity production in Luxembourg

In 2019, Luxembourg produced 6,555 GWh, i.e. 15,9 % of the electricity it consumed. 12,2 % of this electricity production came from renewable sources (802 GWh) (Institut Luxembourgeois de Régulation, 2020).

Wind energy production has been significantly increasing in recent years. The Luxembourg government expects production to reach 314 GWh in 2020, partly as result of the start of production at the Wincrange wind park in March 2020[7] (Luxembourg Ministry of Energy and Spatial Planning, 2020). However, electricity production from wind energy remains well below hydro-electric production and cogeneration (production from excess heat). Over the last decade, thermal electricity production has dropped from 2,588 GWh to 105 GWh (Figure 22). However, this production fluctuated in previous decades. It was only 34 GWh in 2000.

[7] Luxembourg government

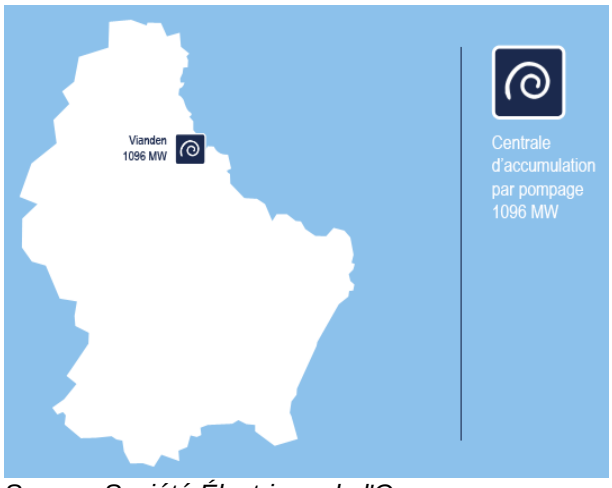
Figure 22 Electricity production in Luxembourg – 2010-2017



Source: Statistical portal of the Grand Duchy of Luxembourg

One of Europe's largest pump storage facilities is located in Vianden in Luxembourg (Figure 23). According to the International Energy Agency, "Luxembourg should continue to co-operate with Germany and Amprion to ensure that the Vianden plant supports effective integration of variable renewable energy (VRE) generation in the joint German-Luxembourg control area, as this will contribute to Luxembourg's security of supply and could allow for greater deployment of VRE generation in Luxembourg" (International Energy Agency, 2020).

Figure 23 Positioning Vianden pump storage facility



Source: Société Électrique de l'Our

3.3 Energy transfers with neighbouring countries

Luxembourg imports 95 % of the energy it consumes[8], i.e. 100 % of oil, natural gas and biofuels. In 2018, renewable energy covered 7.5 % of the country's total primary energy supply (TPES). Renewable energy came primarily from imported biofuels used in transport and biomass used in combined heat and power plants, along with small but growing contributions from electricity generated by wind and solar photovoltaics (PV) (International Energy Agency, 2020).

Electricity

Given its limited production capacities (see section 3.2 above), the Grand Duchy imports most of its electricity from neighbouring regions: 5678 GWh net import in 2018 for a total production of 933 GWh (Institut Luxembourgeois de Régulation, 2019).

All permanent cross-border transmission lines suppling the Luxembourg distribution grid with electricity are connected to the system operated by Amprion in Germany. No connection to the French and Belgian distribution systems is currently used for electricity distribution beyond selected industrial plants[9]. The connection to France (between Moulaine and Sotel, as shown in Figure 24) is solely providing electricity to the Arcelor-Mittal steel plant in Esch/Belval[10]. The same holds true for the connection between Aubange (in Wallonia) and Esch/Belval. An interconnection to Belgium was established in 2017. After one year of technical tests, it was decided that it did not provide significant added-value, and that it would not be commercialised[11].

Currently, the connection to Germany is sufficient to cover peek energy demand in Luxembourg. For this reason, no mechanism to allocate capacity on the network has been established. Such mechanisms may be established if the situation changes.[12] A new line is currently being built between Aach in Rhineland-Palatinate and Bofferdange to increase the exchange capacity between the German and Luxemburgish grids[13]. Electricity import and export figures (Tables 12 to 14) must be interpreted keeping the elements above in mind. Exports to Germany are partly linked to functioning of the storage facility in Vianden (see Figure 23 p. 29).

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[8] World data

[9] Creos

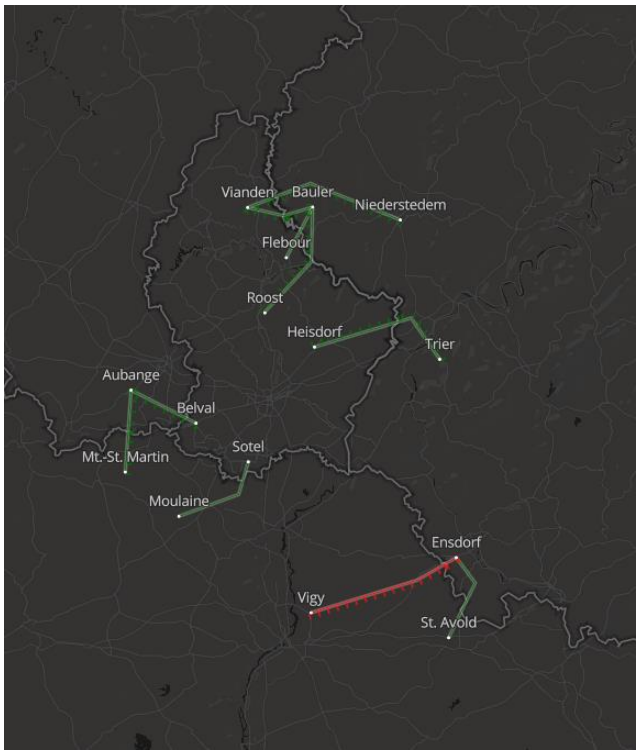
[10] Newspaper article, Républicain Lorrain

[11] Elia

[12] Creos : "La capacité d'interconnexion contractuelle en situation dégradée n-1 pour les lignes en provenance de l'Allemagne s'élève actuellement à 980 MW. Cette capacité est suffisante pour couvrir les besoins du réseau public luxembourgeois dont la charge de pointe prévisible est de 770 MW."

[13] ENTSOE

Figure 24 Cross-border electricity transmission lines Luxembourg (1st January 2019)



Source: ENTSOE

Table 12 Electricity imports in Luxembourg, countries of origin 2013-2018

	2013	2014	2015	2016	2017	2018
Belgium	13.7 %	2.7 %	3.4 %	4.1 %	7.0 %	5.1 %
France	4.3 %	16.1 %	14.0 %	14.8 %	11.7 %	17.2 %
Germany	82.0 %	81.3 %	82.6 %	81.2 %	81.2 %	77.6 %

Source : data.public.lu

Table 13 Electricity exports from Luxembourg, countries of destination 2013-2018

	2013	2014	2015	2016	2017	2018
Belgium	45.5 %	48.7 %	25.4 %	0.4 %	3.7 %	10.5 %
France						
Germany	54.5 %	51.3 %	74.6 %	99.6 %	96.3 %	89.5 %

Source : data.public.lu

Table 14 Luxembourg electricity imports and exports (in MWh) 2013-2018

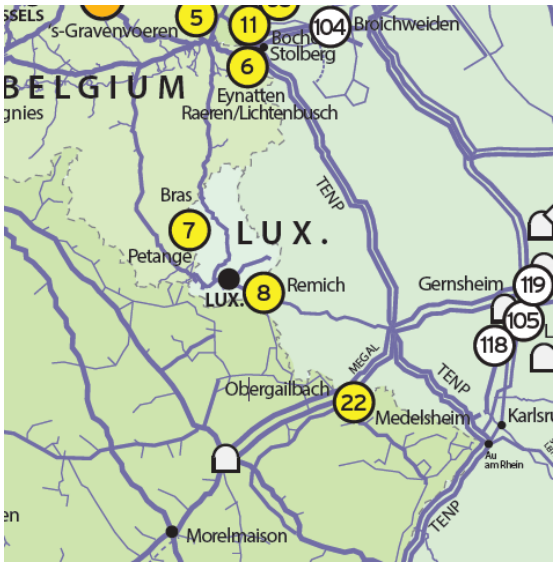
	2013	2014	2015	2016	2017	2018
Imports	6,851,524	6,961,176	7,518,755	7,718,393	7,566,690	7,553,012
Exports	1,039,355	1,061,303	1,431,902	1,413,500	1,336,934	1,244,868
Net imports	5,812,170	5,899,873	6,086,853	6,304,893	6,229,756	6,308,144

Source : data.public.lu

Natural gas

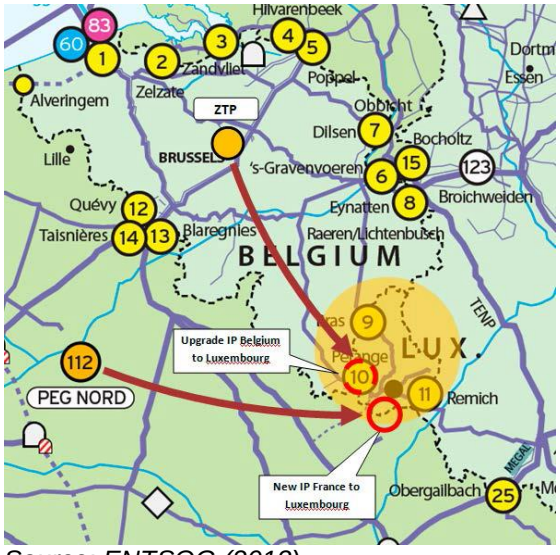
Maps of gas pipelines show that Luxembourg is connected to Belgium and Germany (see Figure 25). The European "Gas Regional Investment Plan 2013-2022" published in 2013 contains a dedicated section dealing with "Luxembourg cross-border congestion". In this section, it is observed that "the sum of firm capacity, at contractual pressure, on all of the Luxembourg's [Transmission System Operator] (Creos) [Interconnection Points] doesn't cover the needs of the Luxembourg national market demand". To address this issue, the report indicates that "Two different infrastructure projects are under investigation in order to comply with the capacity requirements by the end of 2018" (Figure 25). It has not been possible to obtain information on the realisation of either of these projects.

Figure 25 Natural gas pipelines around Luxembourg



Source: ENTSOG (2017)

Figure 26 Cross-border pipeline projects that were proposed in 2013 to reduce congestion in the provision of natural gas to Luxembourg

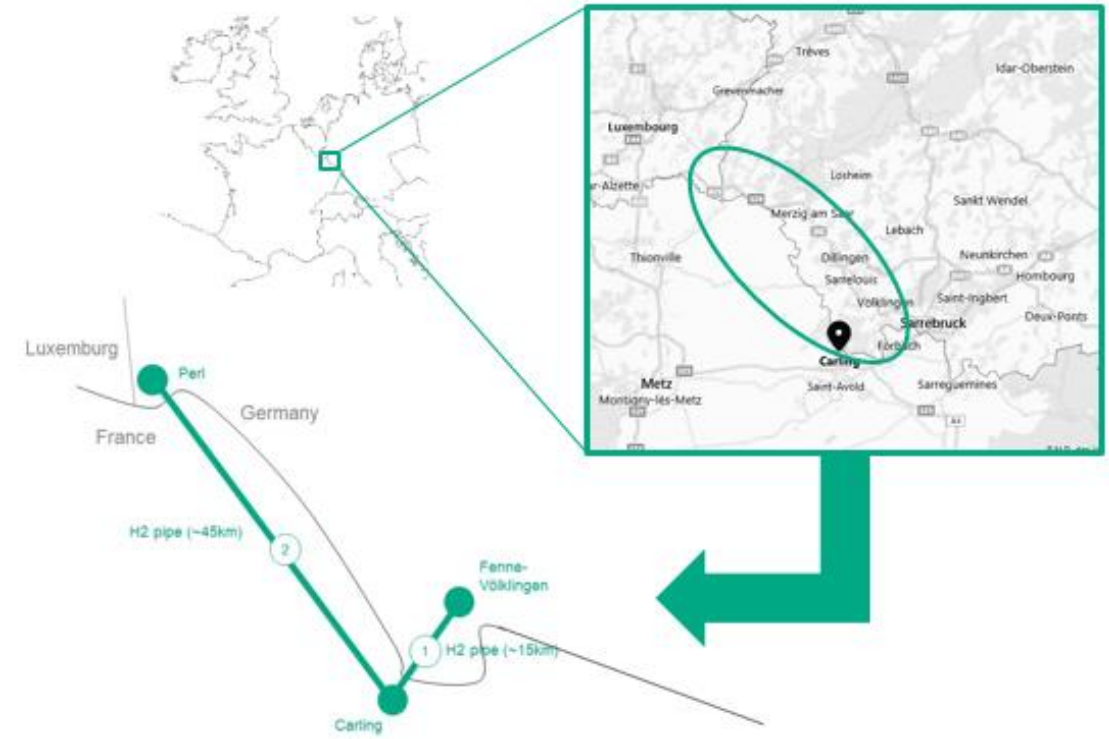


Source: ENTSOG (2013)

Hydrogen

A 70km cross-border system for the distribution of hydrogen is currently being built between Völklingen (Germany), Carling (France), Bouzonville (France) and Perl (Germany) at the Luxembourgish border. MosaHYc (Mosel Saar HYdrogen Conversion) will supply clean hydrogen to the transport sector (train, bus, automobiles, trucks,etc.) in Saarland, the Grand Est region and Luxembourg[14].

Figure 27 MosaHYc distribution system for hydrogen



Source: GRTgaz

[14] GRTgaz

3.4 Electricity production around Luxembourg

In all regions neighbouring Luxembourg, electricity production is equivalent or higher than consumption (Table 15). The ratio is particularly high in the Grand Est, largely as a result of extensive generation from nuclear power plants. Rhineland-Palatinate also has a significant excess production, combined with a large share of renewable energies.

Table 15 Comparison of electricity production and consumption

	Luxem-bourg (2019)	**Grand Est (2019)**	**Wallonia (2018)**	**Saarland (2015)**	**Rhineland-Palatinate (2017)**	**North Rhine-Westphalia (2017)**
Electricity produced (GWh)	1,043	104,662	27,200	157,906	29,056	10,634
Electricity consumed (GWh)	6,555	41,100	24,400	143,710	20,676	9,057
Ratio	15.9 %	254.7 %	111.5 %	109.9 %	140.5 %	117.4 %

Sources: Luxembourg: gouvernement.lu, Wallonia : Iweps, Saarland, Rhineland-Palatinate and North Rhine Westphalia: Föderal erneuerbar

3.4.1 Grand Est

Electricity production in the Grand Est region is primarily based on nuclear energy (73.4 % in 2019). Renewable energies account for 18,3 % of the production. However, renewable energies account for 29.9 % of the production capacity (Figure 28). One nuclear plant is located in the vicinity of Luxembourg, in Cattenom. This plant was built between 1979 and 1986. Luxembourg, Saarland and Rhineland-Palatinate have asked for this plant to be closed for a number of years[15]. However, French authorities foresee to pursue the plant's operations[16].

Overall, the production of the Grand Est region largely exceeds regional consumption (Figure 29). Excess energy is primarily exported to the Hauts-de-France region and to Germany (Figure 30).

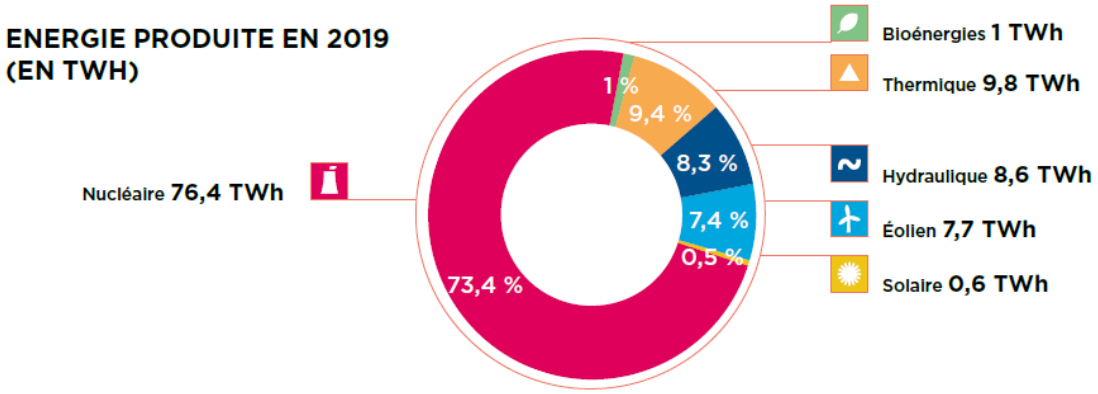
[15]Luxembourg Ministry of Health (2012) Sommet informel de la Grande Région à Metz, 26th June 2012

[16] Communiqué conjoint du ministère des Affaires étrangères et européennes et du ministère de la Santé du Luxembourg et de l'Autorité de sûreté nucléaire (France)

Electricity production from renewable sources is concentrated in different parts of the Grand Est region depending on the source considered (Figure 31):

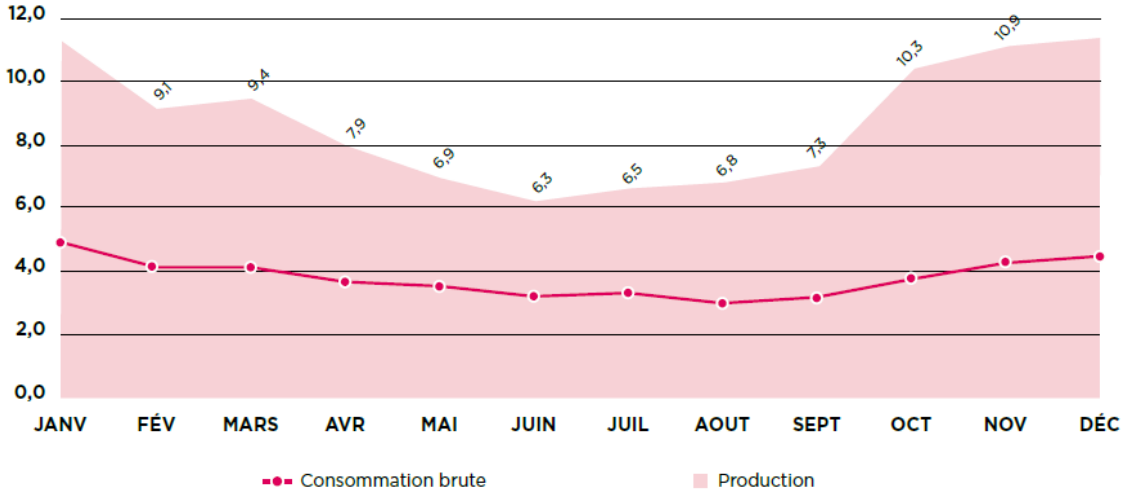
- Marne and Aube for wind energy;
- Meurthe-et-Moselle for solar energy;
- Bas-Rhin, Vosges and Marne for biomass;
- Ardennes and Alsace for hydroelectricity.

Figure 28 Electricity produced (2019)



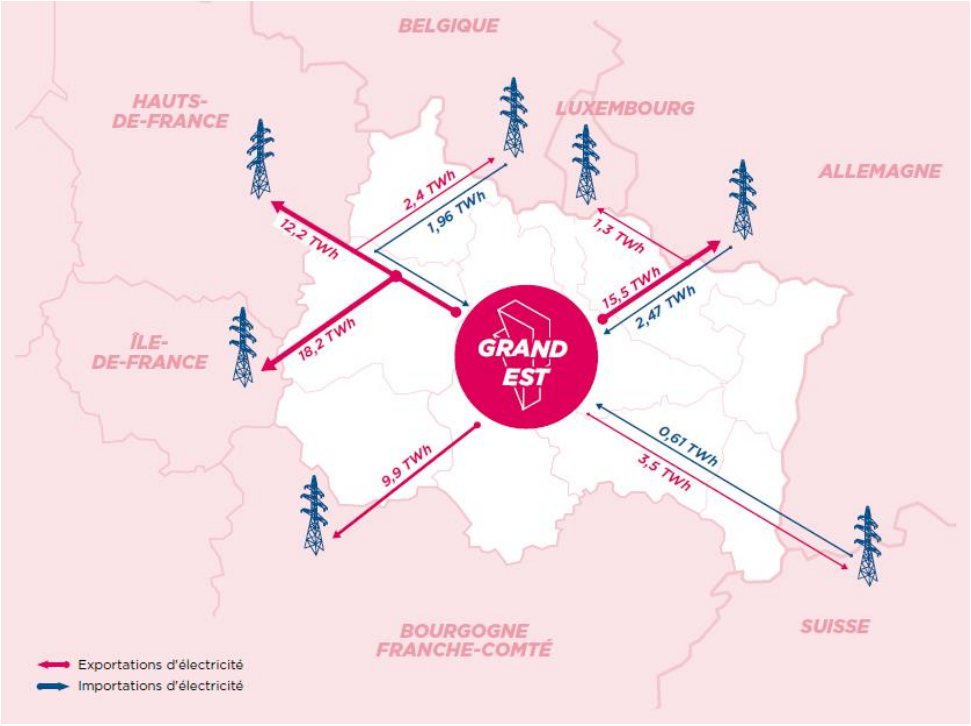
Source: RTE (2019b)

Figure 29 Comparison of electricity production and consumption in Grand Est region (2019)



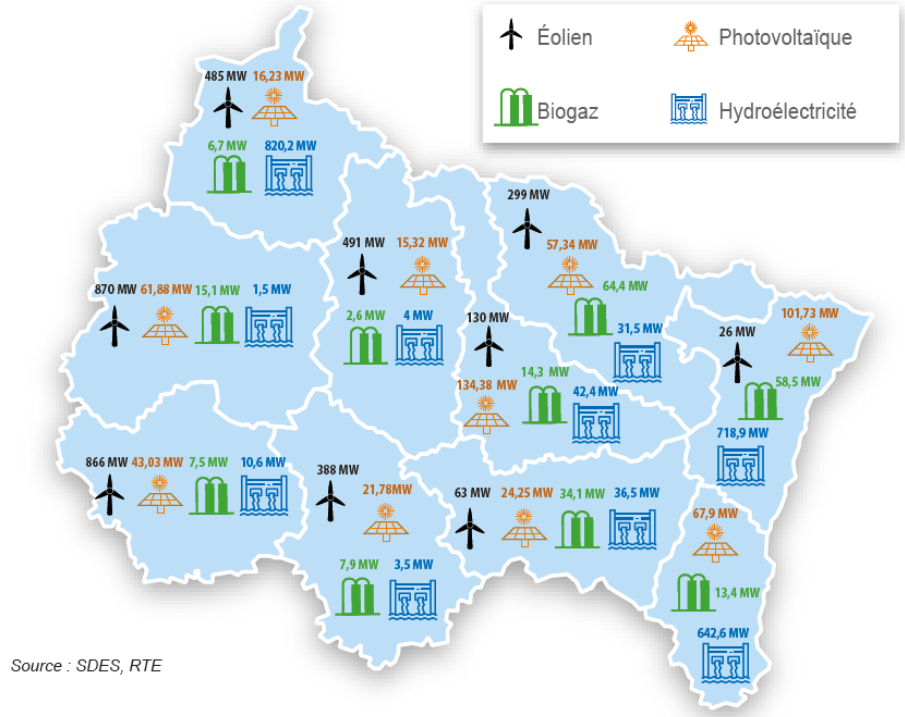
Source: RTE (2019b)

Figure 30 Energy exports and import in Grand Est-Region (2019)



Source: RTE (2019b)

Figure 31 Renewable energy production in the Grand Est region



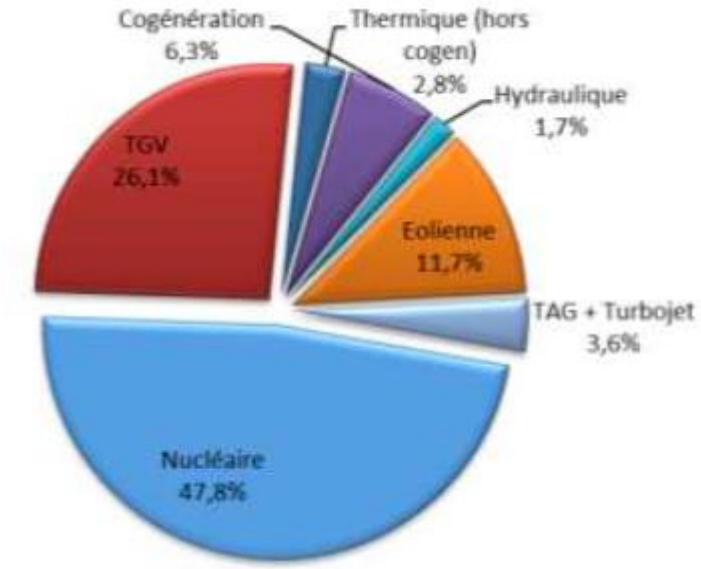
Source: Direction régionale de l'environnement, de l'aménagement et du logement (2020)

3.4.2 Wallonia

Electricity production in Wallonia is characterised by a large share of nuclear energy (47.8 %), followed by gas (TGV – “Turbines gaz vapeur”) (26.1 %) (Figure 32). Wind energy accounts for a relatively high share (11.7 %) compared to neighbouring regions.

Belgian authorities have announced the closure of nuclear plants in 2025. However, policy discussions are ongoing on a possible extension of this delay. The closure of these plants seems unlikely as long as alternative solutions are not in place.

Figure 32 Electricity production in Wallonia by source (2016)



Source: Service public de Wallonie (2018)

3.4.3 Saarland

Electricity production in Saarland is characterised by a large share of electricity coming from hard coal (Table 16). About 56 % of the electricity produced came from coal-fired generation in 2017. The high share can be explained by the regions’ hard coal mining heritage, which has impacted the structure of industry and that of electricity production. In view of the energy transition, the score has been decreased from 80 % to today’s level since 2008. The second largest post are renewable electricity sources, accounting for about 19 % of the region’s energy production. Most renewable electricity is produced from wind energy (9 %), followed by photovoltaic energy (5 %) and biomass (3 %). Natural gas presents the third largest electricity source, accounting for about 18 % of the electricity produced in Saarland.

Table 16 Electricity production in Saarland by source, 2008 and 2017

Year		**2008**	**2017**
Hard coal		80.2 %	55.6 %
Lignite		0 %	0 %
Natural gas		6.1 %	18 %
Nuclear energy		0 %	0 %
Other non-renewable and waste		8.6 %	7.2 %
Share of renewable energies		5.1 %	19.2 %
	from wind power	2.1 %	9.3 %
	from biomass	1.6 %	3.1 %
	from water energy	0.8 %	1.3 %
	from photovoltaic	0.5 %	5.4 %
	from other renewable sources	0 %	0 %

Source: Agentur für erneuerbare Energien (2019),

3.4.4 Rhineland-Palatinate

A large share of electricity production in Rhineland-Palatinate came from renewable sources in 2017 (Table 17). About 48 % comes from renewable sources, with the largest source being wind energy in Rhineland-Palatinate accounting for about 27 %. Wind energy is followed by photovoltaic (9%) and biomass (4 %). The second largest source for electricity in Rhineland-Palatinate is natural gas, accounting for about 47 % of the total electricity produced.

Table 17 Electricity production in Rhineland-Palatinate by source, 2008 and 2017

Year		**2008**	**2017**
Hard coal		0.4 %	0 %
Lignite		0 %	0 %
Natural gas		68.8 %	47.6 %
Nuclear energy		0 %	0 %
Other non-renewable and waste		7 %	4.3 %
Share of renewable energies		23.8 %	48.1 %
	from wind power	10.4 %	28.6 %
	from biomass	4.3 %	6 %
	from water energy	7.1 %	4 %
	from photovoltaic	1.4 %	9 %
	from other renewable sources	0.6 %	0 %

Source: Agentur für erneuerbare Energien (2019)
Due to reporting inconsistencies, some deviations are observed between total electricity production from renewable sources and electricity production by source.

3.4.5 North Rhine-Westphalia

A large share of electricity produced in North Rhine-Westphalia still comes from coal combustion (Table 18). 48 % of the electricity produced comes from lignite and 20 % from hard coal. This means that, in total, 68 % of electricity produced in 2017 resulted from coal combustion. About 11 % of electricity produced comes from renewable sources. Wind energy accounts for 6 %, biomass for 4 %, and photovoltaic panels for 2 %.

North Rhine-Westphalia is the most populated region in Germany and has a long history in industrial production and coal mining. The region is hence also the one with the highest energy consumption. As a result, about 28 % of Germany's production facilities are located in North Rhine-Westphalia.

Table 18 Electricity production in North Rhine-Westphalia by source, 2008 and 2017

Year		**2008**	**2017**
Hard coal		27.7 %	19.6 %
Lignite		44.3 %	48.3 %
Natural gas		15.6 %	9.3 %
Nuclear energy		0 %	0 %
Other non-renewable and waste		8 %	12 %
Share of renewable energies		4.4 %	10.8 %
	from wind power	2.1 %	5.6 %
	from biomass	1.3 %	3.9 %
	from water energy	0.4 %	0.4 %
	from photovoltaic	0.2 %	2.3 %
	from other renewable sources	0.7 %	0.4 %

Source: Agentur für erneuerbare Energien (2019)
Due to reporting inconsistencies, some deviations are observed between total electricity production from renewable sources and electricity production by source.

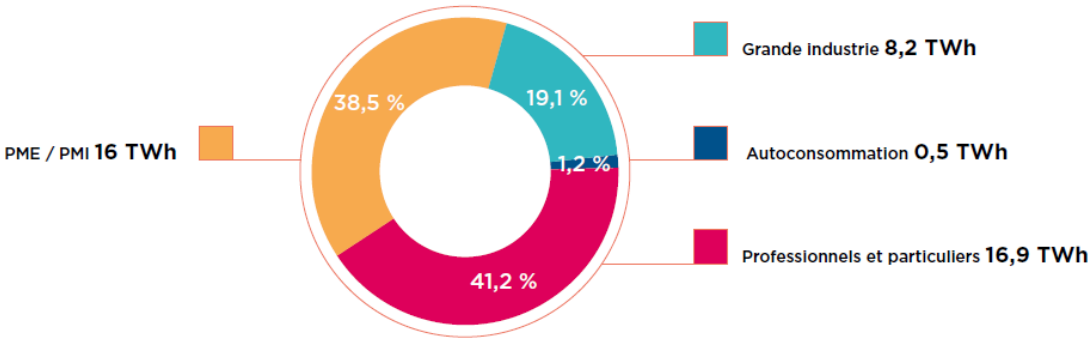
3.5 Electricity consumption around Luxembourg

3.5.1 Grand Est

The Grand Est region has experienced the strongest decline in electricity consumption between 2007 and 2018 among French regions (-9.2 %) (RTE, 2019a), which is linked to deindustrialisation. Nonetheless, the Grand Est region is still in the top 3 among French regions in terms of electricity consumption by major manufacturing plants.

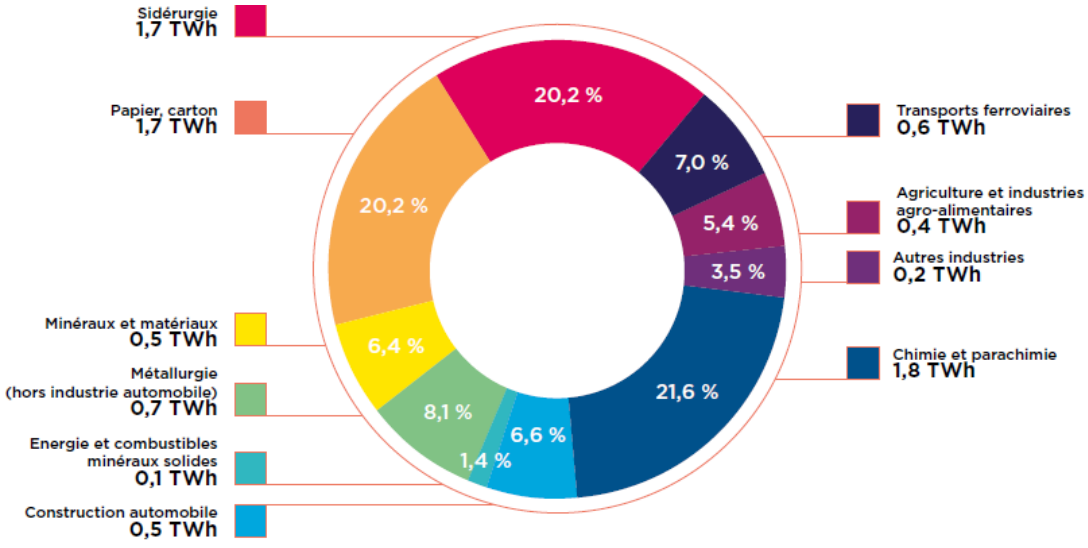
Data on electricity consumption for the Grand Est by sector are difficult to compare with the data for Luxembourg, as the classification is different. Separate figures on energy consumption by the service sector and by households can, for example, not be provided.

Figure 33 Electricity consumption by sector in Grand Est region (2019)



Source: RTE (2019b)

Figure 34 Industrial energy consumption in Grand Est region (2019)

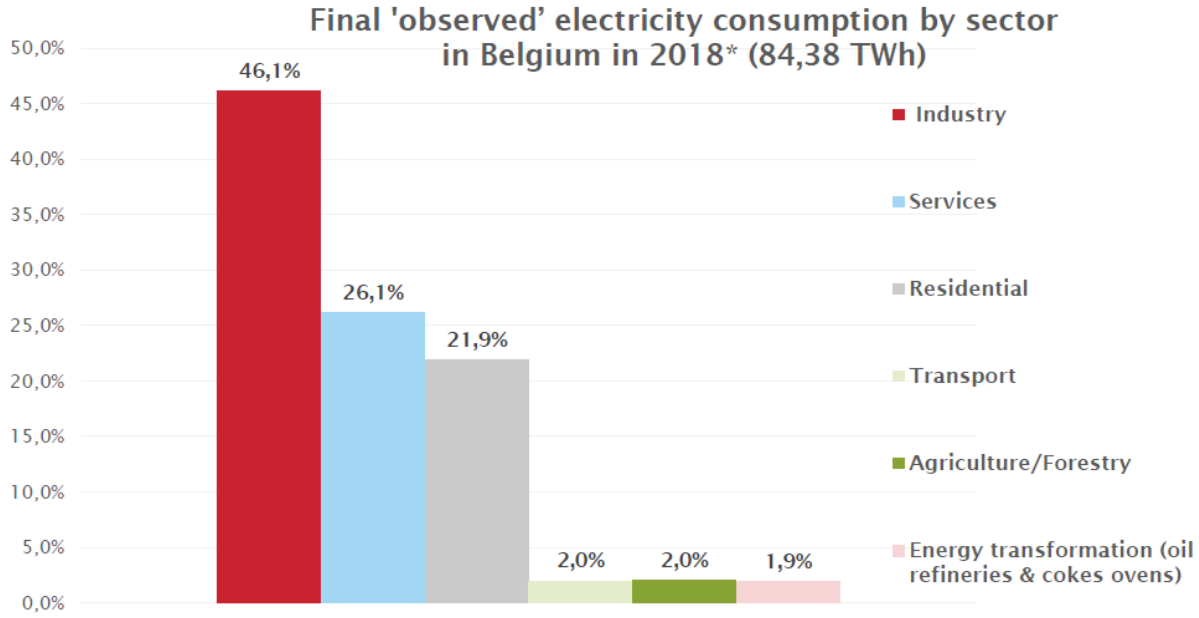


Source: RTE (2019b)

3.5.2 Wallonia

Electricity consumption by sector is only available at the national level in Belgium (Figure 35). 46 % is consumed by manufacturing industries (against 47 % in Luxembourg), 26,1 % by service activities (against 35 % in Luxembourg) and 21.9 % by household (against 14.5 % in Luxembourg). For Wallonia, there is only data on total energy consumption (Table 19), which is difficult to compare to electricity consumption for Luxembourg.

Figure 35 Energy consumption by sector in 2018 in Belgium



Source: FEBEG (2019)

Table 19 Total energy consumption by sector in Wallonia (2018)

Industry (GWh)	33.6 %
Households (GWh)	26.5 %
Services (GWh)	10 %
Transport (GWh)	28.7 %
Agriculture (GWh)	1 %

Source: Iweps

3.5.3 Saarland

Data on electricity consumption by sector in Saarland could not be compiled. If we consider total energy consumption, the mining and quarrying as well as the manufacturing sector accounts for about 63 % of the total energy consumed in 2017. Many production facilities for heavy industry are still producing in the region, explaining the high share of energy consumed by this sector. The second largest consumer of energy are households, the non-producing industry, commerce and services accounting for 24 % of the energy consumption, and only 13 % are used for transport.

Table 20 Energy consumption by user group, 2008 and 2017 as share of total consumption for Saarland

		Mining and quarrying, manufacturing sector	Transport	Households, industry, commerce, services, other consumers
Saarland	2008	61 %	12 %	27 %
	2017	*63 %*	*13 %*	*24 %*

Source: Länderarbeitskreis Energiebilanzen (2018)

3.5.4 Rhineland-Palatinate

Data on electricity consumption by sector in Rhineland-Palatinate could not be compiled. If we consider total energy consumption, households, the non-producing industry, commerce and services account for about 40 % of the total energy consumed in 2017. Mining and quarrying as well as the producing industry account for 32 % of energy consumption, which is a significantly lower share compared to Saarland. In contrast, the transport sector in Rhineland-Palatinate consumes a significantly higher share (28 % of the total energy consumption).

Table 21 Energy consumption by user group, 2008 and 2017 as share of total consumption for Rhineland-Palatinate

		Mining and quarrying, manufacturing sector	Transport	Households, industry, commerce, services, other consumers
Rhineland-Palatinate	2008	32 %	27 %	41 %
	2017	32 %	28 %	40 %

Source: Länderarbeitskreis Energiebilanzen (2018)

3.5.5 North Rhine-Westphalia

Data on electricity consumption by sector in North Rhine-Westphalia could not be compiled. If we consider total energy consumption, mining and quarrying as well as the producing industry account for the majority of energy consumed, with about 37 % of the total energy consumed in 2017. Since 2008, this share has been stable, contrary to the share of energy consumed by households, non-producing industry, commerce and services, which has seen a decrease from 43 % to 37 % and today represents the second biggest post. The share of energy consumed for transport has increased and accounts for 26 % of total energy consumption in North Rhine-Westphalia.

Table 22 Energy consumption by user group, 2008 and 2017 as share of total consumption for North Rhine-Westphalia

	Year	Mining and quarrying, manufacturing sector	Transport	Households, industry, commerce, services, other consumers
North Rhine-Westphalia	2008	37 %	21 %	43 %
	2017	*37 %*	*26 %*	*37 %*

Source: Länderarbeitskreis Energiebilanzen (2018)

3.6 Energy production policy objectives

Information on two types of energy-related policy objectives has been compiled: renewable energy production in 2030, and perspectives for the phasing out or continued operation of nuclear power plants.

Renewable energy

Renewable energy objectives vary significantly from region to region:

- Luxembourg: 33.6 % of electricity production from renewable sources in 2030 (Source: Luxembourg Ministry for Energy and Spatial Planning (2018))
- Grand Est: 42.8 % of electricity production from renewable sources in 2030 (Source: Direction régionale de l'environnement, de l'aménagement et du logement (2020), quoting the SRADDET)

- Wallonia: 37 % of electricity production from renewable sources in 2030[17].
- Saarland: The Saarland Energy Advisory Council is currently working on an energy roadmap for 2050, which is to be discussed by the Council of Ministers in spring 2021. This plan is likely to include targets for 2030[18].
- Rhineland Palatinate: 100 % of electricity production from renewable sources in 2030[19].
- North Rhine-Westphalia: 33 % electricity production from renewable sources in 2030[20].

When comparing regional objectives around Luxembourg, one can observe that the relative change planned by Luxembourg for wind, sun and biomass electricity generation is, by far, the largest (Table 25). Increases in wind energy are the greatest in Grand Est and Rhineland-Palatinate in absolute numbers, but in Wallonia in relative terms. Ambitions regarding photovoltaic energy are the highest in Rhineland-Palatinate and Wallonia. North Rhine-Westphalia has much lower ambitions comparatively, and a particularly low starting point. However, some of the highest mean wind power densities are observed in southernmost parts of North Rhine-Westphalia (Figure 36).

Luxembourg is also a pro-active partner of the North Seas Energy Cooperation, which was initiated by the "Political Declaration on Energy Cooperation between the North Seas Countries" on 6th June 2016. Its general orientations are set by Ministerial meetings and a High Level group. Support Groups and ad hoc working groups are responsible for its implementation. These groups are co-chaired by European Commission and Member State representatives. Luxembourg is the only member of this cooperation with no coastline.

[17] Plan Wallon Energie Climat 2030, definitive version of 28th November 2030 approved by the Wallon government, (p. 31)

[18] Mail exchange with Mr Nicola Saccà , Head of Unit F/1, Policy Issues in relation to Energy and Climate Protection, Saarland Ministry of Economics, Labour, Energy and Transport

[19] Government of Rhineland Palatinate

[20] Föderal Erneuerbar, Aachener Zeitung.

Table 23 Renewable electricity production levels and 2030 objectives (GWh)

	Luxembourg		Grand Est		Wallonia		Rhineland Palatinate		North Rhine Westphalia	
	2016	**2030**	**2019**	**2030**	**2015**	**2030**	**2017**	**2030**	**2018**	**2030**
Hydroelectricity	104	100	7,363	9016	314	440	827	860	553	553
Wind	127	676	6,292	11,988	1437	4,600	5,913	14,405	5,4	10,5
Sun	100	616	552	1081	792	3,300	1,861	5375	4,6	11,5
Biomass / waste / cogeneration	67	271	749	:	1518	1701	1241	:	6,202	6,202

Sources: Luxembourg: Plan national intégré en matière d'énergie et de climat, Grand Est: SRADDET, Annex no 4, version adopted on 22nd November 2019 (p. 101), Wallonia: Plan Wallon Energie Climat 2030, definitive version of 28th November 2030 approved by the Wallon government (p. 31), Saarland: Föderal erneuerbar, Rhineland Pfalz: Föderal erneuerbar, North Rhine Westphalia: Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie

Table 24 Renewable electricity production levels and 2030 objectives: absolute change (GWH)

	Luxembourg	Grand Est	Wallonia	Saarland	Rhineland Palatinate	North Rhine Westphalia
Hydroelectricity	-4	+1653	+126	:	+33	:
Wind	+549	+5,696	+3,163	:	+8,492	+5.1
Sun	+516	+529	+2,508	:	+3,514	+6.9
Biomass / waste / cogeneration	+204	:	+183	:	:	:

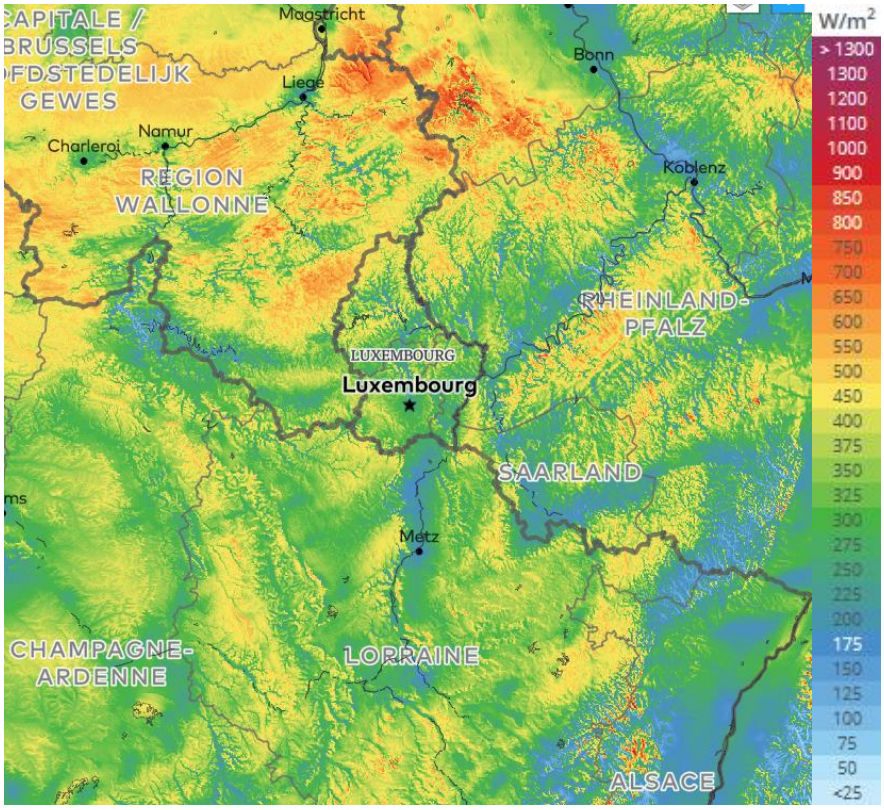
Sources: Luxembourg: Plan national intégré en matière d'énergie et de climat, Grand Est: SRADDET, Annex no 4, version adopted on 22nd November 2019 (p. 101), Wallonia: Plan Wallon Energie Climat 2030, definitive version of 28th November 2030 approved by the Wallon government (p. 31), Saarland: Föderal erneuerbar, Rhineland Pfalz: Föderal erneuerbar, North Rhine Westphalia: Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie

Table 25 Renewable electricity production levels and 2030 objectives: relative change

	Luxembourg	Grand Est	Wallonia	Saarland	Rhineland Palatinate	North Rhine Westphalia
Hydro-electricity	-3.8 %	+22.5 %	+40.1 %	:	+4.0 %	
Wind	+432.3 %	+90.5 %	+220.1 %	:	+143.6 %	+94.4 %
Sun	+516.0 %	+95.8 %	+316.7 %	:	+188.8 %	+150.0 %
Biomass / waste / cogeneration	+304.5 %	:	+12.1 %	:	:	

Sources: Luxembourg: Plan national intégré en matière d'énergie et de climat, Grand Est: SRADDET, Annex no 4, version adopted on 22nd November 2019 (p. 101), Wallonia: Plan Wallon Energie Climat 2030, definitive version of 28th November 2030 approved by the Wallon government (p. 31), Saarland: Föderal erneuerbar, Rhineland Pfalz: Föderal erneuerbar, North Rhine Westphalia: Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie

Figure 36 Mean wind power density



Source: Global wind atlas

Nuclear energy

In 2017, the French government announced that it would reduce the share of nuclear energy production from 75 % to 50 % by 2025[21]. However, in 2018, the time horizon to reach this objective was postponed to 2035[22].

Authorities in both Belgium and Germany plan to phase out nuclear reactors in the coming years. In Belgium, this is supposed to take place between 2022 and 2025. However, a 2019 report by the Belgian System Operator Elia indicates that this would threaten security of supply in Belgium, especially as coal is being phased out in neighbouring countries at the same time[23]. Germany foresees to decommission every nuclear power facility by the end of 2022, while at the same time progressively phasing out coal power by 2038[24].

This reduction of nuclear energy production in neighbouring countries may lead to an increase in electricity prices.

3.7 Functional area

In view of producing a Mapshot, it appears purposeful to focus on electricity production and consumption. Electricity is more 'territorially embedded' than fuels in solid, liquid or gas forms. Admittedly, natural gas is distributed through pipelines, as described in section 3.3. The policy implications of the territorial organisation of Luxembourg's gas provision remain to be identified. Luxembourg also has the ambition to reduce its consumption of natural gas over the coming decades[25].

In terms of functional areas, two parameters may be considered. First, the European electricity market is divided into so-called 'bidding zones'. The assumption is that trading opportunities within these bidding zones are unlimited (i.e. there are no capacity issues on the network). Luxembourg belongs to a bidding zone that includes all of Germany (ENTSO-E, 2018). Austria was excluded from this bidding zone in October 2018[26].

Second, physical infrastructure for energy transmission affects how much trade is possible between bidding zones, e.g. between Luxembourg and Belgium or Luxembourg and France.

This implies that Luxembourg's 'functional area' of electricity production is wide. The current bidding zone it includes all of Germany. Functional integration with other neighbouring

[21] French government

[22] Ministère de la Transition écologique et solidaire (2018)

[23] Elia

[24] BBC news

[25] Government of the Grand Duchy of Luxembourg

[26] APG

territories may change rapidly, depending on usage of existing transmission infrastructure and investments in new such infrastructure. Currently, the only functioning transmission lines for electricity distribution connect Luxembourg to Germany (see section 3.3). Luxembourg's involvement in the North Seas Energy Cooperation illustrates potential evolutions in the boundaries of Luxembourg's energy-related functional neighbourhood.

While these wide-ranging possible future evolutions are difficult to integrate in a Mapshot, considering a functional area that extends well beyond the Greater Region offers a sound basis for reflections on different cooperation operation. The area represented in the Mapshot includes the entire Grand-Est region and extends to the southern part of North Rhine-Westphalia, where renewable energy production is currently less developed and where mean wind power density is high compared to other territories around Luxembourg.

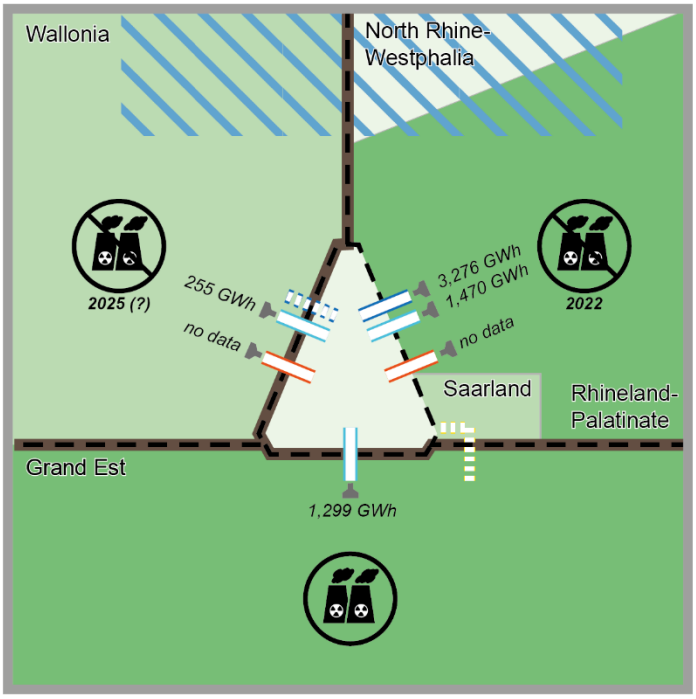
3.8 Mapshot

The Mapshot focuses on the following aspects:

- Borders of current electricity bidding zones;
- Electricity transmission lines, showing that
    - the only currently operational lines for distribution of electricity connect Luxembourg to Germany;
    - that an interconnection for distribution to Belgium has been built, but is currently not operational;
    - that operational transmission lines connecting Luxembourg to France and Belgium only provide electricity to major industrial plants;
- Natural gas pipelines, showing that gas for the Luxembourgish market transits through both Belgium and Germany;
- The MosaHYc distribution system for hydrogen extending to Perl, which is contiguous to Schengen, and will be able to provide hydrogen to Luxembourgish consumer when it is finalised;
- Ratio of electricity production from renewable sources on total electricity consumption, providing a proxy for the level of development of such production activities;
- Future perspectives for electricity production from nuclear power, providing indications of possible future tensions on electricity markets that could result in higher electricity prices.
- Areas with the highest mean wind power density around Luxembourg, while acknowledging that other factors such as density of settlements play an important role when deciding on where to locate wind parks.

The Mapshot shows that electricity production from renewable sources is less developed in Luxembourg than in neighbouring countries. Such production is particularly developed in Rhineland-Palatinate and in the Grand Est region. Nuclear energy may play an important role during a transition phase in the years to come. However, it is expected to be dismantled in Germany and possibly also in Belgium. No transmission lines between France and Luxembourg are currently used for distribution of electricity. Luxembourg is, therefore, currently heavily dependent on how the German electricity market evolves.

Figure 37 *Mapshot - thematic field "energy provision and production"*



ESPON ACTAREA spin-off Luxembourg Spatial Foresight (2020)

The functional zone: Greater Region extended

Functional zone - energy

Zones and networks

Bidding zone borders

National border

Inter-State border (Germany)

Connections between networks

Electricity: interconnection for non-industrial purposes

Electricity: interconnection for industrial purposes

Natural gas

Hydrogen

Active connection

Inactive or potential connection (infrastructure only)

Electricity production

Renewable electricity ratio: ratio of the renewable electricity production on total electricity consumption)

Low (< 11%)

Medium (15-20%)

High (> 40%)

High potential for wind energy generation

Continued electricity production from nuclear power

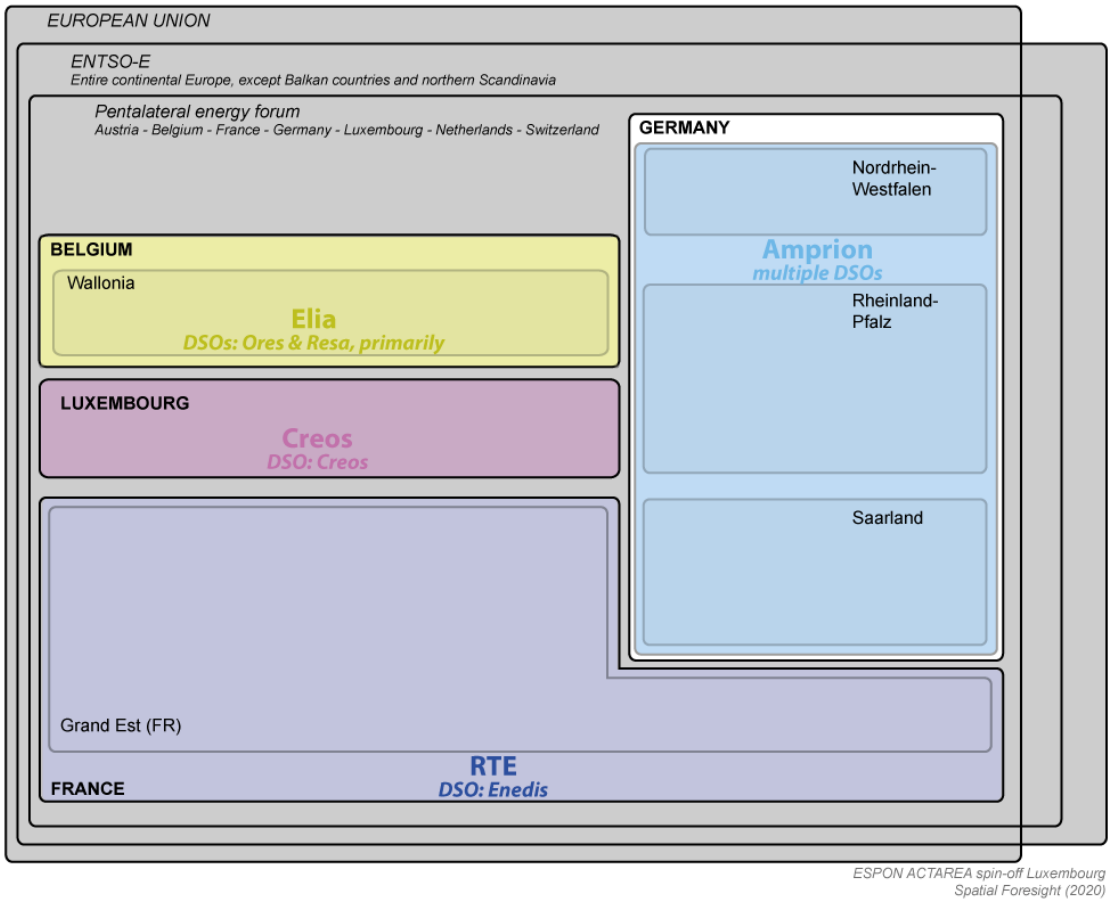
Foreseen shutdown of electricity production from nuclear power (***date***)

3.9 Institutional mapping

The institutional mapping focuses exclusively on electricity production and distribution. It first acknowledges that the European Union plays a significant role providing regulatory frameworks and policy impulses. ENTSO-E, the European Network of Transmission System Operators, represents 43 electricity transmission system operators (TSOs) from 36 countries across Europe. It therefore extends beyond the EU. The Pentalateral Energy Forum is the framework for regional cooperation in Central Western Europe towards improved electricity market integration and security of supply. As it includes Switzerland, it also extends beyond the EU.

The level of the Member States is also an essential level for the definition of energy policy, e.g. with respect to choices regarding the future of nuclear power plants. The organisation of electricity transmission system operators (TSOs) and distribution system operators (DSOs) is specific to each country. In Luxembourg, Creos functions as national TSO and DSO. In France, these roles are carried out by two distinct organisations: the TSO is RTE, while the DSO is Enedis. Elia is the only TSO in Belgium. The main DSOs in Wallonia are Ores and Resa. These are also the only DSOs in the provinces of Luxembourg and Liège. In Germany, there are multiple TSOs. However, Amprion is the only one in the federal states of Saarland, Rhineland-Palatinate and North Rhine-Westphalia.

Figure 38 Institutional mapping - thematic field "energy production and provision"



4 Food provision and associated value chains

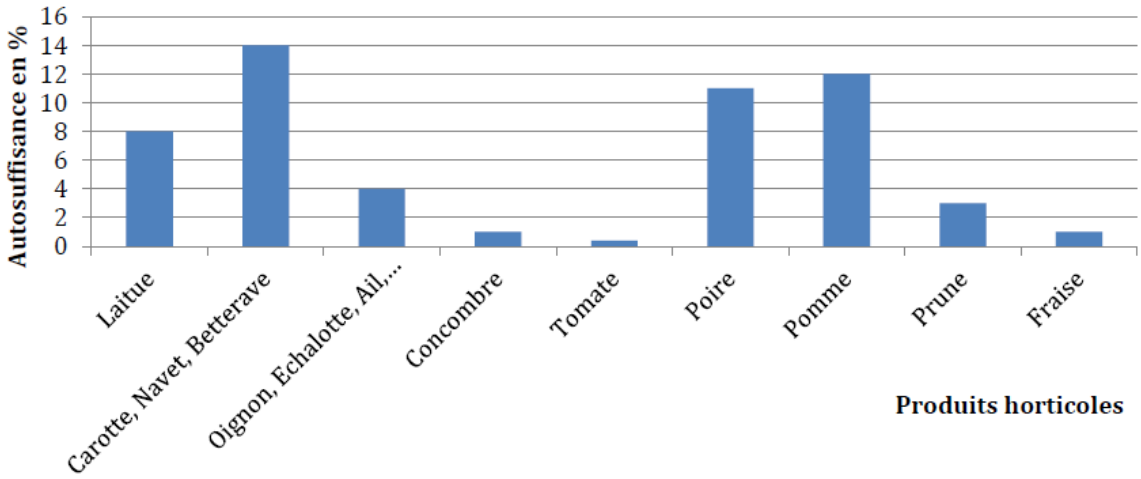
This chapter addresses issues and perspectives related to the food provision of the Luxembourg Cross-border Functional Region. For this purpose, it has also considered information on value chains associated to food processing. However, agricultural production and food production are multi-faceted sectors of activity. Trade patterns, institutional frameworks and public support mechanisms are specific to each production. Furthermore, different forms of agricultural production coexist, e.g. 'ecological', 'sustainable' and 'conventional' agriculture. Food processing industries operate at all scales, from the local to the global. At this stage, it is therefore only possible to provide some frameworks for reflection on food provision and associated value chains of relevance for the Luxembourg Cross-border Functional Region.

The section first describes the low levels of food self-sufficiency of Luxemburg, and patterns of exports and imports of foodstuffs in Luxembourg and its neighbouring regions (section 4.1). Second, these regions are characterised by comparing the relative importance of food processing industries within each region and profiles of agricultural production (section 4.2). Third, data on ecological farming in each region have been compiled (section 4.3). Finally, reflections on functional areas of relevance for strategic reflections on food provision and associated value chains are presented (section 4.4). The Mapshot synthesises these different findings (section 4.5).

4.1 Exports and imports of foodstuffs

Luxembourg is characterised by low levels of self-sufficiency for a number of agricultural products. For some products such as tomatoes, cucumbers and strawberries, the national production corresponds to less than 1 % of the national consumption (Figure 39).

Figure 39 Luxembourg's level of self-sufficiency for selected vegetables and fruits



Source: Ministère luxembourgeois de l'Environnement, du Climat et du Développement durable (2019)

Neighbouring regions host more or less extensive export-oriented agricultural production and food processing industries. While these activities do not compensate for imports in Luxembourg and Saarland, they generate more or less substantial surpluses in the national trade balance for Rhineland-Palatinate, Wallonia and the Grand Est region (Table 26). While imports of foodstuffs are of the same magnitude in these three regions, exports from the Grand Est region are considerably higher. This surplus is generated by some key products, such as 'wine', 'barley, malt and beer', 'milk, dairy products and eggs' as well as 'beets' (Table 27). However, the Grand Est region is dependent on imports of vegetables, fruits and meat.

Table 26 Exports and imports of foodstuffs in 2019 (thousands euros)

	Imports	Exports	Difference
Luxembourg	1,721,000	936,500	-784,500
Grand Est	3,620,453	9,037,139	5,416,686
Saarland	919,741	596,603	-323,138
Rhineland Palatinate	3,383,360	3,874,944	491,584
Wallonia	3,974,882	4,988,415	1,013,533

Sources: Luxembourg: French embassy in Belgium, Grand Est: French Ministry of Finance, Saarland, Statistisches Amt, Rhineland Palatinate: Statistisches Landesamt, Wallonia: NBB

Table 27 Exports and imports of key products in Grand Est Region (2016) with main countries of origin/destination

	Exports	Main export destinations	Imports	Main import destinations
Beets, sugar, ethanol	194	Italy 36 % Germany 24 % Belgium 15 %	42	Germany 77 %
Vegetables	69	Germany 17 % Italy 13 %	91	Netherlands 19 % Spain 17 %
Fruits	11		77	
Processed vegetables and fruit products	57		365	
Milk, dairy, eggs	1,000	Germany 34 % Italy 12 % Belgium 10 %	430	Germany 45 % Belgium 17 % Italy 14 %
Barley, malt and beer	488	Spain 22 % Belgium 18 % Pays-Bas 12 %	51	Germany 52 % Ireland 19 % Belgium 13 %
Meat	225	Germany 44 % Italy 16 % Belgium 10 %	511	Germany 38 % Spain 12 % Belgium 10 %
Wine	2,700	UK 18 % Germany 13 % USA 13 %	63	Italy 20 % Spain 13 % Portugal 13 %

Source: Région Grand Est (2017)

It is important to consider that the values in Table 26 and Table 27 only refer to exports from each region to other countries. Data on the provision of foodstuffs to other regions within the same country could not be compiled.

As illustrated by these examples, the identification of perspectives for cross-border cooperation in the field of food provision and associated value chains requires detailed analyses of production and trade flows for each type of product. A Mapshot can at this stage only provide a general framework for such reflections.

4.2 Production intensities

Luxembourg and its neighbouring regions are territories of diverse sizes and with a wide range of preconditions for agricultural production. This has contributed to the emergence of diverse agricultural production profiles. The Interreg Greater Region project AROMA has compiled detailed figures on the production of a number of crops in different parts of the Greater Region. We have considered production volumes for higher-level classifications of agricultural products, compared them to the regional population (i.e. “kg of product per inhabitant”), and then compared this ratio to the average for the Greater Region as a whole (i.e. deviation to Greater Region average). This makes is possible to generate normalised regional production profiles.

Some general characteristics of the different regions emerge on this basis (Figure 40):

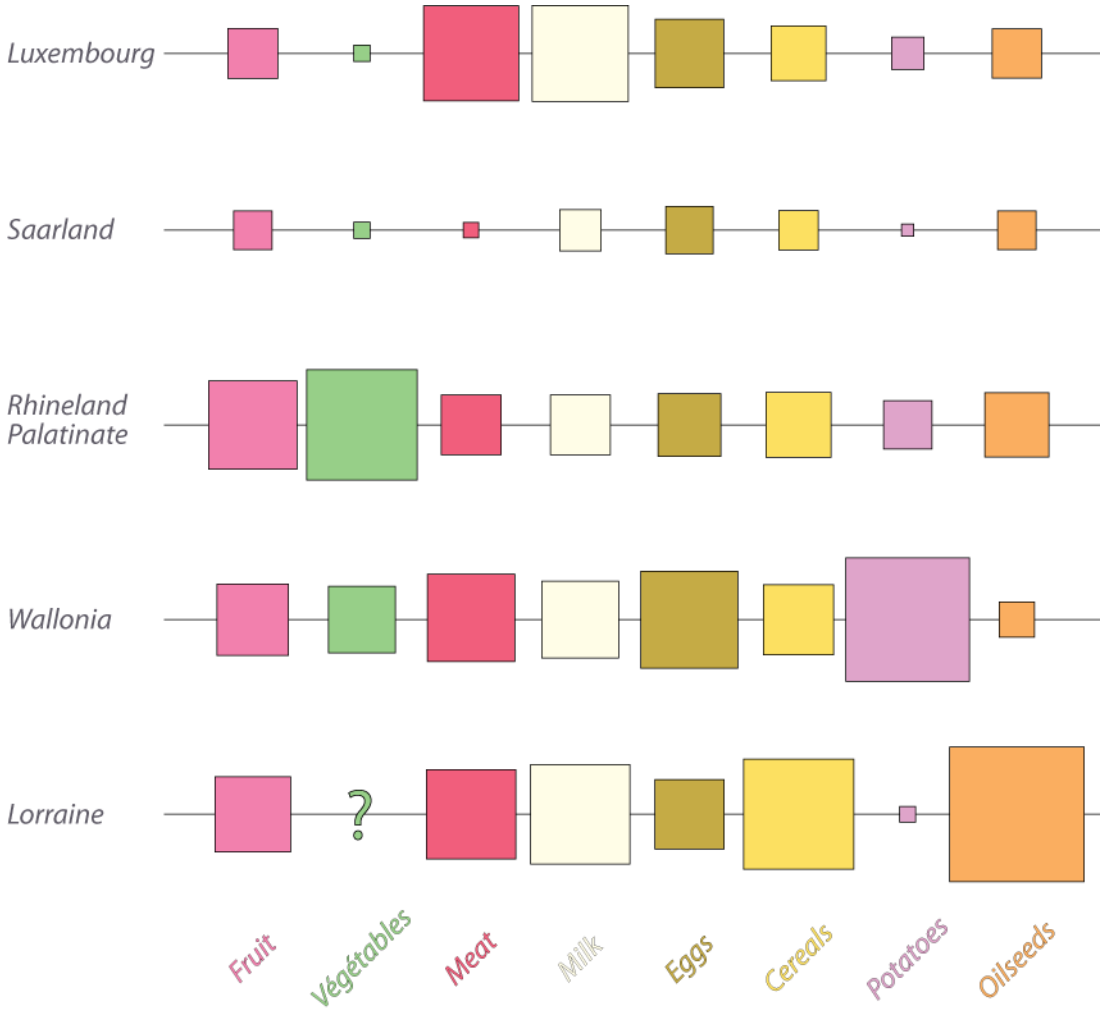
- Luxembourg is specialised in meat and milk production,
- Saarland has a low production intensity for all products, in relation to its population,
- Rhineland-Palatinate is specialised in fruits and vegetables,
- Wallonia is specialised in potatoes, eggs, meat and milk,
- Lorraine[27] is specialised in oilseeds, cereals, milk and meat.

These figures must be interpreted with caution, as they only relate Greater Region territories to each other. When considering potato production in the entire Grand Est region, authorities consider that regional production of untransformed potatoes exceeds regional demand, while production of transformed potato-based products is well below regional demand. (Région Grand Est, 2017)

Data on the proportion of manufacturing turnover general by food processing industries makes it possible to identify two distinct groups of regions. In Grand Est and Wallonia, food processing represents 20 to 25 % of the total manufacturing turnover. The corresponding ratio is around 5 % in Saarland and Rhineland-Palatinate, and just over 7 % in Luxembourg.

[27] Départements of Meuse, Meurthe-et-Moselle, Moselle and Vosges

Figure 40 *Agricultural production intensities per inhabitant, compared to Greater Region average*



Source: INTERREG Greater Region Project AROMA

Table 28 *Proportion of manufacturing turnover general by food processing industries*

	Year	Turnover food processing	Total manufacturing turnover	% of industrial turnover
Luxembourg	2018	985	13,778	7.10 %
Grand Est	2015	13,544	57,632	23.50 %
Wallonia	2019	8,680	44,513	19.50 %
Saarland	2018	1,368	27,927	4.90 %
Rhineland-Palatinate	2016	4,640	92,800	5.00 %

Sources: Luxembourg: Statistical Portal of the Grand Duchy of Luxembourg, Production (P1) par branche (NaceR2) (à prix courants), Grand Est: Ministère de l'agriculture et de l'alimentation (2018), *Wallonia: Fevia Wallonie* (2019), *Saarland: Arbeitskammer des Saarlandes* (2019), *Rhineland-Palatinate: Ministerium für Wirtschaft, Verkehr, Landwirtschaft und Weinbau* (2018)

4.3 Ecological farming

There is an increasing demand for locally produced ecological foodstuffs. When comparing figures on the proportion of ecological farms and of agricultural area used to produce eco-graded foodstuffs, one can observe that Luxembourg ranges at the lower level of the scale together with French regions (Table 29). The highest values can be found in the Province of Luxembourg and in the Saarland.

Table 29 *Ecological production in Luxembourg and neighbouring regions*

		France			Belgium		Germany	
	Luxem-bourg*	Meuse	Moselle	Meurthe-et-Moselle	Province of Luxembourg	Liège	Saarland	Rhine-land-Pala-tinate *
Ecological farms**	148	186	268	252	569	489	237	1 669
% ecological farms	7.91 %	6.00 %	9 %	9 %	24 %	16 %	21 %	10 %
area under organic farming (in ha)	5 782	9 856	19 385	14 270	31 772	19 288	14 400	79 976
% area under organic farming	4.4 %	3.0 %	6.1 %	4.3 %	22.1 %	12.2 %	18.8 %	11.2 %
Areas undergoing conversion (in ha)	654	5 666	4 914	8 805	4 721	3 260	n.d.	n.d.
% Areas undergoing conversion (in ha)	0.5 %	1.7 %	1.6 %	2.7 %	3.3 %	2.1 %	n.d.	n.d.
Total number of farms	1,872	3,100	2,978	2,800	2,346	3,091	1,110	16,850
Total utilised agricultural area (in ha)	131,592	328,370	315,239	328,370	143,953	157,827	76,760	711,900

**2018 data*
*** Including farms of which part of the production only is eco-graded*
Sources: Luxembourg: Landwirtschaftsportal, France: Bio Grand Est, Belgium: Biowallonie (2020), Germany: Ökolandbau, Bundesinformationszentrum Landwirtschaft, Destatis

4.4 Functional area

The functional area for food provision and associated value chains is composed of two components:

- Immediate surrounding areas for local food provision (i.e. Provinces of Luxembourg and Liège, Départements of Meuse, Meurthe-et-Moselle and Moselle, Saarland and Rhineland-Palatinate),
- Neighbouring regions as a whole in terms of trade and organisation of agri-food sector (i.e. Wallonia, Grand-Est, the entire Saarland and Rhineland-Palatinate).

4.5 Mapshot

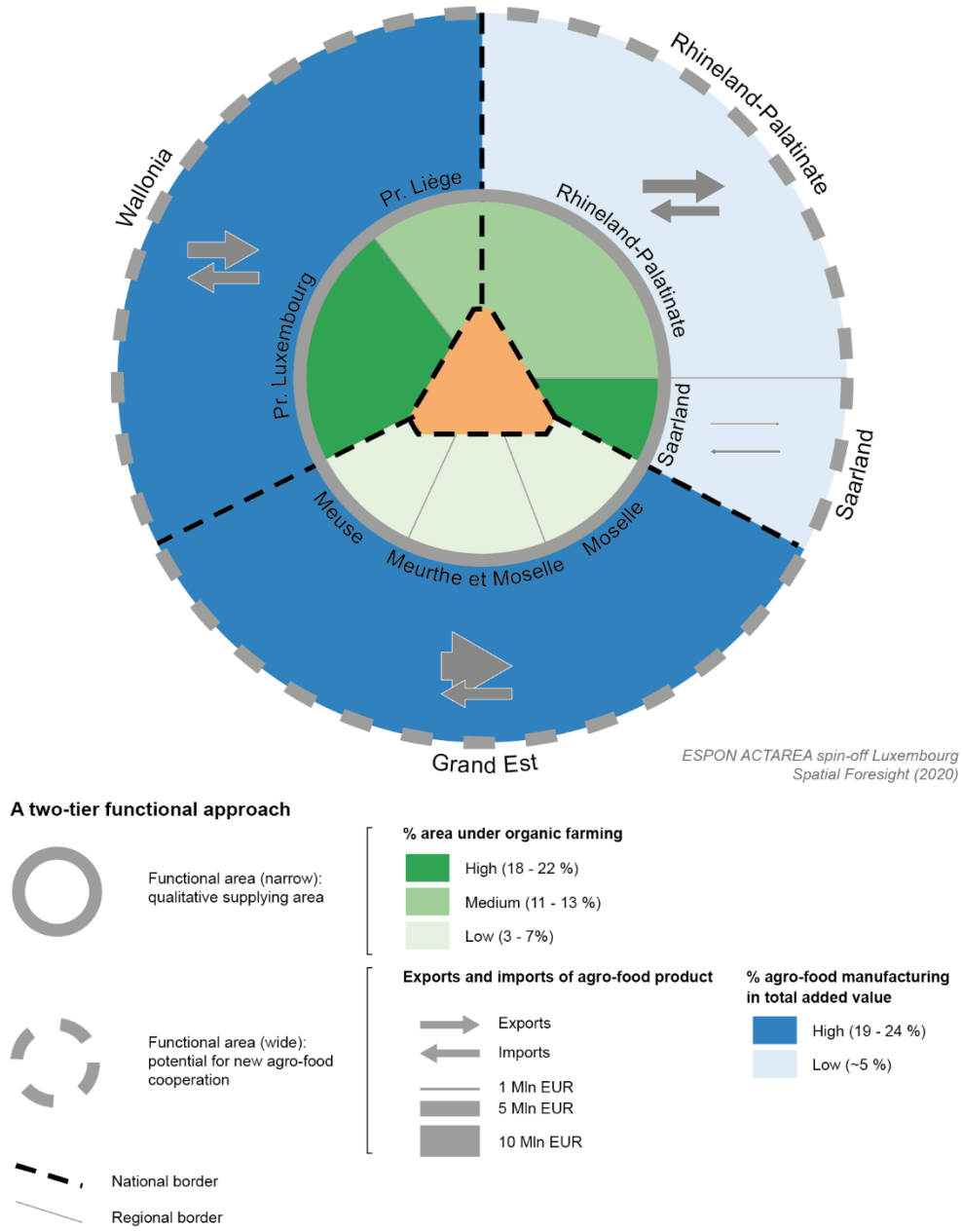
The Mapshot focuses on the following components:

- Relative importance of organic farming in the immediate surroundings, identifying the relative capacity of different neighbouring territories to cater for the demand of such products in Luxembourg.
- Relative importance of food processing within the manufacturing sector in neighbouring regions as a whole (including territories in the immediate surroundings), reflecting different degrees of specialisation in food processing activities.
- Value of food exports and imports in each region, providing information on the export-orientation of each region and its reliance on imports from other countries.

The Mapshot shows that Luxembourg borders two regions with particularly high proportions of ecological farming: Saarland and the Province of Luxembourg. On the other hand, these proportions are particularly low in neighbouring French *Départements*. However, the Grand Est region has the largest food processing industry, both in absolute and relative terms. The Grand Est and Wallonia host a number of major players in this sector, from a European and global perspective. Luxembourg can, therefore, capitalise on these different strengths in neighbouring territories and regions.

Considering the diversity of arrangements within the different categories of agricultural and food processing activity, it has not been possible to elaborate an institutional mapping for this theme. However, the institutional mapping tool could usefully be applied to describe these numerous organisational setups.

Figure 41 *Mapshot – theme "food provision and associated value chains"*



5 Recommendations for soft cross-border territorial cooperation strategy

The report has reviewed development challenges and opportunities for the Luxembourg Cross-border Functional Region within the context of three themes: (1) labour market, housing and transport; (2) energy provision and production; and (3) food provision and associated value chains. This review has first shown that functional areas are specific to each theme. In some instances, multiple functional areas can even be considered for a theme. This is, for example, the case for food provision and associated value chains. For energy, the proposed functional area may evolve as new interconnections and cooperation agreements are established. The borders of the Luxembourg Cross-border Functional Region are thus fuzzy both in time and space.

However, the area of intense in- and out-commuting, as represented in the Mapshot (see Figure 16, p. 22), plays a specific role as the area *in relation to which* reflections on other functional connections and potentials for enhanced cooperation may be organised. It constitutes a meaningful geographical unit both in terms of economic production and living area. As most commuting flows are oriented in direction of workplaces within the Grand Duchy of Luxembourg, and more specifically in and around the City of Luxembourg, the 'polycentricity' of this labour market unit is limited. The first challenge for the cross-border functional region of Luxembourg is to select economic activities whose development could be promoted beyond the borders of the Grand Duchy.

The evidence compiled in the present report provides a number of avenues for reflection and further enquiries in this respect:

- In terms of available human resources, the active population decreases in Saarland and Lorraine [28], but is stable in Rhineland-Palatinate and in the Provinces of Luxembourg and Liège.
- Unemployment is higher in Wallonia and Lorraine than in other neighbouring regions.
- Proportions of electricity production from renewable sources are lowest in Wallonia, Saarland and North Rhine-Westphalia, indicating a potential for further development.
- The Province of Luxembourg and Saarland have a particularly well-developed organic farming sector, which could be mobilised to meet demand for such food products within the Luxembourg Cross-border Functional Region. However, it is possible that opportunities to support a transition towards such forms of production can be identified more easily in Lorraine, where proportions of ecological farming are currently low.

[28] 'Lorraine' in this context designates the three Départements Meuse, Meurthe-et-Moselle and Moselle

- The well-developed food processing industries of Grand Est and Wallonia are important potential strategic partners for the organisation of food value chains around the Luxembourg Cross-border Functional Region.

In this sense, the evidence compiled makes it possible to formulate hypotheses on cooperation perspectives, which are possible starting points for further enquiries. Territorial governance arrangements associated to these multiple cooperation possibilities can be structured around the multiple asymmetric relations between sub-units of the Luxembourg Cross-border Functional Region, e.g. in terms of employment opportunities, income levels, energy and food self-sufficiency, as well as turnover and investment capacity of food processing companies. This presupposes a multi-sectoral approach, as the unequal territorial distribution benefits of cooperation in one field can be compensated by a different territorial distribution of benefits in another field. Imagining governance mechanisms that would make it possible to acknowledge these cross-sectoral win-win solutions is key to a successful and sustainable cooperation. These arrangements will need to be tailored to each bilateral relation, considering the variety profiles of Luxembourg's neighbouring regions.

The Mapshots presented in this report are based on evidence that has been compiled. Other types of Mapshots can be developed, building on stakeholders' perceptions of social and economic dividing lines, existing or potential cooperation axes, structuring infrastructures, relevant central nodes and hubs. On this basis, different representations of the cooperation area may be compared. Dialogues between stakeholders may help to elaborate a shared consensual representation. The Mapshot based on statistical evidence is one input among many others in the elaboration of such a representation, as available data offer an incomplete picture of factors of relevance for the design of a cooperation strategy and joint actions.

Similarly, the institutional mapping presented may be further developed in dialogue with stakeholders, in order to elaborate a relevant and consensual representation of the institutional landscape of cooperation in and around the Luxembourg metropolitan cross-border functional region. Institutional mappings in the field of food provision and associated value chains can be elaborated for each type of food production (e.g. cereals, oil seeds, (organic) vegetables). Their design will also depend on the end products to be focused on (e.g. more or less processed products). While the evidence compiled suggests that short-distance distribution channels for food could provide for the needs of the Luxembourg Cross-border Functional Region, the institutional mechanisms that would establish such distribution as a mainstream solution among farmers and food producers are not yet established. In neighbouring regions with the largest agricultural and food processing sectors, the focus is on global exports. The Luxembourg Cross-border Functional Region could promote complementary local and regional perspectives, enhancing the overall resilience of these industries in the face of uncertain developments on world markets.

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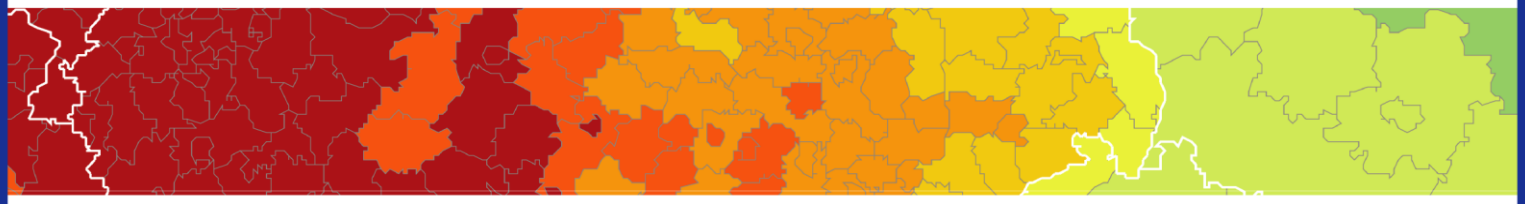

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