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GREEN BOND – METHODOLOGY FOR BANQUE INTERNATIONALE À LUXEMBOURG

SUSTAINABLE FINANCE METHODOLOGY – RESIDENTIAL BUILDINGS IN LUXEMBOURG

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DREES & SOMMER

AGENDA

BANQUE INTERNATIONALE À LUXEMBOURG – SUSTAINABLE FINANCE

EU Taxonomy – eligibility criteria for climate change mitigation – residential assets in Luxembourg

Economic activity	*Screening criteria*	🇱🇺 Single-Family houses[1]		🇱🇺 Multi-Family houses[2]	
7.1 **Construction of new buildings**	**Nearly Zero-Energy Building** Primary energy demand minus 10%	At least 10% lower than the requirements for the primary energy demand of the "Nearly Zero-Energy Building" standard (NZEB). Based on the "Energy Performance of Buildings Directive (EBPD)", the NZEB-standard is implemented in the "Règlement grand-ducal du 9 juin 2021 (RGD 2021)" requirements.			
	Indicative reference values:	Small SFH: (163 m²)	Large SFH: (306 m²)	Small MFH: (1275 m²)	Large MFH: (3060 m²)
		PED ≤ 46.6 kWh/(m²a)	PED ≤ 41.8 kWh/(m²a)	PED ≤ 47.0 kWh/(m²a)	PED ≤ 41.7 kWh/(m²a)
7.2 **Renovation of existing buildings**	**Major Renovation** Cost optimal level	The building renovation complies with the applicable requirements for major renovations as defined in the Energy Performance of Buildings Directive (EBPD), based on the cost-optimal level as defined in "Règlement du 23 juillet 2016".			
	Property Upgrade Relative improvement ≥ 30% in primary energy demand	Relative improvement in primary energy demand ≥ 30% in comparison to the performance of the building before the renovation. Reductions through renewable energy sources are not taken into account.			
7.7 **Acquisition and ownership of buildings**	**Energy Performance Certificate** EPC at least class A	Energy performance class A+ or A Final energy demand: A+ ≤ 22 | A ≤ 41 kWh/(m²a)		Energy performance class A+ or A Final energy demand: A+ ≤ 16 | A ≤ 41 kWh/(m²a)	
		Primary energy demand: < 123 kWh/(m²a)		Primary energy demand: < 71 kWh/(m²a)	
	top 15% of the national existing building stock	Final energy demand: < 107 kWh/(m²a)		Final energy demand: < 62 kWh/(m²a)	
		Primary energy demand: RGD 2016 or better		Primary energy demand: RGD 2019 or better	
		Year of construction: 2017 or newer based on RGD 2016		Year of construction: 2019 or newer based on RGD 2019	

SFH: Single-Family house with 1-2 units | MFH: Multi-Family house with >2 units

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ENERGY & CO2-BENCHMARKS
Luxembourg – Residential buildings

	Ø-Reference values: Energy		Ø-Reference values: CO_2	
Building stock weighted reference benchmarks: End energy: Ø186.5 kWh/(m²a) Primary energy factor: Ø1.147 Primary energy demand: Ø214 kWh/(m²a)	<table><tr><td rowspan="2">Label</td><td colspan="2">End energy demand</td></tr><tr><td>MFH</td><td>SFH</td></tr><tr><td>A+</td><td>≤ 16 kWh/(m²a)</td><td>≤ 22 kWh/(m²a)</td></tr><tr><td>A</td><td>≤ 41 kWh/(m²a)</td><td>≤ 41 kWh/(m²a)</td></tr><tr><td>B</td><td>≤ 71 kWh/(m²a)</td><td>≤ 90 kWh/(m²a)</td></tr><tr><td>C</td><td>≤ 84 kWh/(m²a)</td><td>≤ 123 kWh/(m²a)</td></tr><tr><td>D</td><td>≤ 98 kWh/(m²a)</td><td>≤ 142 kWh/(m²a)</td></tr><tr><td>E</td><td>≤ 154 kWh/(m²a)</td><td>≤ 208 kWh/(m²a)</td></tr><tr><td>F</td><td>≤ 225 kWh/(m²a)</td><td>≤ 295 kWh/(m²a)</td></tr><tr><td>G</td><td>≤ 280 kWh/(m²a)</td><td>≤ 395 kWh/(m²a)</td></tr><tr><td>H</td><td>≤ 355 kWh/(m²a)</td><td>≤ 530 kWh/(m²a)</td></tr><tr><td>I</td><td>> 355 kWh/(m²a)</td><td>> 530 kWh/(m²a)</td></tr></table>		Building stock weighted reference benchmark: CO_2-Intensity: Ø0.273 $kgCO_2$/kWh	Building stock weighted reference benchmark: Carbon emissions 50.9 $kgCO_2$/(m²a)

SFH: Single-Family house with 1-2 units | MFH: Multi-Family house with >2 units

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Energy standards - Nearly-Zero-Energy-Building (NZEB)

Directive 2010/31/EU:

- Implementation of a "Nearly-Zero-Energy-Building" as a standard for all new buildings since 2021, for public authority buildings already since 2019: This standard describes a building that has a very high energy performance. "Near-zero or very low energy demand should be met to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby." (Article 9)

- Calculation of the "cost-optimal level" for energy requirements for new and existing buildings by the member states and comparison with the currently valid minimum requirements.

„Nearly-Zero-Energy-Building" NZEB:

Each member state of the EU is obliged to implement the requirements of the EPBD Directive ("**European Performance of Buildings Directive**") in national law by 2018. This also includes the obligation to define a new energy standard for buildings since 2021, which is defined as **"NZEB = Nearly-Zero-Energy-Buildings"**. In Luxembourg, this was fulfilled by the "**Règlement grand-ducal du 23 juillet 2016 modifiant – RGD 2016**", which introduced the residential **NZEB-standard**. The current energy standard is defined in **RGD 2021**.

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Energy standards – EU-cost optimal level in Luxembourg

Calculation of cost-optimal levels
of minimum energy performance requirements
for new and existing residential and non-resi-
dential buildings

in accordance with Directive 2010/31/EU of 19 May 2010
on the energy performance of buildings (recast)

Luxembourg, May 2019

2018 Update Report

"…the primary energy requirements for new residential buildings in Luxembourg are already considerably below the cost-optimal primary energy requirements."

The calculation of the **cost-optimal level** provides the basis for whether a member state has to tighten the energy standards (energy requirements) or not.

In 2019, Luxembourg published a report on this subject ("**Calculation of cost-optimal levels of minimum energy performance requirements for new and existing residential and non-residential buildings**"), which confirms that the **RGD 2016** as an energy standard does **not need to be tightened** to meet the "cost-optimal level" for residential buildings.

Table 18: Residential buildings – New buildings – Development scenario S1 – Micro- and macroeconomic.

Variante Kennung	Fläche A_n	Energiekennwert Q_{primär}	Globalkosten Mikroökonomisch	Globalkosten Makroökonomisch
-	m²	kWh/(m²a)	€/m²	€/m²
N_A_G9_A2_E2,8%_D3%	163	80,1 (-39,7%)	692	601
N_B_G9_A2_E2,8%_D3%	163	100,9	657	578
N_C_G9_A2_E2,8%_D3%	163	132,9	579	519
N_D_G9_A2_E2,8%_D3%	163	156,3	594	538
N_E_G9_A2_E2,8%_D3%	163	187,9	608	558
N_F_G9_A2_E2,8%_D3%	163	214,7	645	596
N_G_G9_A2_E2,8%_D3%	163	245,2	687	638
N_A_G10_A2_E2,8%_D3%	306	70,1 (-40,4%)	590	514
N_B_G10_A2_E2,8%_D3%	306	88,3	566	497
N_C_G10_A2_E2,8%_D3%	306	117,7	504	452
N_D_G10_A2_E2,8%_D3%	306	138,8	518	469
N_E_G10_A2_E2,8%_D3%	306	167,7	534	490
N_F_G10_A2_E2,8%_D3%	306	193,4	570	527
N_G_G10_A2_E2,8%_D3%	306	221,9	609	567
N_A_G11_A2_E2,8%_D3%	1.275	49,9 (-41,9%)	418	363
N_B_G11_A2_E2,8%_D3%	1.275	61,9	400	352
N_C_G11_A2_E2,8%_D3%	1.275	85,8	345	311
N_D_G11_A2_E2,8%_D3%	1.275	103,7	358	326
N_E_G11_A2_E2,8%_D3%	1.275	125,2	372	344
N_F_G11_A2_E2,8%_D3%	1.275	147,6	404	376
N_G_G11_A2_E2,8%_D3%	1.275	170,4	435	408
N_A_G12_A2_E2,8%_D3%	3.060	45,3 (-41,4%)	372	324
N_B_G12_A2_E2,8%_D3%	3.060	55,2	358	315
N_C_G12_A2_E2,8%_D3%	3.060	77,3	301	272
N_D_G12_A2_E2,8%_D3%	3.060	93,2	312	285
N_E_G12_A2_E2,8%_D3%	3.060	111,9	326	301
N_F_G12_A2_E2,8%_D3%	3.060	132,5	356	332
N_G_G12_A2_E2,8%_D3%	3.060	152,1	382	359

Extract of the Calculation of cost-optimal levels of minimum energy performance requirements 2019

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Energy standards – EU-cost optimal level and NZEB in Luxembourg

Calculation of cost-optimal levels
of minimum energy performance requirements
for new and existing residential and non-resi-
dential buildings

in accordance with Directive 2010/31/EU of 19 May 2010
on the energy performance of buildings (recast)
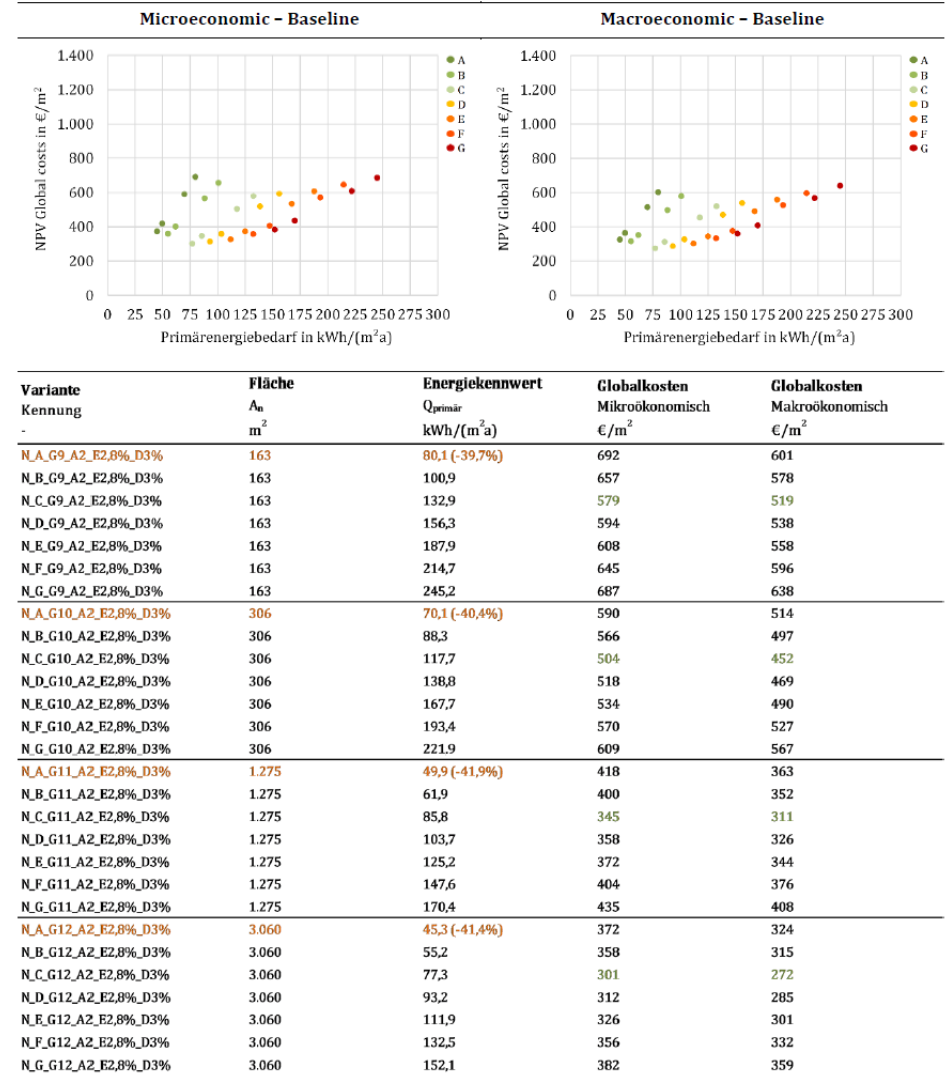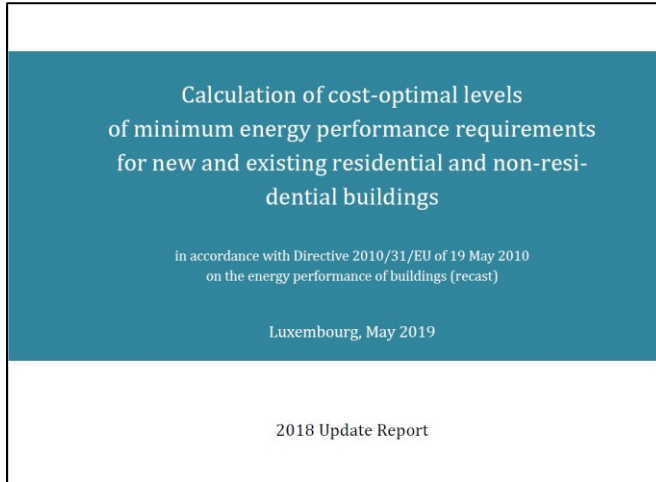
Luxembourg, May 2019

2018 Update Report

"…the primary energy requirements for new residential buildings in Luxembourg are already considerably below the cost-optimal primary energy requirements."

Building type	Compactness (A/Ve)	Total Primary Energy Demand Cost-Optimal level	Requirements RGD 2016 (NZEB)	RGD 2016 below Cost optimal level
SFH	0,77	125 kWh/m²a	46,64 kWh/m²a	63%
	0,62		41,84 kWh/m²a	67%
MFH	0,39	85 kWh/m²a	47,01 kWh/m²a	45%
	0,3		41,70 kWh/m²a	51%

[1] Drees & Sommer figure based on Cost-optimal report Luxembourg 2019

- SFH: Single-Family-House
- MFH: Multi-Family-House

The results for the residential **cost-optimal levels** are shown in the table on the right.

The **cost-optima**l for thermal insulation corresponds with a level C class which is significantly lower than the legally required level A class.

The **cost-optimal** for technical systems is **achieved** when using a **condensing boiler** with fossil fuels. However, to comply with the **NZEB-standard** it is generally necessary to include **renewable energies**.

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SUSTAINABLE FINANCE
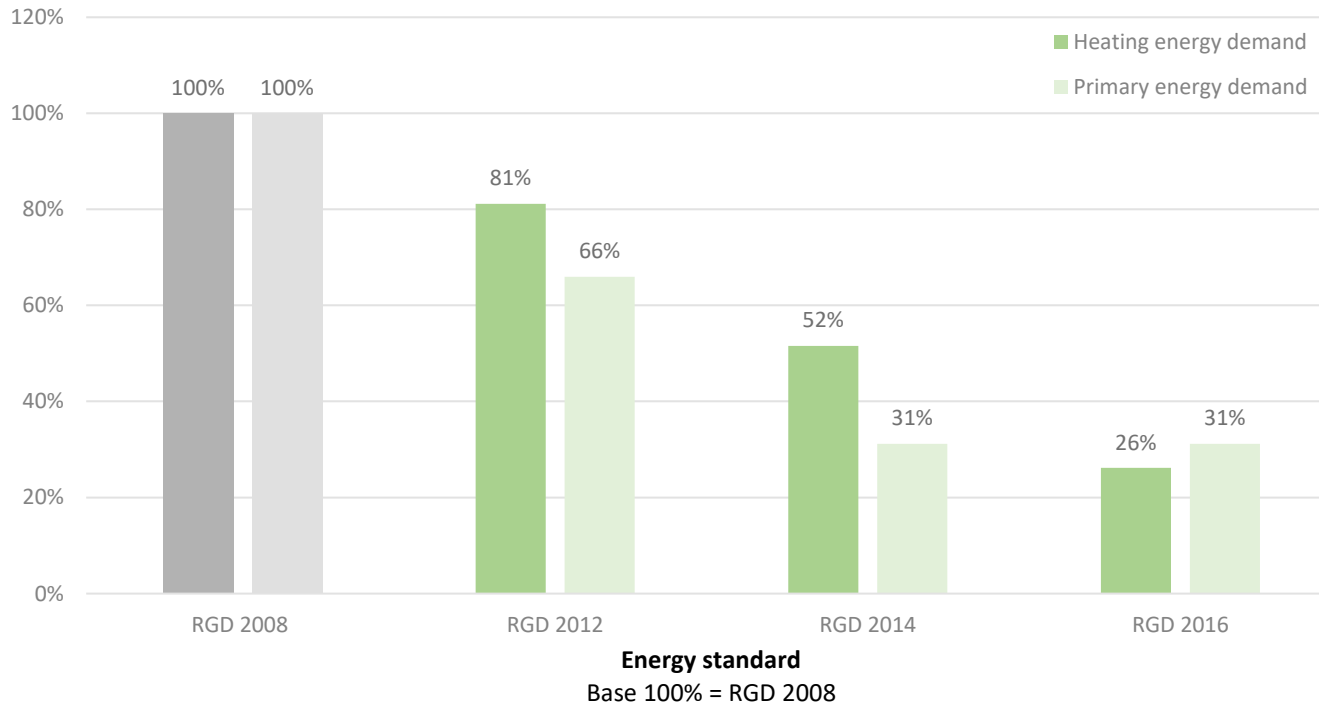## Building energy codes in Luxembourg

- Règlement grand-ducal du 22 novembre 1995 concernant l'isolation thermique des immeubles– **RGD 1995**

- Règlement grand-ducal du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation et modifiant– **RGD 2007**

- Règlement grand-ducal du 19 août 2008 modifiant :
  1. le règlement grand-ducal du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation;
  2. le règlement grand-ducal modifié du 22 novembre 1995 concernant l'isolation thermique des immeubles;
  3. le règlement grand-ducal modifié du 10 février 1999 relatif à l'agrément de personnes physiques ou morales privées ou publiques, autres que l'Etat, pour l'accomplissement de tâches techniques d'étude et de contrôle dans le domaine de l'énergie.– **RGD 2008**

- Règlement grand-ducal du 8 janvier 2010 modifiant le règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation.– **RGD 2010**

- Règlement grand-ducal du 5 mai 2012 modifiant :
  1. le règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation;
  2. le règlement grand-ducal du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels. – **RGD 2012**

- Règlement grand-ducal du 26 mai 2014 modifiant :
  1. le règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation;
  2. le règlement grand-ducal modifié du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels; et
  3. le règlement grand-ducal du 27 février 2010 concernant les installations à gaz. – **RGD 2014**

- Règlement grand-ducal du 23 juillet 2016 modifiant :
  1. le règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation;
  2. le règlement grand-ducal modifié du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels; et
  3. le règlement grand-ducal du 12 décembre 2012 instituant un régime d'aides pour la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables dans le domaine du logement.– **RGD 2016**

- Règlement grand-ducal du 7 mars 2019 modifiant :
  1. le règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation ; et
  2. le règlement grand-ducal modifié du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels. – **RGD 2019**

- Règlement grand-ducal du 9 juin 2021 concernant la performance énergétique des bâtiments. – **RGD 2021**

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SUSTAINABLE FINANCE
Building energy codes – RGD

Energy requirements for new SFH in Luxembourg

Legend: ■ Heating energy demand   ■ Primary energy demand

- RGD 2008: 100%, 100%
- RGD 2012: 81%, 66%
- RGD 2014: 52%, 31%
- RGD 2016: 26%, 31%

Energy standard
Base 100% = RGD 2008

Drees & Sommer figure based on the Règlement grand-ducal

The **heating energy demand** for single-family houses defined in the RGD 2012 is 19% lower than prescribed in the RGD 2008.

The requirement for the heating demand in RGD 2014 is 29% lower than in RGD 2012.

Finally, in the RGD 2016, the heating demand was tightened by 26% compared to RGD 2014.

The **primary energy demand** defined in the RGD 2012 is 34% lower than prescribed in the RGD 2008.
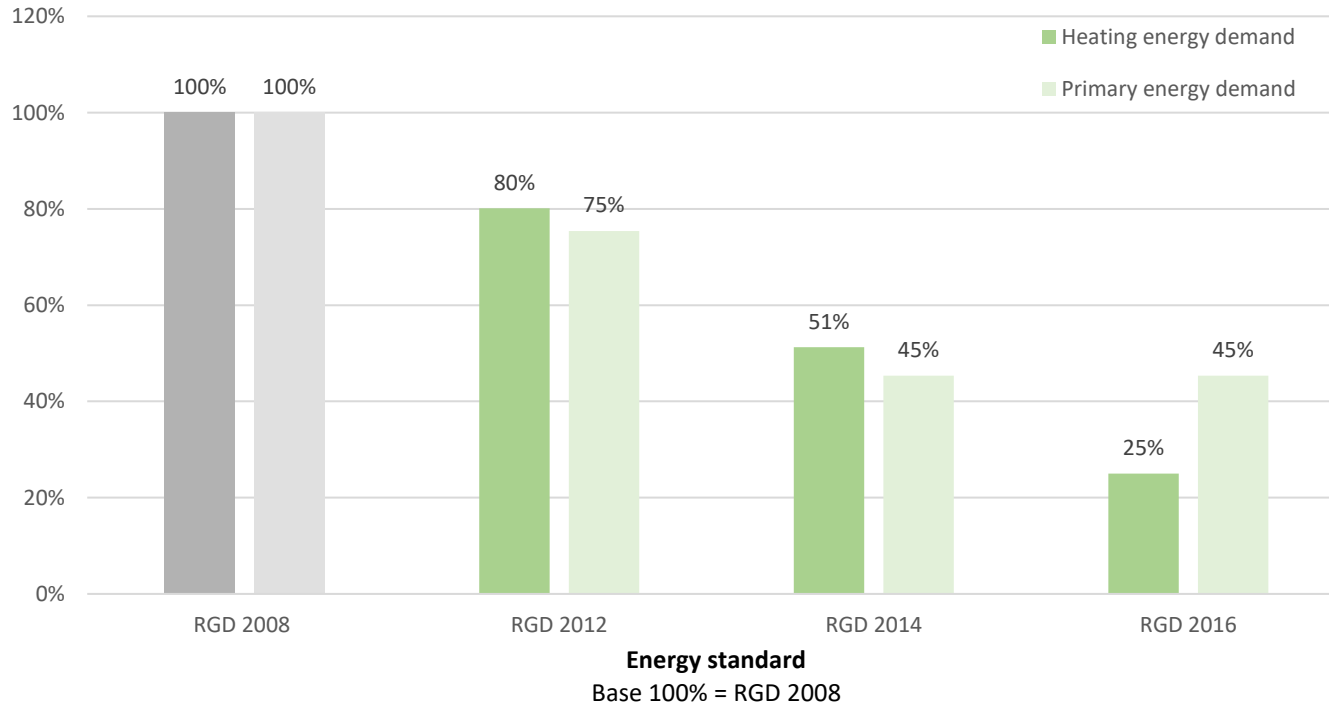
For RGD 2014 and RGD 2016, the primary energy demand requirement is 35% lower than prescribed in RGD 2012.

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SUSTAINABLE FINANCE
Building energy codes – RGD

Energy requirements for new MFH in Luxembourg

■ Heating energy demand
■ Primary energy demand

Energy standard
Base 100% = RGD 2008

Drees & Sommer figure based on the Règlement grand-ducal du 26 mai 2014 modifiant

The **heating energy demand** for multi-family houses defined in the RGD 2012 is 20% lower than prescribed in the RGD 2008.

The requirement for the heating demand in RGD 2014 is 29% lower than in RGD 2012.

Finally, in the RGD 2016, the heating demand was tightened by 26% compared to RGD 2014.

The **primary energy demand** defined in the RGD 2012 is 25% lower than prescribed in the RGD 2008.

For RGD 2014 and RGD 2016, the primary energy demand requirement is 30% lower than prescribed in RGD 2012.

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1. Energy performance & thermal efficiency class

2. General building data (construction year, usable area, …)

3. Annual performance per m² for primary energy demand, thermal insulation and carbon emissions

4. Annual primary energy-, thermal- and carbon performance

5. Information on heating system (distribution, storage, energy carriers) & final heating consumption

6. Information on hot water installations & final energy consumption for hot water

7. Verification after 4 year between real end energy consumption of the building and initial estimated energy consumption

8. Improvement measures to enhance building energy performance

AGENDA

SUSTAINABLE FINANCE
Indication – Residential Building Stock – Luxembourg

"Régistre des certificats de performance énérgétique" gives users the opportunity to provide Energy Performance Certificate (EPC) of their building for a national building database.

Access to the database could not be granted in the scope of this study.

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SUSTAINABLE FINANCE
Residential Building Stock – Single Family House – Luxembourg

	-	RGD 1995	RGD 2007	RGD 2012	RGD 2014	RGD 2016	RGD 2019	RGD 2021
Permits SFM	22,010.50	13,228.50	5,370.00	3,585.00	2,403.00	2,748.00	3,918.50	830.5
Share	41%	24%	10%	7%	4%	5%	7%	2%

Information and data is based on:

- Statistics portal of the Grand-Duchy of Luxembourg "Statistiques.lu"

- The data consists of the approved building permits from 1970 until 2021

Number of buildings, which have undergone an energy efficient retrofit, are not included.

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Residential Building Stock – Multi-Family House – Luxembourg

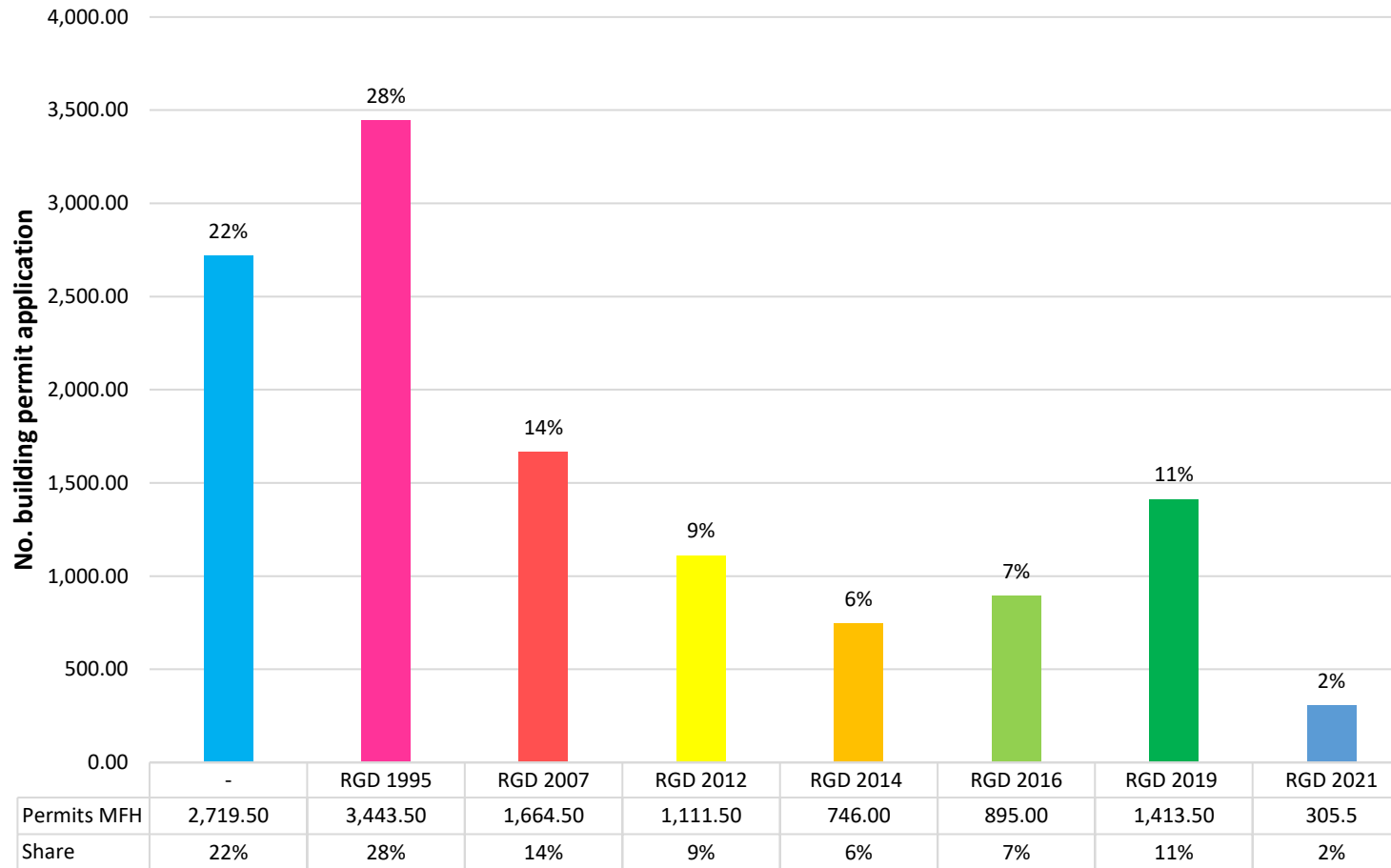|	-	RGD 1995	RGD 2007	RGD 2012	RGD 2014	RGD 2016	RGD 2019	RGD 2021
Permits MFH	2,719.50	3,443.50	1,664.50	1,111.50	746.00	895.00	1,413.50	305.5
Share	22%	28%	14%	9%	6%	7%	11%	2%

Information and data is based on:

- Statistics portal of the Grand-Duchy of Luxembourg "Statistiques.lu"

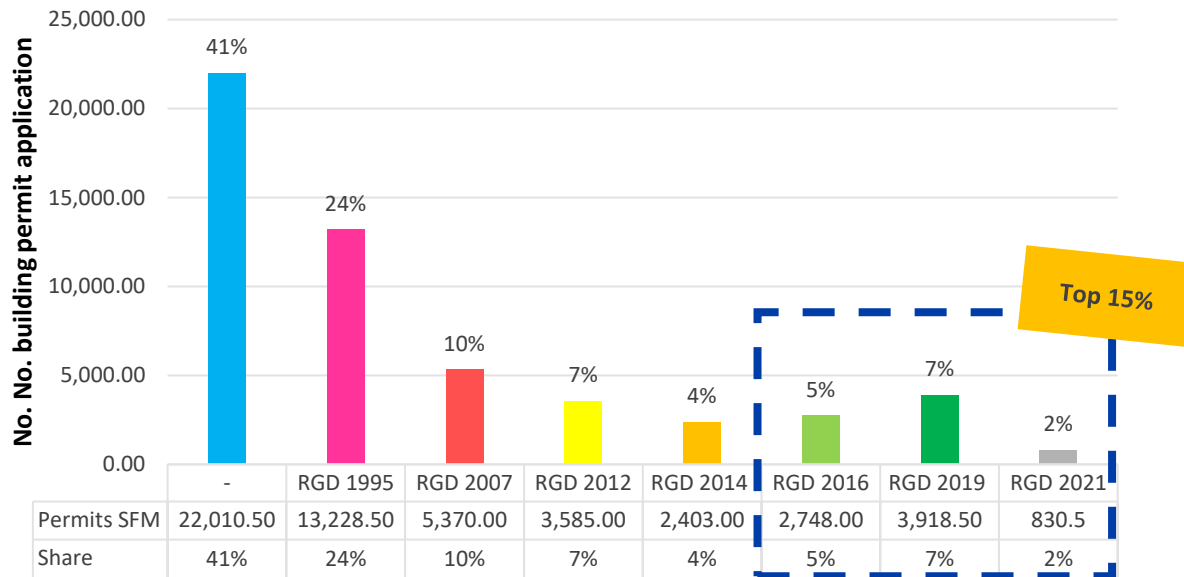- The data consists of the approved building permits from 1970 until 2021

Number of buildings, which have undergone an energy efficient retrofit, are not included.

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SUSTAINABLE FINANCE
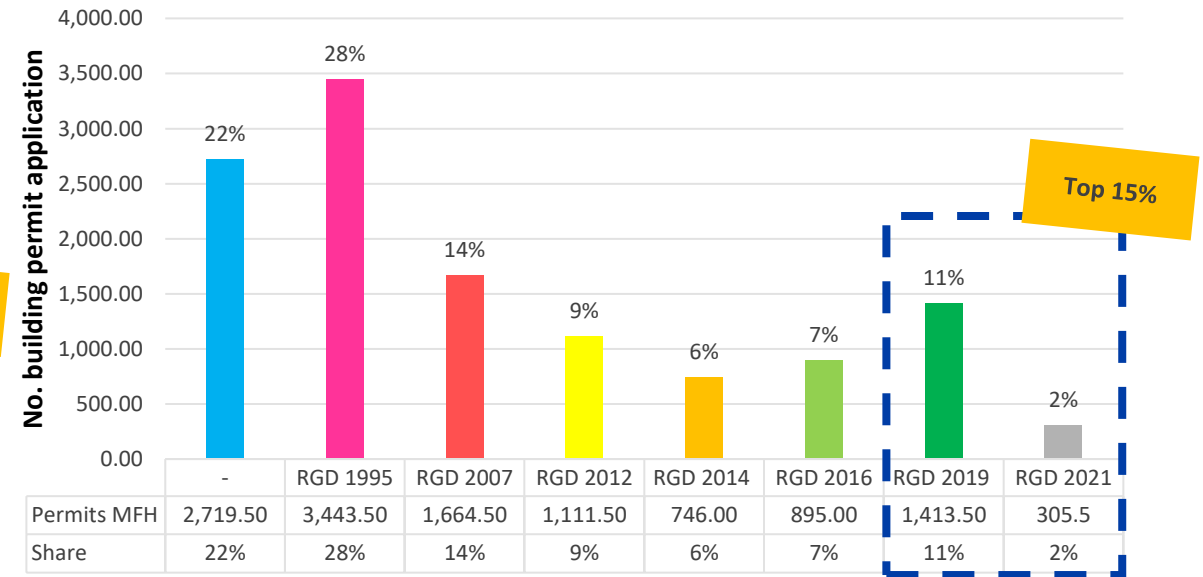## Residential Building Stock – Single & Multi-Family House – Luxembourg

Single Family House

	-	RGD 1995	RGD 2007	RGD 2012	RGD 2014	RGD 2016	RGD 2019	RGD 2021
Permits SFM	22,010.50	13,228.50	5,370.00	3,585.00	2,403.00	2,748.00	3,918.50	830.5
Share	41%	24%	10%	7%	4%	5%	7%	2%

Drees & Sommer figure based on Autorisations de bâtir (Statistiques.lu)

Single Family Houses build according to **RGD 2016** or better represent the **Top 14%** of its local market with a construction year 2017 or newer.

Multi-Family House

	-	RGD 1995	RGD 2007	RGD 2012	RGD 2014	RGD 2016	RGD 2019	RGD 2021
Permits MFH	2,719.50	3,443.50	1,664.50	1,111.50	746.00	895.00	1,413.50	305.5
Share	22%	28%	14%	9%	6%	7%	11%	2%

Drees & Sommer figure based on Autorisations de bâtir (Statistiques.lu)

Multi-Family Houses built according to **RGD 2019** or better represent the **Top 13%** of its local market with a construction year of construction 2019 or newer.

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SUSTAINABLE FINANCE
Luxembourg – primary energy factors (PEF)

Primary energy conversion factor

Category	Value
Oil	1.1
Natural Gas	1.12
LNG (Liqufied Natural Gas)	1.13
Hard Coal	1.08
Lignite	1.21
Renewable Fuels	0.2
Electricity (conventional mix)	1.5
CHP (Combined Heat & Power) with fossil fuels	1.14
District Heting - CHP with fossil fuels	1.29
District Heating - centralised from renewables	0.61
District Heating -centralised from fossil fuels	1.41

- The Primary Energy Factors for the different energy carriers are provided in the national building energy codes (Règlement Grand-Ducal)

- Fuels include fossil fuels (oil, natural gas, LNG, coal and lignite) as well as renewable fuels such as wood

- The energy mix for electricity is given with 1.5

- Next to the direct combustion of fuels, Combined Heat & Power as well a District Heating Heating is used to provide heat for buildings. Depending on the energy sources the factor varies between 1.5 – 0.6.
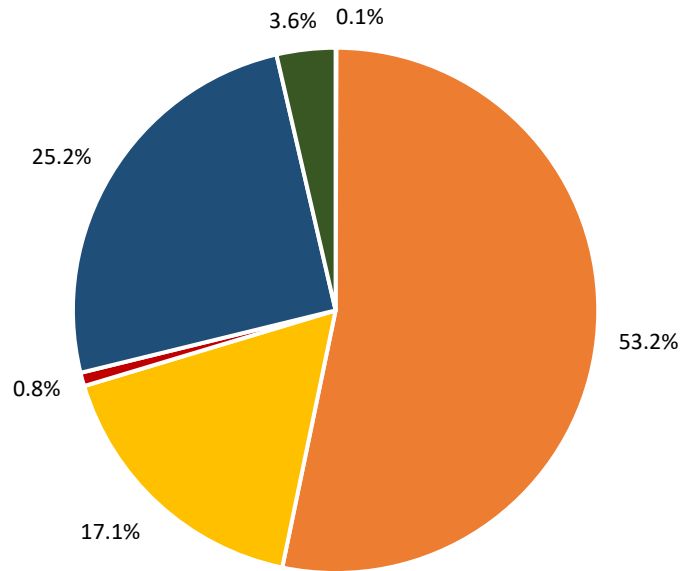
Drees und Sommer figure based on Règlement Grand-Ducal du 9 Juin 2021

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DISTRIBUTED ENERGY CARRIERS
Weighted National Primary Energy Factor

Distributed Energy Carriers - Residential Buildings 2019

Energy Source	Distributed Energy Carriers 2019	Primary Energy Factor	Weighted Primary Energy Factor
Solid Fuels	0.1%	1.1	
Natural Gas	53.2%	1.1	
Electric Energy	17.1%	1.5	**1.147**
Heat	0.8%	1.1	
Oil Products	25.2%	1.1	
Renewable Energies & Energy generated from Waste	3.6%	0.2	

Dreso figures based on „Bilan énerégetique par type de produits – batîments residentiel" (lustat.statec) & RGD 2021

Total Energy Consumption (2020)	5,765 GWh/a	186.5 kWh/(m²a)

Dreso Figures based on EU Building Database

Building weighted national reference benchmark for end energy demand:
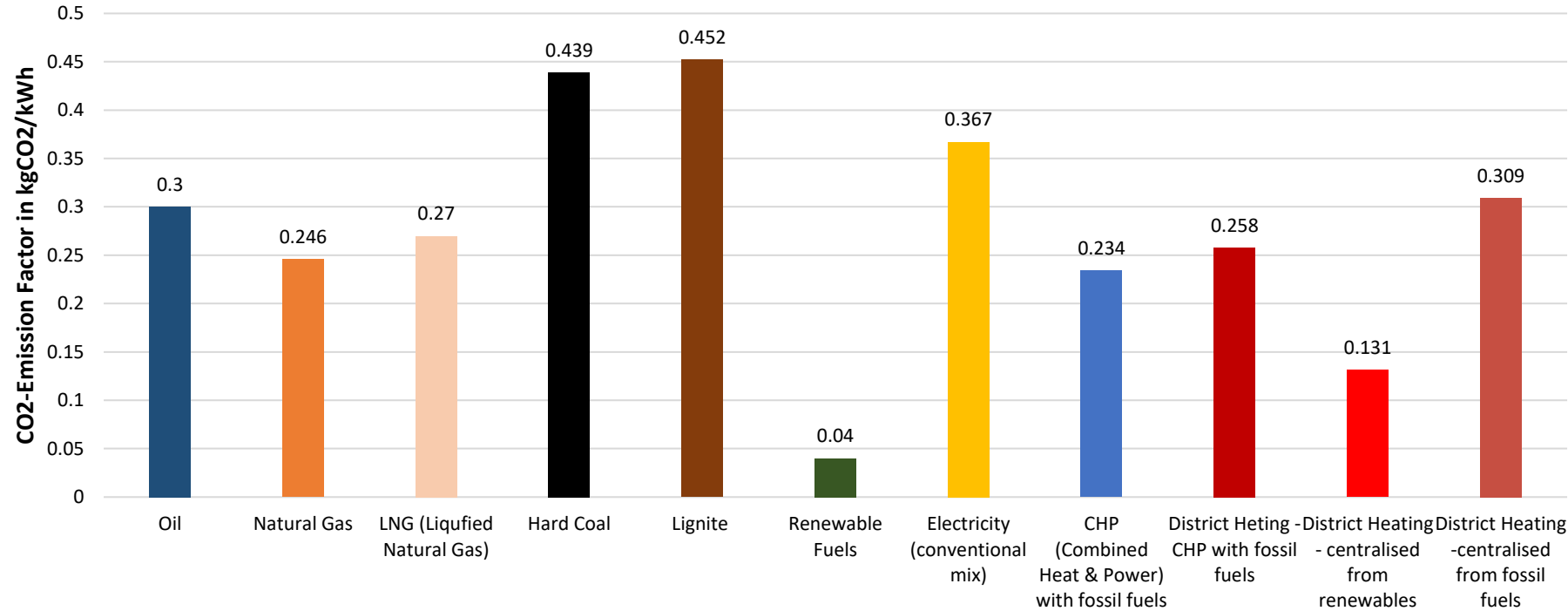- **Ø 186.5 kWh/(m²a)**

Primary energy factor:
- **1.147**

Building weighted national reference benchmark for primary energy demand:
- **Ø 214 kWh/(m²a)**

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SUSTAINABLE FINANCE
Luxembourg – primary energy factors (PEF)

CO2-Emission Factor in kgCO2/kWh

Category	Value
Oil	0.3
Natural Gas	0.246
LNG (Liqufied Natural Gas)	0.27
Hard Coal	0.439
Lignite	0.452
Renewable Fuels	0.04
Electricity (conventional mix)	0.367
CHP (Combined Heat & Power) with fossil fuels	0.234
District Heting - CHP with fossil fuels	0.258
District Heating - centralised from renewables	0.131
District Heating -centralised from fossil fuels	0.309

- The Carbon Factors for the different energy carriers are provided in the national building energy codes (Règlement Grand-Ducal)

- Fuels include fossil fuels (oil, natural gas, LNG, coal and lignite) as well as renewable fuels such as wood

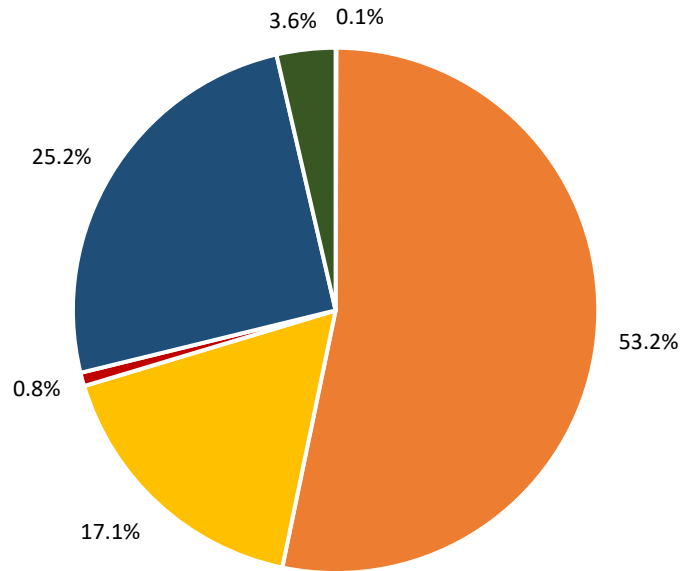- The carbon factor for the electric energy mix is 0.367 kgCO2/kWh

Drees und Sommer figure based on Règlement Grand-Ducal du 9 Juin 2021

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DISTRIBUTED ENERGY CARRIERS

Weighted National Carbon Factor

Distributed Energy Carriers - Residential Buildings 2019

Energy Source	Distributed Energy Carriers 2019	Carbon Emission Factor	Weighted Carbon Intensity
Solid Fuels	0.1%	0.446	
Natural Gas	53.2%	0.246	
Electric Energy	17.1%	0.367	**0.273**
Heat	0.8%	0.233	
Oil Products	25.2%	0.300	
Renewable Energies & Energy generated from Waste	3.6%	0.040	

Dreso figures based on „Bilan énerégetique par type de produits – batîments residentiel" (lustat.statec) & RGD 2021

Total Energy Consumption (2020)	5,765 GWh/a	186.5 kWh/(m²a)

Dreso Figures based on EU Building Database

Building weighted national reference benchmark for end energy demand:
- Ø **186.5 kWh/(m²a)**

CO2-inensity:
- **0.273**

Building weighted national reference benchmark for CO_2-emissions:
- Ø **50.9 kgCO_2/(m²a)**

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ENERGY & CO2-BENCHMARKS
Luxembourg – Residential buildings

Ø-Reference values: Energy		Ø-Reference values: CO_2	
Building stock weighted reference benchmarks: End energy: Ø186.5 kWh/(m²a) Primary energy factor: Ø1.147 Primary energy demand: Ø214 kWh/(m²a)	(see table below)	Building stock weighted reference benchmark: CO_2-Intensity: Ø0.273 kgCO$_2$/kWh	Building stock weighted reference benchmark: Carbon emissions 50.9 kgCO$_2$/(m²a)

Label	End energy demand	
	MFH	SFH
A+	≤ 16 kWh/(m²a)	≤ 22 kWh/(m²a)
A	≤ 41 kWh/(m²a)	≤ 41 kWh/(m²a)
B	≤ 71 kWh/(m²a)	≤ 90 kWh/(m²a)
C	≤ 84 kWh/(m²a)	≤ 123 kWh/(m²a)
D	≤ 98 kWh/(m²a)	≤ 142 kWh/(m²a)
E	≤ 154 kWh/(m²a)	≤ 208 kWh/(m²a)
F	≤ 225 kWh/(m²a)	≤ 295 kWh/(m²a)
G	≤ 280 kWh/(m²a)	≤ 395 kWh/(m²a)
H	≤ 355 kWh/(m²a)	≤ 530 kWh/(m²a)
I	> 355 kWh/(m²a)	> 530 kWh/(m²a)

SFH: Single-Family house with 1-2 units | MFH: Multi-Family house with >2 units

DREES & SOMMER

SUCCESSFUL BUILDINGS

LIVEABLE CITIES

HIGH-YIELD PORTFOLIOS

POWERFUL INFRASTRUCTURE

FUTURE-ORIENTED CONSULTING

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