DIRECTIVE 2012/27/EU (ENERGY EFFICIENCY DIRECTIVE) – ARTICLE 14

POTENTIAL FOR EFFICIENCY IN HEATING AND COOLING

Strategy for district heating and cooling networks supplied by cogeneration, waste heat or renewable energy sources

endorsed by the Walloon Government on 11 March 2021

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General introduction

This report forms part of the implementation of Article 14 of Directive 2012/27/EU on energy efficiency and of Annexes VIII and IX thereto, as amended by Delegated Regulation (EU) 2019/826 of 4 March 2019.

In particular, Article 14(1) of the Directive lays down that Member States must carry out and notify to the Commission a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling, containing the information set out in Annex VIII. An update to that assessment is required every 5 years (first version submitted in December 2015). The following assessment is therefore intended to fulfil the aforementioned requirement under Article 14.

This report contains the results of the 11 chapters of the assessment entrusted to 'Deplasse & Associés – PwC' by SPW-TLPE. The structure of the document is presented below. In order to ensure that this assessment meets the expectations of the Directive as laid down in Annex VIII, each point of that Annex is linked to a corresponding chapter in the assessment.

This document is accompanied by a summary and 14 maps.

Structure of report	Corresponding point under Annex VIII in conjunction with Article 14
Chapter 1: Heating demand and supply	Part I: Overview of heating and cooling, item 1
Chapter 2: Cooling demand and supply	Part I: Overview of heating and cooling, item 1
Chapter 3: Current heating and cooling supply	Part I: Overview of heating and cooling, item 2(a)
Chapter 4: Identification of waste heat sources	Part I: Overview of heating and cooling, item 2(b)
Chapter 5: Renewable energy	Part I: Overview of heating and cooling, item 2(c)
Chapter 6: Heating and cooling demand trends	Part I: Overview of heating and cooling, item 4
Chapter 7: Mapping	Part I: Overview of heating and cooling, item 3
Chapter 8: General description of heating and cooling policy and measures currently in place in Wallonia	Part II: Objectives, strategies and policy measures
Chapter 9: Identification of technology available for providing low-carbon energy in Wallonia	Part III: Analysis of the economic potential for efficiency in heating and cooling, item 7
Chapter 10: Scenario design and financial, economic and sensitivity analysis	Part III: Analysis of the economic potential for efficiency in heating and cooling, item 8
Chapter 11: Proposed measures for Wallonia	Part IV: Potential new strategies and policy measures

To ensure a shared understanding of the terms used in this assessment, definitions are provided in the glossary below.

Glossary

Definitions

- **Sector Agreements:** Agreements whereby a voluntary contract is drawn up between Wallonia and industrial sectors represented by the most energy-intensive businesses through their federation. Under such a contract, those businesses commit to improving their energy efficiency and reducing their CO_2 emissions by a given deadline. This type of agreement guarantees that businesses enjoy financial and administrative benefits (e.g. a share of the cost of an energy audit), enabling them to improve their energy efficiency and thus their competitiveness. It also assures public authorities that significant and objectively measured efforts are being made to reduce energy consumption and CO_2 emissions by industry. We are currently working with the second generation of Sector Agreements (2014-2020).

- **Overall heating need:** All heating needs, irrespective of temperature. This corresponds to the total heating required for industrial processes, heating systems, domestic hot water and cooking. This document uses the term ‘heating need’ to refer to this concept.

- **Substitutable heating need:** Share of the overall heating need corresponding to heating uses catered for by lower-temperature heating (50°C to 250°C[1]). There is potential and solid justification for supplying such heating needs by district heating. Substitutable heating needs exclude high-temperature industrial heating needs and heating needs for cooking purposes, these being difficult to supply by district heating. This document uses the term ‘substitutable heating needs’ to refer to this concept.

- **Overall cooling need:** All cooling needs linked to refrigeration, freezing and air cooling systems (air conditioning, etc.). This document uses the term ‘cooling needs’ to refer to this concept.

- **Substitutable cooling need:** Share of the overall cooling need corresponding to cooling uses which may be supplied by district cooling. In terms of uses and for the purposes of this report, only air conditioning and cooling at positive temperatures are considered substitutable cooling. This document uses the term ‘substitutable cooling needs’ to refer to this concept.

- **CCGT (combined cycle gas turbine):** High-efficiency energy production technology using both a gas and steam turbine. Installations use a gas turbine to generate electricity. They subsequently capture the resulting waste heat, creating steam which, in turn, drives a steam turbine. This greatly increases the power of the system without increasing the amount of fuel.

- **Green certificates:** Support system for environmentally-friendly production. Electricity producers – businesses or individuals – receive green certificates to compensate the cost of producing green energy relative to the electricity price. They may subsequently sell those green certificates on the market or at a fixed price to the electricity transmission system operator. Since 1 May 2019, support activities by the CWaPE related to green electricity have been assigned to the SPW-TLPE, including the management of green certificates and origin guarantee labels.

- **Useful energy (net need):** The amount of energy needed to satisfy the heating and cooling needs of end-users (definition from Annex VIII to Directive 2012/27/EU in conjunction with Article 14). In other words, the quantity of heating or cooling supplied to end-users once all energy conversion and distribution stages in the heating or cooling device are complete.

- **Final energy:** The amount of energy effectively supplied to power heating or cooling devices. It is recorded by a meter at the entrance to the site or building using the energy. Final energy is therefore not the same as primary energy. The difference between final energy and useful energy corresponds to the energy lost during production and distribution of heating and cooling.

[1] The current method for gathering data used to draw up energy balances does not allow 90°C heating needs to be isolated from heating needs below 250°C.

- **Renewable energy:** In line with the definition in Directive (EU) 2018/2001, energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas.

Acronyms

- AEER: L'Alliance Emploi-Environnement recentrée – Plan pluriannuel 2016-2019, 2016 [refocused Employment-Environment Alliance – 2016-2019 multi-year plan, 2016]
- AGW: Arrêté du Gouvernement wallon [Walloon Government Decree]
- HN: Heating need
- SHN: Substitutable heating need
- CN: Cooling need
- SCN: Substitutable cooling need
- CoDT: Code du développement territorial [Regional Development Code]
- COMPIL-SER: Compilation des ressources d'énergie renouvelables [compilation of renewable energy sources]
- CPAS: Centres publics d'action sociale [public social welfare centres]
- EPC: Energy performance contract
- H-RES Heating produced from renewable energy sources
- CWaPE : Commission wallonne pour l'énergie [Walloon Energy Commission]
- CWHD: Code wallon de l'habitat durable [Walloon Sustainable Homes Code]
- GHG: Greenhouse gas
- WG: Walloon Government
- LGO: Label de garantie d'origine [origin guarantee label]
- PACE 2016-2022: Plan Air Climat Energie 2016-2022 [Air-Climate-Energy Plan 2016-2022]
- PEB: Performance énergétique des bâtiments [energy performance of buildings]
- PLCP: Plan wallon de Lutte contre la Pauvreté, 2018 [Walloon anti-poverty plan, 2018]
- PM4: Plan Marshall 4.0, 2015 [Marshall Plan 4.0, 2015]
- WP: Walloon Parliament
- PWEC 2030: Wallonia's contribution to the 2030 National Energy Climate Plan, 2019
- SDD: 2ème Stratégie de Développement Durable, 2016 [2nd Sustainable Development Strategy, 2016]
- RES Renewable energy source
- SPW: Service Public de Wallonie [Public Service of Wallonia]
- SLSP: société de logement de service public [public service housing association]
- SWR: Stratégie wallonne de rénovation énergétique à long terme du bâtiment, 2017 [Walloon strategy for the long-term energy improvement of buildings, 2017]
- VAACN: Annualised and updated value of net costs

Chapter 1: Heating demand and supply

I. Heating demand and supply

I.1. *Recap of Annex VIII*

Point 1 of Part I of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling requires the following:

> A presentation of heating and cooling demand expressed as useful energy and useful energy consumption in GWh by year and sector:
>
> a. Residential
> b. Services
> c. Industry
> d. Any other sector that individually consumes more than 5% of national useful heating and cooling demand.

Belgium's analysis of point d was performed by region (Wallonia, Brussels and Flanders).

I.2. *Introduction*

Information to determine Wallonia's heating needs was sourced from the 2016 official energy balance[2], published in 2019 by SPW-Énergie. At the time work started, this was the most recent energy balance. The balance contains statistics on energy consumption used for international reporting, in particular reporting requested by the European Union.

The reporting methods used to draw up those energy balances are not described in this report. They are, however, covered in reports available from SPW-Énergie.

For the purposes of this analysis, a distinction is made between heating needs and substitutable heating needs. Both terms are defined in the glossary.

Heating needs and substitutable heating needs are analysed for each sector of Wallonia's energy landscape (residential, services and industry). Consumption in agriculture and transport are excluded from the analysis. Agriculture represented less than 1% of energy consumption in Wallonia in 2016. Consequently, the share of such energy for heating and cooling purposes is negligible for the analysis. Heating and cooling needs are not applicable to transport. 37 575 GWh or nearly 30% of Wallonia's final energy consumption balance is therefore excluded from the analysis. In the case of industry, only energy consumption is covered, i.e. 39 674 GWh out of 44 539 GWh. Non-energy consumption refers to the use of fuel to manufacture products, such as natural gas used to make fertilisers.

For the purposes of this analysis, a distinction is also made between heating needs expressed as final energy and useful energy. Both terms are defined in the glossary.

I.3. *Overall results*

A summary of final energy heating needs is presented in the table below, with the details for each sector presented in the paragraphs thereafter. In 2016, energy consumption in the residential, service and industrial

[2] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019)

sectors was 83 137 GWh, equating to 66.1% of overall consumption in Wallonia (125 772 GWh). The column 'Substitutable heating needs' corresponds to the total for heating, supplementary heating and domestic hot water (indicated with a '(1)' in the table). The breakdown of heating needs between the different uses indicated in the table follows the breakdown in the 2016 energy balance[3].

Sectors (2016, GWh)	Process heat (high temp.)	Heating (1)	Supplementary heating (1)	Domestic hot water (1)	Cooking purposes	Heating needs		Substitutable heating needs (∑1)		Other uses (excluding heating)	Total energy consumption
						Total	Share of total	Total	Share of total		
Residential	-	19 148.6	2 782.3	3 759.5	817.2	26 507.5	87.1%	25 690.4	84.4%	3 935.0	**30 442.5**
Services	-	6 261.6	-	718.7	5.5	6 985.8	53.6%	6 980.3	53.6%	6 034.9	**13 020.7**
Industry	18 085.2	11 639.3	-	-	-	29 724.5	74.9%	11 639.3	29.3%	9 949.5	**39 674.0**
Total	**18 085.2**	**37 049.5**	**2 782.3**	**4 478.2**	**822.7**	**63 217.9**	**76.1%**	**44 310**	**53.3%**	**19 919.3**	**83 137.2**

Table 1: Summary of heating needs in Wallonia by use and by sector in 2016 (GWh)

For these three sectors, heating needs (63 218 GWh) represent 76.1% of their total energy consumption, demonstrating the importance of those needs to the energy balance. More than half (53.3%) of energy consumption in the three sectors corresponds to substitutable heating needs, i.e. a total of 44 310 GWh. The primary contributor to the total are residential sector needs (25 690 GWh, 58%), followed by industry (11 639 GWh, 26%) and finally services (6 980 GWh, 16%).

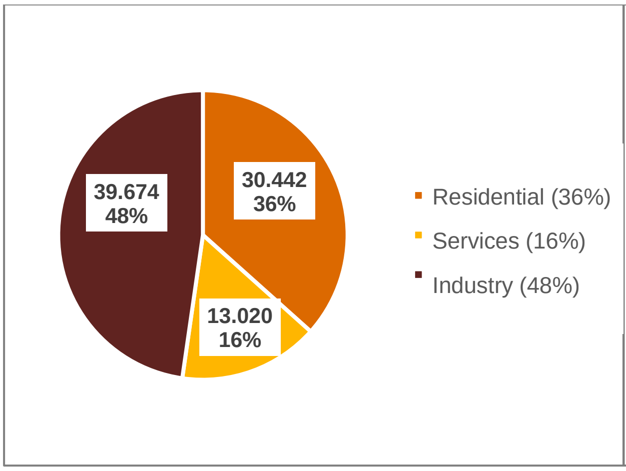

Figure 1: Breakdown of final energy consumption by sector in 2016 (GWh)

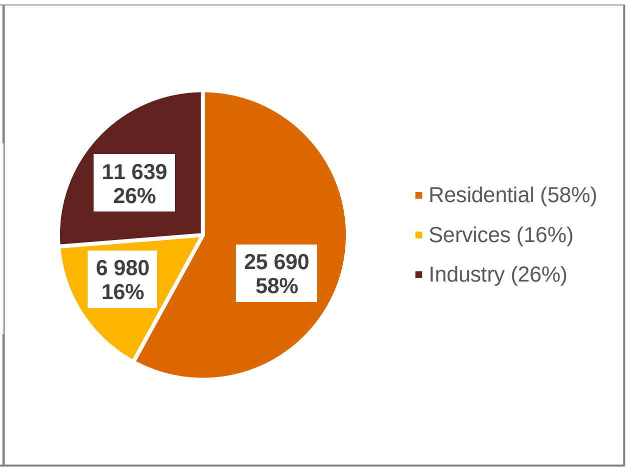

Figure 2: Breakdown of substitutable heating needs by sector in 2016 (GWh)

[3] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 10

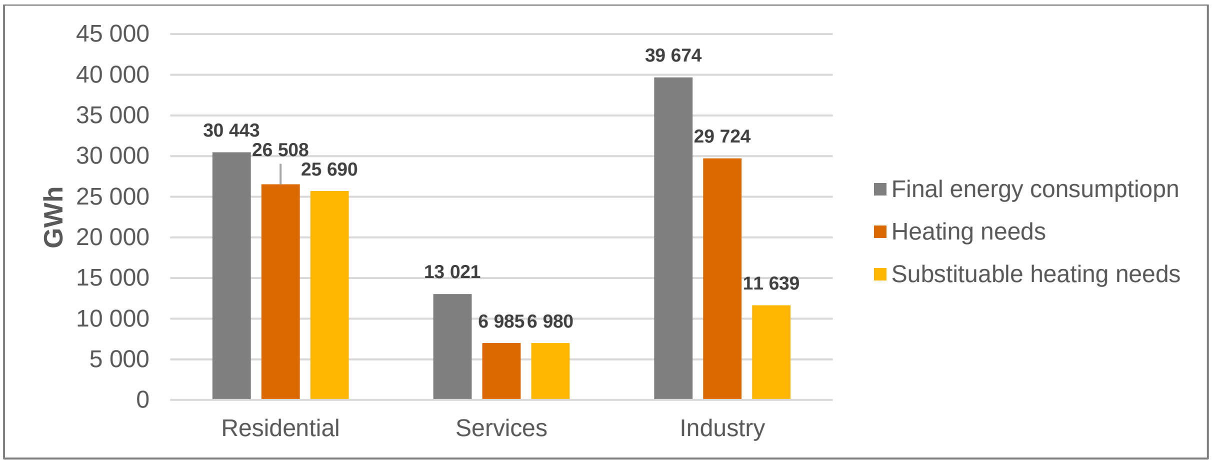

Figure 3: Presentation of final energy consumption, heating needs and substitutable heating needs by sector in 2016 (GWh)

Figure 1 above shows the share of final energy consumption represented by each sector (residential, service and industry) from a cumulation of all three sectors. Figure 2 shows the share of all substitutable heating needs accounted for by those three sectors.

Although industry accounts for almost half (48%) of energy consumption, its heating needs which district heating or cogeneration are able to supply represent only a quarter of all substitutable heating needs. By contrast, the residential sector, which represents 36% of final energy consumption, accounts for 58% of substitutable heating needs, making it by far the sector with the greatest substitution potential. Almost 97% of heating needs in the residential sector are substitutable needs.

I.4. *Heating needs in the residential sector: final energy*

I.4.1. *Sources and methodology*

SPW-Énergie's regional energy balance is the information source regarding final energy consumption by vector for all uses in the residential sector in 2016[4]. The data from the energy balance is reproduced in this assessment without any processing.

Energy consumed in the residential sector is broken down into the following uses:

- Primary heating system, which can be central (a heat production and distribution system in the rooms of a dwelling or electric convection heaters) or decentralised (independent convection heaters, wood burners or inserts in the rooms of a dwelling)
- Supplementary heating system (additional heating with a time-limited heating capacity)
- Production of domestic hot water
- Cooking
- Other electricity uses (lighting, fridges, freezers, washing machines/tumble dryers, etc.).

Heating needs consist of primary heating, supplementary heating, domestic hot water and cooking. Substitutable heating needs, which can be covered by an external supply linked to a district heating network or cogeneration, do not include cooking.

The energy vectors which supply the heating needs are presented for each use, namely: domestic fuel oil, natural gas, coal, butane-propane, wood, steam/cogeneration, geothermal (deep or shallow), heat pumps, solar thermal and electricity (all sources combined).

[4] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 13.

I.4.2. *Results*

According to the explanation of the methodology provided above and the data from 2016, total energy consumption in the residential sector was 30 442 GWh, while heating needs amounted to 26 507 GWh or 87% of all energy needs.

Potential substitutable heating needs reached 25 690 GWh in 2016 or 84% of total consumption in the sector and accounted for almost 97% of the sector's heating needs. 25 690 GWh is therefore the maximum theoretical substitutable potential of the residential sector in Wallonia.

Details of the heating needs by energy vector and use can be found in Table 2.

Figure 5 below presents a breakdown of the energy vectors covering energy needs and Figure 4 presents a breakdown of energy uses. In the residential sector, heating systems (primary and supplementary) account for more than 80% of heating needs. The main energy vectors are domestic fuel oil and natural gas, which cover 39.9% and 33.9% respectively of the sector's heating needs. Fossil fuels (domestic fuel oil, natural gas, coal, butane/propane) cover more than 75% of the sector's heating needs.

Type of housing	Use	Domestic fuel oil	Natural gas	Coal	Butane/propane	Wood	Cogen. steam	Geothermal	Heat pumps	Solar thermal	Electricity	Total
All housing	Cooking	-	174.7	0.4	74.5	5.6	-	-	-	-	562.0	817.2
All housing	Domestic hot water	983.3	1 351.2	0.7	271.9	33.1	1.7	-	69.1	85.6	962.9	3 759.5
Heating needs – Total excluding heating systems		983.3	1 525.9	11.1	346.3	2 365.6	1.7	-	69.1	85.6	1 524.9	4 576.7
All housing	Supplementary heating	-	-	10.0	-	2 326.9	-	-	-	-	445.3	2 782.3
Apartments – primary heating	Central heating	567.4	1 153.1	0.5	6.9	3.7	3.5	2.2	29.7	-	90.6	1 857.7
Apartments – primary heating	Decentr. heating	3.7	84.7	8.1	6.7	8.3	-	-	-	-	63.8	175.3
Single-family homes – primary heating	Central heating	8 552.1	5 682.8	10.2	163.1	405.0	0.5	0.3	185.3	-	325.0	15 324.3
Single-family homes – primary heating	Decentr. heating	481.0	551.1	204.2	19.3	321.0	-	-	-	-	214.8	1 791.3
Heating needs – total heating		9 604.2	7 471.6	233.1	195.9	3 064.9	4.0	2.6	215.1	-	1 139.6	21 930.9
Energy needs – excluding heating		-	-	-	-	-	-	-	-	-	3 935.0	3 935.0
Total energy consumption		**10 587.5**	**8 997.5**	**234.2**	**542.3**	**3 103.5**	**5.7**	**2.6**	**284.2**	**85.6**	**6 599.5**	**30 442.5**
Share of energy needs covered by vector		**35%**	**29%**	**1%**	**2%**	**10%**	**0%**	**0%**	**1%**	**0%**	**22%**	**100%**
Heating needs	Total	10 587.5	8 997.5	234.2	542.3	3 103.5	5.7	2.6	284.2	85.6	2 664.5	26 507.5
	As share of total	100%	100%	100%	100%	100%	100%	100%	100%	100%	40%	87%
Substitutable heating needs	Total	10 587.5	8 822.8	233.8	467.8	3 097.9	5.7	2.6	284.2	85.6	2 102.5	25 690.4
	As share of total	100%	98%	100%	86%	100%	100%	100%	100%	100%	32%	84%

Table 2: Breakdown of final energy consumption in the residential sector by vector and use in 2016 (GWh)

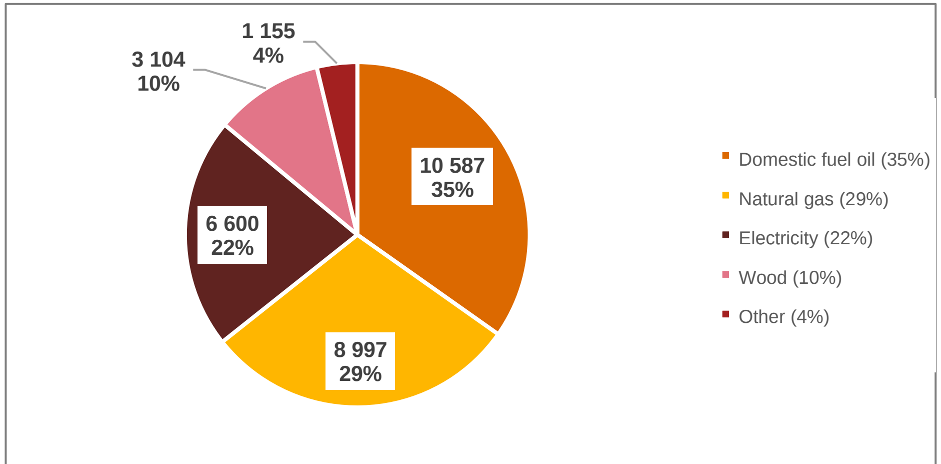

Figure 5: Breakdown of energy vectors covering energy needs in the residential sector in 2016 (GWh)

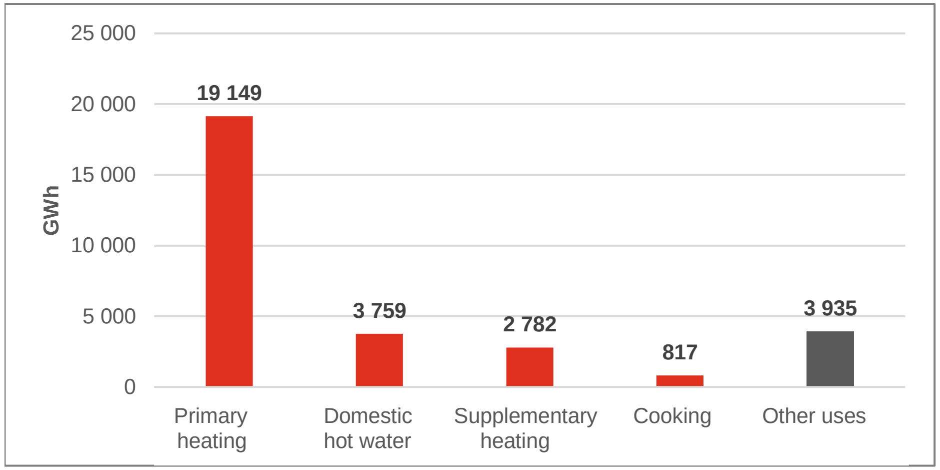

Figure 4: Breakdown of energy needs by use in the residential sector in 2016 (GWh)

I.5. *Heating needs in the residential sector: useful energy*

I.5.1. *Sources and methodology*

As data on energy consumption is expressed as final energy in the 2016 energy balance, the aim is to estimate losses related to the heating production and distribution process. This relationship is expressed by the following formula:

Final energy = Useful energy + Energy losses related to process

The energy efficiency of a device corresponds to the relationship between the final energy provided and the useful energy supplied to the end user, this relationship being expressed by the following formulae:

Energy efficiency of device = Useful energy/Final energy
Useful energy = Final energy * Energy efficiency of device

The methodology chosen to estimate heating needs in the residential sector expressed as useful energy is based on energy vectors and comprises the following four steps:

Identifying the primary uses of each vector

Wallonia's 2016 energy balance[5] presented a breakdown of energy vectors between different uses. As a consequence, it was easy to identify the primary uses of the different vectors. Once the primary uses for each vector had been identified, all energy supplied by a vector was broken down pro-rata between those uses on the basis of their initial breakdown. In so doing, the aim was for all final energy in the sector to be broken down between those primary uses, enabling an energy efficiency value to be applied to all final energy. In most cases, the primary uses identified cover more than 85% of the energy supplied by the vector.

Identifying reference technologies for those primary uses

One or more reference technologies was associated with each of the primary uses identified.

Estimating the breakdown for those technologies

For a given energy vector, where several reference technologies were associated with a single use, the energy consumption for that use was broken down between those technologies on the basis of their distribution on the market[6].

Estimating the energy efficiency of those technologies

An energy efficiency value[7] was associated with each reference technology. These are instantaneous efficiency values (net heat).

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[5] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 13.

[6] The market distribution was obtained primarily from the following documents and bodies: *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), *Compilation des données sur les installations produisant de l'électricité et/ou de la chaleur à partir de sources renouvelables d'énergie et les cogénérations aux énergies fossiles* (ICEDD, 2018), Valbiom, Energie+.

[7] Energy efficiency values were obtained primarily from the following documents: *Stratégie wallonne de rénovation énergétique à long terme du bâtiment* (SPW, 2017); Chapter 4 (building analysis) of the *Guide de la rénovation énergétique et durable des logements de Wallonie* (SPW, 2014); *Enquête sur la qualité de l'habitat en Wallonie – Résultats clés* (CEHD, 2014).

I.5.2.Results

Heating needs in the residential sector expressed as useful energy amount to 21 973 GWh. The average energy efficiency of the sector is therefore 83.5%.

Energy vectors in the residential sector covering heating needs	Final energy (GWh)	Primary use	Primary use as share of vector	Breakdown of vector between primary uses (%)	Final consumption/use (GWh)	Main technologies	Breakdown of technology in associated primary use	Breakdown of final consumption (GWh)	Efficiency	Useful energy (GWh)
Domestic fuel oil	**10 587.5**	Central heating	86.1%	100%	10 587.5	Domestic oil-fired condensing boiler	15.0%	1 588.1	90%	**1 429.3**
						Oil-fired boiler (>15 years)	85.0%	8 999.4	82%	**7 379.5**
Natural gas	**8 997.5**	Central heating	76.0%	83.5%	7 512.5	Gas-fired condensing boiler	25.1%	1 885.6	90%	**1 697.1**
						Traditional boiler	74.9%	5 623.1	85%	**4 779.9**
		Domestic hot water	15.0%	16.5%	1 485.0	Gas water-heater	100%	1 485.0	85%	**1 262.2**
Coal	**234.2**	Decentralised heating	90.7%	100%	234.2	Coal burner	100%	234.2	74%	**173.3**
Butane/propane	**542.3**	Domestic hot water	50.1%	52.7%	285.6	Gas water-heater	100%	285.6	90%	**257.0**
		Central heating	31.3%	32.9%	178.5	Gas-fired condensing boiler	100%	178.5	90%	**160.6**
		Cooking	13.7%	14.4%	78.2	Gas cooker	100%	78.2	58%	**45.4**
Wood	**3 103.5**	Supplementary heating	78.2%	78.2 %	2 427.0	Open fire (wood)	4.0%	97.1	12%	**11.6**
						Wood burner (>10 years)	29.0%	703.8	35%	**246.3**
						Wood burner (recent)	25.0%	606.7	70%	**424.7**
						Pellet burner	42.0%	1 019.3	87%	**886.8**
		Primary heating	21.8%	21.8%	676.6	Log boiler	90.0%	608.9	80%	**487.1**
						Pellet boiler	8.3%	56.1	80%	**44.9**
						Wood chip boiler	1.7%	11.5	80%	**9.2**
Cogen. steam	**5.7**	Central heating	70.4%	100%	5.7	District heating gas cogen.	40.0%	2.3	55%	**1.2**
						District heating solid biomass	60.0%	3.4	75%	**2.6**
Geothermal	**2.6**	Central heating	100%	100%	2.6	Deep geothermal	100%	2.6	100%	**2.6**
Heat pumps	**93.6**	Central heating	71.8%	71.8%	67.2	Heat pump heating system	100%	67.2	320%	**215.1**
		Domestic hot water	28.2%	28.2%	26.4	Heat pump domestic hot water	100%	26.4	250%	**66.0**
Solar thermal	**85.6**	Domestic hot water	100%	100%	85.6	Solar water heater	100%	85.6	100%	**85.6**
Electricity	**2 664.5**	Domestic hot water	36.1%	48.9%	1 302.2	Electric boiler	100%	1 302.2	87%	**1 132.9**
		Cooking	21.1%	28.5%	760.1	Electric cooker	100%	760.1	75%	**570.1**
		Supplementary heating	16.7%	22.6%	602.3	Electric resistance heating	100%	602.3	100%	**602.3**
Total final energy consumption for heating needs	**26 317.0**				**26 317.0**		**Total useful energy needs required to cover heating needs**			**21 973.3**

Table 3: Presentation of the methodology for converting final energy into useful energy for the residential sector (2016)

I.6. *Heating needs in the service sector: final energy*

I.6.1. *Sources and methodology*

SPW-Énergie's regional energy balances are the information source regarding consumption by energy vector, sub-sector and use in the service sector in 2016[8]. Due to a reporting problem in the detailed data for this document, the data presented in this section has been estimated on the basis of figures for 2017[9]. For each sub-sector of the service sector, the share of energy consumption accounted for by each use was identified. Those ratios were then applied to the energy consumption of each sub-sector in 2016 in order to establish the breakdown by use in GWh.

Energy consumed in the service sector is broken down into the following uses:

- Heating
- Production of domestic hot water
- Cooking
- Other uses (air conditioning, electronic office equipment, lighting, etc.).

Heating needs consist of heating, domestic hot water and cooking. Substitutable heating needs, which can be covered by an external supply linked to a district heating network or cogeneration, do not include cooking. Needs associated with semi-industrial processes occurring in the service sector (laundry, sterilisation, etc.) have not been taken into account in this analysis due to a lack of sufficiently representative data for the sector. It is therefore highly likely that needs have been slightly underestimated.

The energy balance also presents a breakdown of the vectors covering all energy needs, i.e. petroleum products, natural gas, electricity and others. The details of the energy balance also provide a breakdown of energy needs by sub-sector of the service sector, namely trade, transport and communication, banking/insurance/business services, education, health, culture and sport, other services, administration, other.

I.6.2. *Results*

According to the explanation of the methodology provided above and the data from 2016, energy consumption in the service sector was 13 021 GWh, while heating needs amounted to 6 986 GWh or 53.7% of all energy needs.

Substitutable heating needs reached 6 980 GWh in 2016 or 53.6% of total consumption in the sector and accounted for nearly all (99.9%) heating needs. 6 980 GWh is therefore the maximum substitutable potential of the service sector in Wallonia.

Details of the heating needs by use and sub-sector can be found in Table 4. Figure 7 below presents a breakdown of the energy vectors covering energy needs and Figure 6 presents a breakdown of energy uses. In the service sector, heating systems account for almost 90% of heating needs. The 'trade' sub-sector notably claims more than 40% of the heating needs of the service sector. The main energy vectors are electricity (46%), natural gas (35%) and petroleum products (17%). The column 'Substitutable heating needs' corresponds to the total for heating systems and domestic hot water (indicated with a '(1)' in the table). The breakdown of heating needs between the different uses indicated in the table follows the breakdown in the 2016 energy balance[10].

Service sector (2016, GWh)	Total heating (1)	Domestic hot water (1)	Cooking	Heating need		Substitutable heating needs (∑1)		Other uses (excluding heating)	Total energy consumption
				Total	Share of total	Total	Share of total		
Trade	2 563.1	243.4	5.5	2 812.1	55.8%	2 806.6	55.7%	2 230.3	**5 042.3**

[8] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 15-16.
[9] *Inventaire Réseaux de chaleur et de froid 2017*, (ICEDD, 2020)
[10] Ibid.

Transport and communication	218.8	24.2	-	243.0	45.0%	243.0	45.0%	297.2	**540.2**
Banking, insurance and business services	246.3	20.8	-	267.0	23.7%	267.0	23.7%	857.6	**1 124.6**
Education	1 103.8	57.3	-	1 161.1	77.0%	1 161.1	77.0%	346.2	**1 507.3**
Health	621.7	218.1	-	839.8	56.2%	839.8	56.2%	655.8	**1 495.6**
Culture, sport	361.1	40.9	-	402.0	61.5%	402.0	61.5%	251.9	**653.9**
Other services	445.6	51.3	-	496.8	77.9%	496.8	77.9%	141.2	**638.1**
Administration	622.5	53.5	-	675.9	64.6%	675.9	64.6%	369.8	**1 045.8**
Other	78.9	9.2	-	88.1	9.1%	88.1	9.1%	884.8	**972.9**
Total	**6 261.6**	**718.7**	**5.5**	**6 985.9**	**53.7%**	**6 980.3**	**53.6%**	**6 034.8**	**13 020.7**

Table 4: Breakdown of final energy consumption by use in each sub-sector of the service sector in 2016 (GWh)

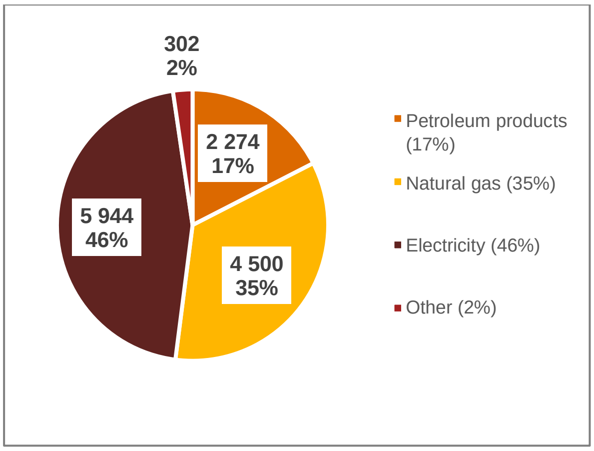


Figure 7: Breakdown of energy vectors covering energy needs in the service sector in 2016 (GWh)

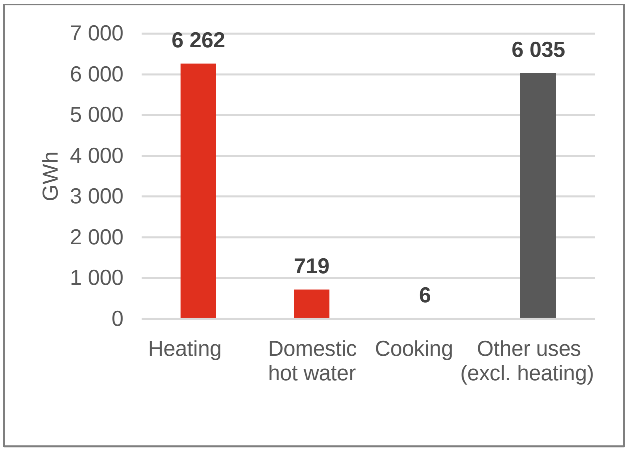


Figure 6: Breakdown of energy needs by use in the service sector in 2016 (GWh)

I.7. *Heating needs in the service sector: useful energy*

I.7.1. *Sources and methodology*

The approach chosen to estimate heating needs in the service sector expressed as useful energy is based on energy vectors and comprises five steps:

Estimating the share of each vector covering heating needs

For the service sector, the energy balance did not break down energy vectors by use. It was therefore necessary in the first instance to estimate the share of each energy vector intended to cover heating needs.

Identifying the primary uses of each vector

For each energy vector, several primary uses were identified.

Identifying reference technologies for those primary uses

For each of the primary uses identified, one or more reference technologies was associated with them.

Estimating the breakdown for those technologies

The final energy of each energy vector intended to cover heating needs was broken down between the different technologies.

Estimating the energy efficiency of those technologies

An energy efficiency value was associated with each reference technology[11]. These are instantaneous efficiency values (net heat). For the energy efficiency of the 'Other' category, the average efficiency of the service sector was applied. The impact of this on the estimations is very limited given that the category accounts for just over 1% of heating needs.

I.7.2. *Results*

Heating needs in the service sector expressed as useful energy amount to 6 004 GWh. The average energy efficiency of the sector is therefore 85.6%.

Energy vectors covering heating needs	Final energy (GWh)	Primary use	Main technologies	Share	Breakdown of final energy (GWh)	Efficiency of technology	Useful energy (GWh)
Natural gas	**4 493.9**	Heating	Gas-fired condensing boiler	30%	1 348.2	93%	**1 253.8**
		Heating	Traditional boiler	60%	2 696.3	80%	**2 157.1**
		Domestic hot water	Gas water-heater	10%	449.4	80%	**359.5**
Petroleum products	**2 273.9**	Heating	Domestic oil-fired condensing boiler	10%	227.4	90%	**204.7**
		Heating	Oil-fired boiler (>15 years)	80%	1 819.1	82%	**1 491.7**
		Domestic hot water	Boiler-domestic hot water	10%	227.4	82%	**186.5**
Electricity	**150.2**	Heating	Direct electric heating	30%	45.1	100%	**45.1**
		Domestic hot water	Boiler-domestic hot water	31%	46.9	100%	**46.9**
		Heating	Heat pump	39%	58.6	300%	**175.7**
Other	**67.9**		Other technologies	100 %	67.9	86%	**58.4**
Total final energy consumption for heating needs	**6 985.9**			**Total useful energy needs required to cover heating needs**			**5 979.4**

Table 5: Presentation of the methodology for converting final energy into useful energy for the service sector (2016)

[11] Energy efficiency values were obtained primarily from the following documents: *Stratégie wallonne de rénovation énergétique à long terme du bâtiment* (SPW, 2017); Chapter 4: (building analysis) of the *Guide de la rénovation énergétique et durable des logements de Wallonie* (SPW, 2014); *Enquête sur la qualité de l'habitat en Wallonie – Résultats clés* (CEHD, 2014).

I.8. Heating needs in the industrial sector: final energy

I.8.1. Sources and methodology

SPW-Énergie's regional energy balances are the information source regarding consumption by energy vector and sub-sector in the industrial sector in 2016[12]. The data from the energy balance is reproduced in this assessment without any processing. Energy consumed in the industrial sector is broken down into the following uses:

- Process heat (high-temperature)
- Substitutable heat
- Other uses (air conditioning, refrigeration, lighting, etc.).

The sector's heating needs are calculated by adding together process heat and substitutable heating.

The energy balance also presents a breakdown of the vectors covering all energy needs, i.e. solids and derived gases, petroleum products, natural gas, electricity and others. The analysis also provides a breakdown of energy needs by sub-sector of the industrial sector, namely iron and steel, non-ferrous, chemicals, non-metallic minerals, food, textiles, paper, metal manufacturing, and other industries.

I.8.2. Results

According to the data from 2016, energy consumption in the industrial sector was 39 674 GWh, while heating needs amounted to 29 724 GWh or 74.9 % of all energy needs.

Substitutable heating needs (<250°C) reached 11 639 GWh in 2016 or 29.3% of total consumption in the sector and accounted for almost 40% of heating needs. 11 639 GWh is therefore the maximum substitutable potential of the industrial sector in Wallonia. The substitutable heating need is notably influenced by temperature. Cogeneration and district heating networks are easier to use at distribution temperatures below 90°C. Unfortunately, we do not have the data to isolate that heating need. Consequently, all needs are considered substitutable. Details of the heating needs by energy vector and sub-sector can be found in Table 6. This table does not have the same structure as the data tables for the residential and service sectors (based on use), as the energy balance did not identify uses for the industrial sector. Figure 8 below presents a breakdown of the energy vectors covering energy needs and Figure 9 presents a breakdown of energy uses. In the industrial sector, process heat accounts for more than 60% of heating needs. The main energy vectors are natural gas (35%) and electricity (25%). The breakdown of heating needs between the different vectors indicated in the table follows the breakdown in the 2016 energy balance[13].

Industrial sector (2016, GWh)	Solids and derived gases	Petroleum products	Natural gas	Electricity	Other vectors	Heating need		Substitutable heating needs		Total energy consumption (excluding non-energy consumption)
						Total	Share of total	Total	Share of total	
Iron and steel	123.3	23.0	3 221.5	1 916.3	12.6	3 380.3	63.8%	169.0	3.2%	**5 296.7**
Non-ferrous	-	14.6	117.5	67.1	-	132.1	66.3%	6.6	3.3%	**199.1**
Chemicals	-	161.6	3 405.7	2 933.3	1 956.8	5 524.1	65.3%	4 081.8	48.3%	**8 457.4**
Non-metallic minerals	4 123.6	549.7	3 710.8	1 733.2	2 754.9	11 139.0	86.5%	305.4	2.4%	**12 872.2**
Food	38.4	142.2	2 330.5	1 304.7	1 547.2	4 058.2	75.7%	2 922.4	54.5%	**5 362.8**
Textiles	-	7.0	56.4	157.7	-	63.4	28.7%	48.2	21.8%	**221.1**
Paper	-	201.0	484.9	720.1	2 390.5	3 076.4	81.0%	2 830.3	74.5%	**3 796.5**
Metal manufacturing	50.3	151.5	526.3	527.8	9.0	737.1	58.3%	420.1	33.2%	**1 264.9**

[12] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 19.
[13] Ibid.

Other industries	-	187.6	218.5	589.3	1 207.8	1 613.9	73.3%	855.4	38.8%	**2 203.2**
Total	**4 335.6**	**1 438.1**	**14 072.0**	**9 949.5**	**9 878.8**	**29 724.5**	**74.9%**	**11 639.3**	**29.3%**	**39 674.0**

Table 6: Breakdown of final energy consumption by use in each sub-sector of the industrial sector in 2016 (GWh)

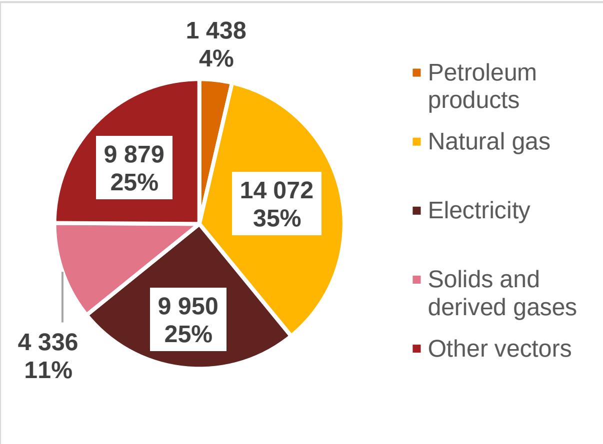


Figure 8 : Breakdown of energy vectors covering energy needs in the industrial sector in 2016 (GWh)

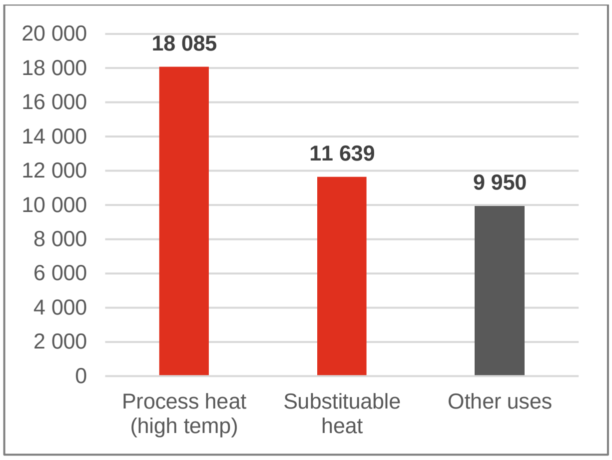


Figure 9 : Breakdown of energy needs by use in the industrial sector in 2016 (GWh)

I.9. *Heating needs in the industrial sector: useful energy*

I.9.1. *Sources and methodology*

The approach chosen to estimate heating needs in the industrial sector expressed as useful energy is based on the different industry sub-sectors and on the expertise of an industry facilitator designated by Wallonia. Five sub-sectors represent 91% of industrial heating needs, namely iron and steel, chemicals, non-metallic minerals, food and paper. The energy efficiency of each of those sub-sectors was determined by the industry facilitator on the basis of data taken from audits carried out under Sector Agreements (see glossary). For the other industrial sectors, the average efficiency of the five aforementioned sub-sectors was applied (pro-rata based on consumption), i.e. 73%.

I.9.2. Results

Heating needs in the industrial sector expressed as useful energy amount to 21 673 GWh. The average energy efficiency of the sector is therefore 73%. These are instantaneous efficiency values (net heat).

Sub-sectors of the industrial sector	Final energy (GWh)	Efficiency	Useful energy (GWh)
Iron and steel	**3 380.3**	69%	2 332.4
Non-ferrous	**132.1**	73%	96.4
Chemicals	**5 524.1**	48%	2 651.6
Non-metallic minerals	**11 139.0**	93%	10 359.2
Food	**4 058.2**	70%	2 840.7
Textiles	**63.4**	73%	46.3
Paper	**3 076.4**	53%	1 630.5
Metal manufacturing	**737.1**	73%	538.1
Other industries	**1 613.9**	73%	1 178.1
Total final energy consumption of the industrial sector for heating needs	**29 724.5**	**Total useful energy needs required to cover heating needs**	**21 673.4**

Table 7: Presentation of the methodology for converting final energy into useful energy for the industrial sector (2016)

I.10. Summary

In 2016, energy consumption associated with heating broke down as follows between the different sectors:

- Residential sector: 42%, or 26 508 GWh
- Service sector: 11%, or 7 022 GWh
- Industrial sector: 47%, or 29 724 GWh

For these three sectors, heating needs (63 218 GWh) represent 76.1% of their total energy consumption.

In 2016, the primary uses for heating were as follows:

- Residential sector: heating systems accounted for 21 931 GWh, or 83% of heating consumption.
- Service sector: heating systems accounted for 6 262 GWh, or 89% of heating consumption.
- Industrial sector: process heat (high-temperature) accounted for 18 085 GWh, or 61% of heating consumption.

In 2016, the main energy vectors covering all energy consumption (not only heating) in each sector were as follows:

- Residential sector: domestic fuel oil (35%), natural gas (29%) and electricity (22%).
- Service sector: electricity (46%), natural gas (35%) and domestic fuel oil (17%).
- Industrial sector: natural gas (35%) and electricity (25%).

In 2016, the average energy efficiency of the different heat-producing technologies was as follows:

- Residential sector: 83.5%
- Service sector: 85.6%

Chapter 2: Cooling demand and supply

II. Cooling demand and supply

II.1. *Recap of Annex VIII*

Point 1 of Part I of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling requires the following:

> A presentation of heating and cooling demand expressed as useful energy and useful energy consumption in GWh by year and sector:
>
> a. Residential
> b. Services
> c. Industry
> d. Any other sector that individually consumes more than 5% of national useful heating and cooling demand.

II.2. *Introduction*

Information to determine Wallonia's cooling needs in 2016 was sourced from the official energy balance[14] published by SPW-Énergie. It provides statistics on energy consumption used for international reporting and for complying with European directives on energy and regional policies in this area.

The author of this assessment does not explain the reporting methods used to draw up those energy balances, as they are covered in reports available from SPW-Énergie.

For the purposes of this analysis, a distinction is made between cooling needs and substitutable cooling needs. Both terms are defined in the glossary.

Overall and substitutable cooling needs are analysed for each sector of Wallonia's energy landscape (residential, services and industry). Consumption in agriculture and transport is excluded from the analysis. Agriculture represented less than 1% of energy consumption in Wallonia in 2016. Consequently, the share of such energy for heating and cooling purposes is negligible for the analysis. Furthermore, there are no statistics available about this for the sector. Heating and cooling needs are not applicable to transport.

For the purposes of this analysis, a distinction is also made between cooling needs expressed as final energy and useful energy. Both terms are defined in the glossary.

II.3. *Overall results*

A summary of cooling needs is presented in the table below, with the details for each sector presented in the paragraphs thereafter. In 2016, energy consumption in the residential, service and industrial sectors was 83 137 GWh, equating to 66.1% of overall consumption in Wallonia (125 772 GWh). The column 'Substitutable cooling needs' corresponds to air conditioning (indicated with a '(1)' in the table). The breakdown of cooling needs between the different uses indicated in the table follows the breakdown in the 2016 energy balance[15].

Sectors (2016, GWh)	Air conditioning (1)	Refrigeration	Cooling needs	Substitutable cooling needs (∑1)		Total energy consumption

[14] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019)
[15] Ibid., p. 20.

			Total	Share of total	Total	Share of total	Other uses (excluding cooling)	
Residential	116.0	881.0	997.0	3.3%	116.0	0.4%	29 445.5	**30 442.5**
Services	532.6	381.3	913.9	7.0%	532.6	4.1%	12 106.8	**13 020.7**
Industry	129.1	723.0	852.1	2.1%	129.1	0.3%	38 821.9	**39 674.0**
Total	**777.7**	**1 985.3**	**2 763.0**	**3.3%**	**777.7**	**0.9%**	**80 374.2**	**83 137.2**

Table 8: Summary of cooling needs in Wallonia by use and by sector in 2016 (GWh)

For these three sectors, cooling needs (2 763 GWh) represent 3.3% of their total energy consumption. 28% of those cooling needs are substitutable cooling needs, i.e. a total of 777.7 GWh. The primary contributor to the total are service sector needs (532.5 GWh, 68%), followed by industry (129.1 GWh, 17%) and finally residential (116 GWh, 15%).

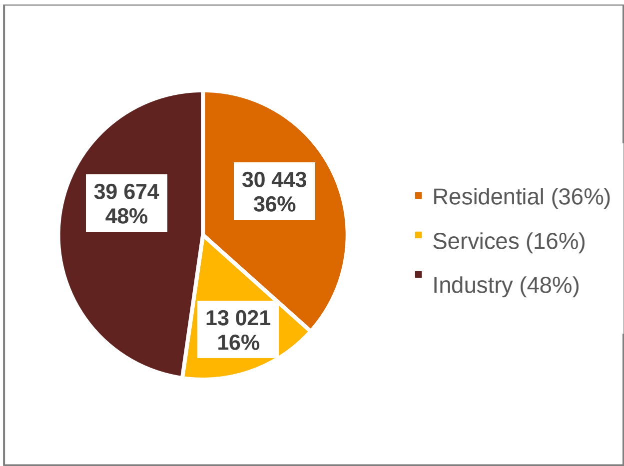


Figure 11: Breakdown of final energy consumption by sector in 2016 (GWh)

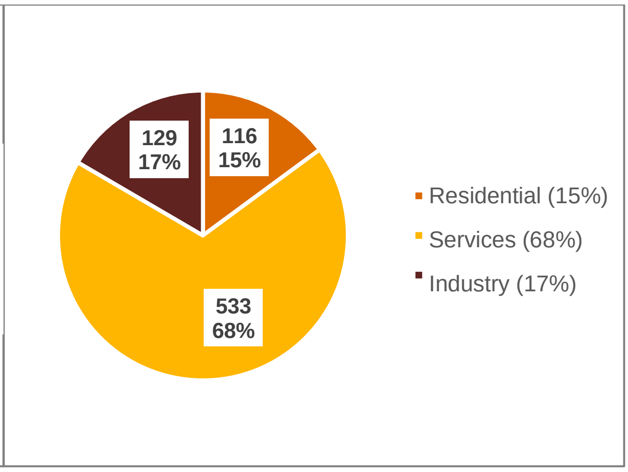


Figure 10: Breakdown of substitutable cooling needs by sector in 2016 (GWh)

The charts above show – from left to right – the share of total energy consumption accounted for by each sector and the share of substitutable cooling needs accounted for by those three sectors.

Although industry accounts for 48% of final consumption (excluding agriculture and transport), its contribution to substitutable cooling needs is just 17%. The lion's share of substitutable cooling needs (68%) comes from the service sector, although its contribution to total consumption is only 16%. Finally, the residential sector, despite accounting for 36% of final consumption, contributes a mere 15% to substitutable cooling needs.

II.4. Cooling needs in the residential sector: final energy

II.4.1. Sources and methodology

SPW-Énergie's regional energy balances are the information source regarding final energy consumption by use for cooling needs in the residential sector in 2016[16]. The data from the energy balance is reproduced in this assessment without any processing.

Cooling needs consist of air conditioning and refrigeration. Substitutable cooling needs, which can be covered by an external supply linked to a district heating network or cogeneration, do not include refrigeration.

[16] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019)

II.4.2. *Results*

According to the data from 2016, total energy consumption in the residential sector was 30 442 GWh, while cooling needs amounted to 997 GWh or 3.3% of all energy needs. Electricity is the energy vector which covers all cooling needs, with 15.1% of electricity consumption in the residential sector catering for cooling needs.

Substitutable cooling needs (air conditioning) reached 116 GWh in 2016 or 0.4% of total consumption in the sector and accounted for 11.6% of cooling needs. 116 GWh is therefore the maximum substitutable potential of the residential sector in Wallonia.

Details of the cooling needs can be found in the table below. In the residential sector, nearly 90% of cooling needs are linked to refrigeration.

Type of housing	Use	Electricity	Total
All housing	Air conditioning	116	**116**
All housing	Refrigeration	881	**881**
All housing	Other uses (excluding cooling)	5 603	**29 446**
Total energy consumption		**6 599**	**30 442**
Cooling need	Total	997	**997**
	As share of total	15.1%	**3.3%**
Substitutable cooling	Total	116	**116**
	As share of total	1.8%	**0.4%**

Table 9: Breakdown of final energy consumption linked to cooling needs in 2016 (GWh)

II.5. Cooling needs in the residential sector: useful energy

II.5.1. Sources and methodology

The approach chosen to estimate cooling needs in the residential sector expressed as useful energy is based on uses for cooling and comprises the following four steps:

Identifying the primary uses

Cooling needs subdivide into two uses, namely air conditioning and refrigeration. All cooling needs are powered by electricity.

Identifying reference technologies for those primary uses

For each of the primary uses, one or more reference technologies was associated with them.

Estimating the breakdown for those technologies

Where several reference technologies were associated with a single use, a breakdown rate was attributed to each of them on the basis of their market presence.

Estimating the energy efficiency of those technologies

An energy efficiency value was associated with each reference technology.

II.5.2. Results

Cooling needs in the residential sector expressed as useful energy amount to 2 354 GWh. The average energy efficiency of the sector is therefore 236%.

Energy vectors in the residential sector	Final energy (GWh)	Primary use	Share of primary use (%)	Share of primary use (GWh)	Main technologies	Distribution on the market	Breakdown of final consumption (GWh)	Efficiency	Useful energy (GWh)
Electricity	**997.0**	Refrigeration	88.4%	881.0	Household appliances – old	44.4%	391.6	200%	**783.1**
					Household appliances – recent	55.6%	489.4	250%	**1 223.6**
		Air conditioning	11.6%	116.0	Direct expansion/air condenser	100%	116.0	300%	**348.0**
Total final energy consumption for cooling needs	**997.0**			**997.0**		**Total useful energy needs required to cover cooling needs**			**2 354.7**

Table 10: Presentation of the methodology for converting final energy covering cooling needs into useful energy for the residential sector (2016)

II.6. Cooling needs in the service sector: final energy

II.6.1. Sources and methodology

SPW-Énergie's regional energy balances are the information source regarding final energy consumption by use for cooling needs and by sub-sector of the service sector in 2016[17]. Due to a reporting problem in the detailed data for this document, the data presented in this section has been estimated on the basis of figures for

[17] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 24.

2017[18]. For each sub-sector of the service sector, the share of energy consumption accounted for by each use was identified. Those ratios were then applied to the energy consumption of each sub-sector in 2016 in order to establish the breakdown by use in GWh.

Cooling needs consist of air conditioning and refrigeration. Substitutable cooling needs, which can be covered by an external supply linked to a district heating network or cogeneration, do not include refrigeration.

II.6.2. *Results*

According to the explanation of the methodology provided above and the data from 2016, energy consumption in the service sector was 13 021 GWh, while cooling needs amounted to 894.9 GWh or 6.9% of all energy needs.

Substitutable cooling needs (air conditioning) reached 518.4 GWh in 2016 or 4% of total consumption in the sector and accounted for 58% of cooling needs. 518.4 GWh is therefore the maximum substitutable potential of the service sector in Wallonia.

Details of the cooling needs by sub-sector and use can be found in the table below. In the service sector, cooling needs break down as follows: 58% corresponds to air conditioning and 42% to refrigeration. The ‘trade’ sub-sector notably accounts for more than 95% of the refrigeration needs of the sector.

Service sector (2016, GWh)	Air conditioning (1)	Refrigeration	Cooling need		Substitutable cooling needs (∑1)		Other uses (excluding cooling)	Total energy consumption
			Total	Share of total	Total	Share of total		
Trade	255.5	363.1	618.6	12.3%	255.5	5.1%	4 423.8	**5 042.3**
Transport and communication	28.9	-	28.9	5.4%	28.9	5.4%	511.3	**540.2**
Banking, insurance and business services	78.1	-	78.1	6.9%	78.1	6.9%	1 046.5	**1 124.6**
Education	28.8	13.4	42.2	2.8%	28.8	1.9%	1 465.1	**1 507.3**
Health	43.5	-	43.5	2.9%	43.5	2.9%	1 452.1	**1 495.6**
Culture, sport	22.8	-	22.8	3.5%	22.8	3.5%	631.0	**653.9**
Other services	11.7	-	11.7	1.8%	11.7	1.8%	626.3	**638.1**
Administration	49.1	-	49.1	4.7%	49.1	4.7%	996.7	**1 045.8**
Other	-	-	-	0%	-	0%	972.9	**972.9**
Total	**518.4**	**376.5**	**894.9**	**6.9%**	**518.4**	**4.0%**	**12 125.8**	**13 020.7**

Table 11: Breakdown of final energy consumption linked to cooling needs by use in each sub-sector of the service sector in 2016 (GWh)

II.7. *Cooling needs in the service sector: useful energy*

II.7.1. *Sources and methodology*

The approach chosen to estimate cooling needs in the service sector expressed as useful energy is based on uses and comprises the following four steps:

Identifying the primary uses

Cooling needs subdivide into two uses, namely air conditioning and refrigeration. All cooling needs are powered by electricity.

[18] *Inventaire Réseaux de chaleur et de froid 2017*, (ICEDD, 2020)

Identifying reference technologies for those primary uses

For each of the primary uses identified, one or more reference technologies was associated with them.

Estimating the breakdown for those technologies

The final energy was broken down between the different technologies on the basis of an estimate of the breakdown between uses.

Estimating the energy efficiency of those technologies

An energy efficiency value was associated with each reference technology.

II.7.2. *Results*

Cooling needs in the service sector expressed as useful energy amount to 2 360 GWh. The average energy efficiency of the sector is therefore 258%.

Energy vectors in service sector	Final energy (GWh)	Primary use	Main technologies	Distribution on the market	Breakdown of final consumption (GWh)	Efficiency	Useful energy (GWh)
Electricity	**913.9**	Refrigeration	Household appliances – old	41.7%	381.3	200%	**762.6**
		Air conditioning	Air conditioning (direct expansion/air condenser)	58.3%	532.6	300%	**1 597.8**
Total final energy consumption for cooling needs	**913.9**				**Total useful energy needs required to cover cooling needs**		**2 360.4**

Table 12: Presentation of the methodology for converting final energy covering cooling needs into useful energy for the service sector (2016)

II.8. Cooling needs in the industrial sector: final energy

II.8.1. Sources and methodology

SPW-Énergie's regional energy balances are the information source regarding final energy consumption by use for cooling needs and by sub-sector of the industrial sector in 2016[19]. The data from the energy balance is reproduced in this assessment without any processing.

Cooling needs consist of air conditioning and refrigeration. Substitutable cooling needs, which can be covered by an external supply linked to a district heating network or cogeneration, do not include refrigeration. Absorption chillers are notably not taken into account, as they are not appropriate in our climate[20]. Such systems are only efficient if heating and cooling needs coincide.

II.8.2. Results

According to the explanation of the methodology provided above and the data from 2016, energy consumption in the industrial sector was 39 674 GWh, while cooling needs amounted to 852 GWh or 2.1% of all energy needs.

Substitutable cooling needs (air conditioning) reached 129 GWh in 2016 or 0.3% of total consumption in the sector and accounted for 15% of cooling needs. 129 GWh is therefore the maximum substitutable potential of the industrial sector in Wallonia.

Details of the cooling needs by sub-sector and use can be found in the table below. In the industrial sector, cooling needs break down as follows: 15.1% corresponds to air conditioning and 84.9% to refrigeration. The majority of refrigeration needs are shared between the 'Chemicals' and 'Food' sub-sectors, which represent 54.8% and 38.7% respectively of the sector's refrigeration needs.

Industrial sector (2016, GWh)	Air conditioning (1)	Refrigeration	Cooling need		Substitutable cooling needs (∑1)		Other uses (excluding cooling)	Total energy consumption (excluding non-energy consumption)
			Total	Share of total	Total	Share of total		
Iron and steel	1.0	10.4	11.5	0.2%	1.0	0.0%	5 285.2	**5 296.7**
Non-ferrous	-	-	0.0	0%	-	0%	199.1	**199.1**
Chemicals	12.9	395.8	408.6	4.8%	12.9	0.2%	8 048.8	**8 457.4**
Non-metallic minerals	0.9	9.4	10.4	0.1%	0.9	0.0%	12 861.8	**12 872.2**
Food	37.4	280.2	317.7	5.9%	37.4	0.7%	5 045.2	**5 362.8**
Textiles	6.1	2.1	8.2	3.7%	6.1	2.7%	212.9	**221.1**
Paper	27.7	9.8	37.5	1.0%	27.7	0.7%	3 759.0	**3 796.5**
Metal manufacturing	20.3	7.2	27.5	2.2%	20.3	1.6%	1 237.4	**1 264.9**
Other industries	22.7	8.0	30.7	1.4%	22.7	1.0%	2 172.4	**2 203.2**
Total	**129.1**	**723.0**	**852.1**	**2.1%**	**129.1**	**0.3%**	**38 821.9**	**39 674.0**

Table 13: Breakdown of final energy consumption linked to cooling needs by use in each sub-sector of the industrial sector in 2016 (GWh)

[19] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p. 26.
[20] Energie Plus (2019) https://energieplus-lesite.be/techniques/climatisation8/production-de-froid/machine-frigorifique-a-ab-adsorption/#L%E2%80%99efficacite_energetique_ou_COPfroid

II.9. Cooling needs in the industrial sector: useful energy

II.9.1. Sources and methodology

The approach chosen to estimate cooling needs in the industrial sector expressed as useful energy is based on uses and comprises four steps. The same reference technologies used for the service sector have been used for the industrial sector due to a lack of information/data.

Identifying the primary uses

Cooling needs subdivide into two uses, namely air conditioning and refrigeration. All cooling needs are powered by electricity.

Identifying reference technologies for those primary uses

For each of the primary uses identified, one or more reference technologies was associated with them.

Estimating the breakdown for those technologies

The final energy was broken down between the different technologies on the basis of an estimate of the breakdown between uses[21].

Estimating the energy efficiency of those technologies

An energy efficiency value was associated with each reference technology.

II.9.2. Results

Cooling needs in the industrial sector expressed as useful energy amount to 1 833 GWh. The average energy efficiency of the sector is therefore 215%.

Energy vectors	Final energy (GWh)	Primary use	Main technologies	Distribution on the market	Breakdown of final consumption (GWh)	Efficiency	Useful energy (GWh)
Electricity	**852**	Refrigeration	Cooling unit – old	84.8%	723	200%	**1 446**
		Air conditioning	Air conditioning (direct expansion/air condenser)	15.2%	129	300%	**387**
Total final energy consumption for cooling needs	**852**				**Total useful energy needs required to cover cooling needs**		**1 833**

Table 14: Presentation of the methodology for converting final energy covering cooling needs into useful energy for the industrial sector (2016)

[21] The distribution on the market was taken from the 2016 energy balance. It was estimated on the following basis: Share of cooling needs for refrigeration = cooling needs for refrigeration / total cooling needs.

II.10. *Summary*

In 2016, energy consumption associated with cooling broke down as follows between the different sectors:

- Residential sector: 36%, or 997 GWh
- Service sector: 33%, or 914 GWh
- Industrial sector: 31%, or 852 GWh

For these three sectors, cooling needs (2 763 GWh) represent 3.3% of their total energy consumption.

In 2016, the primary uses for cooling were as follows:

- Residential sector: refrigeration (88%) and air conditioning (12%)
- Service sector: air conditioning (58%) and refrigeration (42%)
- Industrial sector: refrigeration (85%) and air conditioning (15%)

In 2016, the average energy efficiency of the different cooling technologies was as follows:

- Residential sector: 236%
- Service sector: 258%
- Industrial sector: 215%

Chapter 3: Current heating and cooling supply

III. Estimation of the current heating and cooling supply

III.1. *Recap of Annex VIII*

Point 2(a) of Part I of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling requires the following:

> Identification of the current heating and cooling supply:
>
> a. by technology, in GWh per year, within sectors mentioned under point 1 where possible, distinguishing between energy derived from fossil and renewable sources:
>   i. provided on-site in residential and service sites by:
>   - heat only boilers;
>   - high-efficiency heat and power cogeneration;
>   - heat pumps;
>   - other on-site technologies and sources;
>   ii. provided on-site in non-service and non-residential sites by:
>   - heat only boilers;
>   - high-efficiency heat and power cogeneration;
>   - heat pumps;
>   - other on-site technologies and sources;
>   iii. provided off-site by:
>   - high-efficiency heat and power cogeneration;
>   - waste heat;
>   - other off-site technologies and sources.

III.2. *Estimation of the current heating and cooling supply*

III.2.1. *Sources and methodology*

In line with the running principle of Annex VIII, a distinction was made between the three main sectors. For each sector, the methodology used to analyse the current heating and cooling supply comprised four steps.

Step 1: Total consumption by sector and distinction by technology

It was firstly necessary to establish total consumption by sector and technology. This came from the results presented in Chapters 1 and 2 of this report. Those results could be supplemented, where necessary, in order to cover all the technologies listed in Annex VIII.

Step 2: Identifying needs covered by renewable energy

Secondly, it was necessary to establish the quantity of heating produced from renewable energy. Directive 2009/28/EC defines **energy from renewable sources** as: *energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.* As the finer details vary between the three different sectors, different assumptions have been made:

Residential: Production of heating from renewable energy for the residential sector equals the total volume of heating produced from wood, cogeneration, heat pumps[22], solar thermal panels and green electricity[23][24].
Services: Production of heating from renewable energy for the service sector equals the total volume produced from 'other' sources, as indicated in the energy balance[25], and green electricity. The 'other' category encompasses coal[26], cogenerated heating and the other renewable energy sources. The value used for cogenerated heating is based on the values indicated in Wallonia's 2016 primary production and recovery balance[27].
Industry: Production of heating from renewable energy for the industrial sector equals the volume identified under the 'other energy' category of the energy balance[28]. The 'other energy' category encompasses renewable energy, waste and recovery of cogenerated steam/heat. The value used for cogenerated heating is based on the values indicated in Wallonia's 2016 primary production and recovery balance[29].

Step 3: Identifying needs covered by energy produced off-site

Finally, it was necessary to establish the quantity of heating and cooling produced 'off-site'. The quantity of heating produced off-site was considered equivalent to the quantity of heating distributed via district heating and cooling networks in Wallonia[30]. By contrast, on-site heating and cooling production was considered equivalent to Wallonia's heating needs minus the quantity of heating distributed via district heating networks.

[22] The renewable share from heat pumps is based on the energy gain, i.e. total heating production minus electricity consumption.
[23] A share of the electricity consumed by households is used to cover their heating needs. Due to Wallonia's energy mix, a share of electricity should be considered renewable. A figure of 14% was used on the basis of data from the website of the IWEPS (https://www.iweps.be/indicateur-statistique/production-nette-delectricite-vecteur-energetique/).
[24] The data from the 2016 energy balance was used. The energy balance distinguishes between heating produced from wood, cogenerated steam, geothermal energy, heat pumps, solar thermal energy and electricity. The share of green electricity is determined on the basis of Wallonia's energy mix.
[25] *Bilan énergétique de la Wallonie – Secteur domestique et équivalents – chiffres de 2016*.
[26] The degree of detail in the energy balance does not allow coal to be separated from the other renewable sources identified. However, as coal only accounts for a very small proportion in the residential sector (1.6% according to Wallonia's 2017 energy balance), the share of the 'other' category accounted for by coal would seem unlikely to have a significant impact on the results.
[27] *Bilan de production primaire et récupération pour la Région Wallonne pour l'année 2016*, p.42.
[28] *Bilan énergétique de la Wallonie – Secteur domestique et équivalents – chiffres de 2016*.
[29] *Bilan de production primaire et récupération pour la Région Wallonne pour l'année 2016*, p.42.
[30] Figures do not take into account possible heat loss from district heating networks.

Step 4: Cross-referencing the results to achieve the required degree of detail for the reporting

As shown below, the last step was to produce the desired final results from the results obtained in the previous steps. The final results were obtained by subtracting the rectangles linked by the same colours. In other words:

- (1) – (2) = total consumption from fossil fuels;
- (2) – (4) = consumption covered by on-site production from RES;
- (3) – (4) = off-site consumption covered by fossil fuels;
- (1) – (3) = consumption covered by on-site production;
- (5) – (6) = consumption produced on-site from fossil fuels;

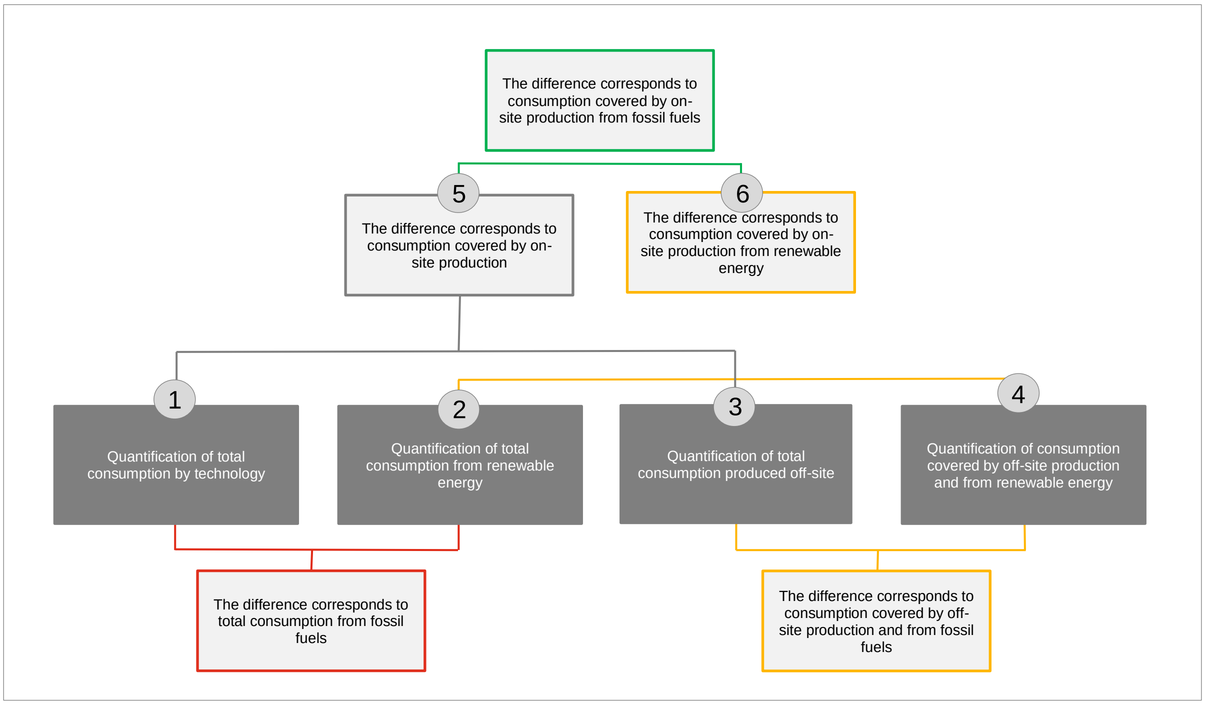


Image 1: Methodology used for step 4

III.2.2. *Results – Current heating supply*

Step 1: Total consumption by sector and distinction by technology

The total consumption by sector and technology is presented in the tables below. Each table corresponds to a sector. The 'Sources/assumptions' column identifies the sources used and, where appropriate, the assumptions made.

Residential sector

Technology	Value (GWh)	Sources/assumptions
Boiler	19 878.12	Assumption that the total heating needs covered by domestic fuel oil, gas and butane/propane are for domestic hot water and heating[31].
Cogeneration	5.67	Figures used in Wallonia's 2016 energy balance provided by SPW-Énergie.
Heat pump	284.18	Figures used in Wallonia's 2016 energy balance provided by SPW-Énergie.
Other	6 339.02[32]	Value corresponds to the difference between (1) the overall total and (2) the total of the above three entries.
TOTAL	26 507	Extract of results presented under steps 1 and 2.

Table 15: Total consumption by technology in the residential sector (GWh)

[31] The energy balance also includes the share corresponding to cooking. This is not taken into account in the indicated value, as it is not supplied by a boiler.
[32] Figure mostly based on (1) real consumption of wood (3 103 GWh) and (2) real consumption of electricity (2 664.5 GWh).

Service sector

Technology	Value (GWh)	Sources/assumptions
Boiler	6 699.36	Assumption that the substitutable heating referred to in step 1 is reduced by the heating needs covered by renewable energy[33].
Cogeneration	153.40	Figure published in the 2016 primary production and recovery balance[34].
Heat pump	21.10	Figure published in the 2016 primary production and recovery balance[35].
Other	147.74	Value corresponds to the difference between (1) the overall total and (2) the total of the above three entries.
TOTAL	7 022	Extract of results presented under steps 1 and 2.

Table 16: Total consumption by technology in the service sector (GWh)

Industrial sector

Technology	Value (GWh)	Sources/assumptions
Boiler	5 721.71	Assumption that the substitutable heating is reduced by heating produced from cogeneration and heat pumps.
Cogeneration	5 862.40	Figure published in the 2016 primary production and recovery balance.
Heat pump	55.20	Figure published in the 2016 primary production and recovery balance.
Other	18 085.19	Value corresponds to the difference between (1) the overall total and (2) the total of the above three entries.
TOTAL	29 725	Extract of results presented under steps 1 and 2.

Table 17: Total consumption by technology in the industrial sector (GWh)

[33] A similar methodology to that used for the residential sector could not be used, as sufficiently detailed information was not available. However, cooking only represents 6.5 GWh, i.e. less than 0.1% of total heating needs in the service sector.
[34] *Bilan de production primaire et récupération pour la Région Wallonne pour l'année 2016*, p. 42.
[35] *Bilan de production primaire et récupération pour la Région Wallonne pour l'année 2016*, p. 76.

Step 2: Identifying needs covered by renewable energy

The graph below shows the heating needs of each sector covered by renewable energy. 4% of heating needs are covered by renewable energy in the service sector, compared to 15% in the residential sector and 22% in the industrial sector. It is estimated that a total of 10 833 GWh of heating is provided by renewable energy[36].

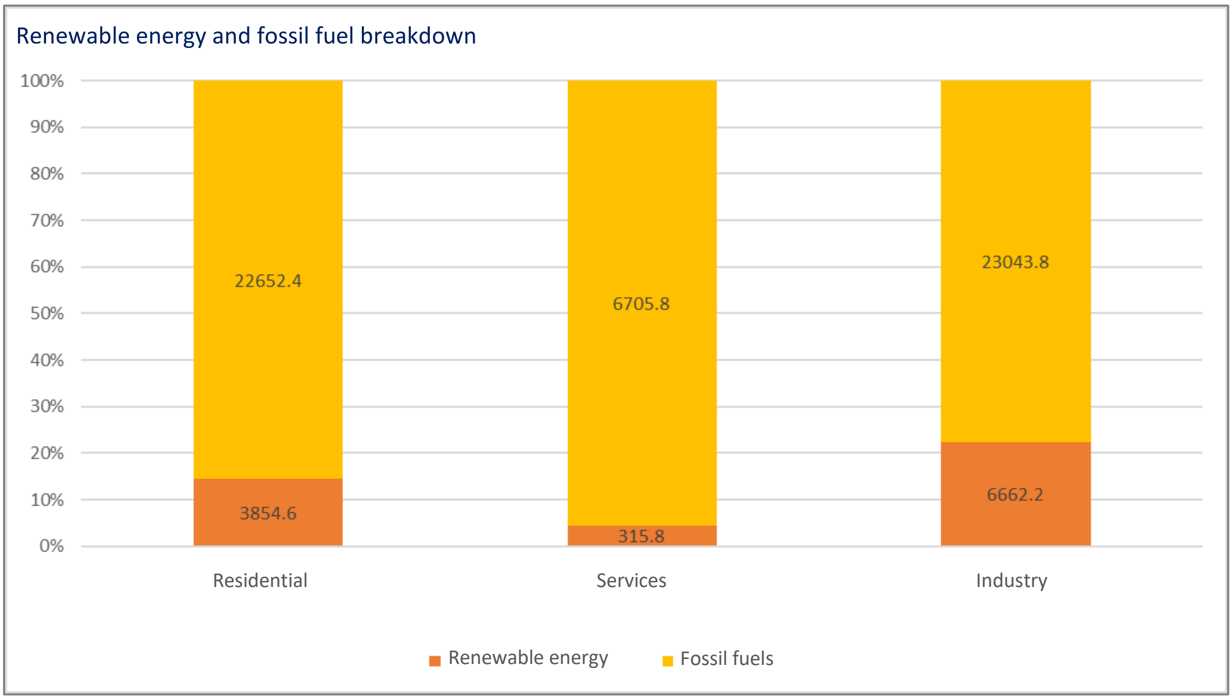


Figure 12: Share of Wallonia's heating production from renewable energy

Heating needs covered by renewable energy are presented in the tables below. Each table corresponds to a sector. The 'Sources/assumptions' column identifies the sources used and, where appropriate, the assumptions made.

36 This is different to the value indicated in the *Compilation des données sur les installations produisant de l'électricité et/ou de la chaleur à partir de sources renouvelables d'énergie et les cogénérations aux énergies fossiles*, as (1) the share corresponding to green electricity is taken into account (+/- 350 GWh) and (2) the energy balance indicates a value of 1 458.4 GWh for the 'Other biomass' vector which does not appear to have been included in the aforementioned compilation.

Residential sector

Technology	Value (GWh)	Sources/assumptions
Boiler	7	Unavail.[37].
Cogeneration	6	Assumption that the heating produced by cogeneration is 100% renewable in the residential sector.
Heat pump	190	Assumption that the share corresponding to the energy gain is renewable. Value taken from Wallonia's 2016 primary production and recovery balance[38].
Other	3 652[39]	Value equals the difference between the total heating needs covered by renewable energy and the values identified for heat pumps and cogeneration.
TOTAL	3 855	According to Wallonia's energy balance, total heating from renewable energy (wood + cogenerated steam + heat pumps + solar-thermal + geothermal + renewable electricity) amounts to 3 855 GWh.

Table 18: Total consumption by technology in the residential sector (GWh)

Service sector

Technology	Value (GWh)	Sources/assumptions
Boiler	22	Unavail.
Cogeneration	91	Assumption that heating considered to be renewable is identified pro-rata on the basis of renewable fuels. Value taken from Wallonia's 2016 primary production and recovery balance.
Heat pump	14	Assumption that the share corresponding to the energy gain is renewable. Value taken from Wallonia's 2016 primary production and recovery balance.
Other	189[40]	Value equals the difference between the total heating needs covered by renewable energy and the values identified for heat pumps and cogeneration.
TOTAL	316	Value obtained by adding together the share of green electricity used and the share of 'other fuels' used for heating and hot water in the service sector.

Table 19: Total consumption by technology in the service sector (GWh)

Industrial sector

Technology	Value (GWh)	Sources/assumptions
Boiler	**4**	Unavail.

[37] Unavailable.
[38] *Bilan de production primaire et récupération pour la Région Wallonne pour l'année 2016*, p. 76.
[39] This value includes the share of heating from off-site wood-fired boilers, i.e. 7.15 MWh.
[40] This value includes the share of heating from off-site wood-fired boilers, i.e. 22.36 MWh.

Cogeneration	3 175	Assumption that heating considered to be renewable is identified pro-rata on the basis of renewable fuels. Value taken from Wallonia's 2016 primary production and recovery balance.
Heat pump	38	Assumption that the share corresponding to the energy gain is renewable. Value taken from Wallonia's 2016 primary production and recovery balance.
Other	3 446[41]	Value equals the difference between the total heating needs covered by renewable energy and the values identified for heat pumps and cogeneration.
TOTAL	6 662	Assumption that all 'other energy' identified in Wallonia's 2016 energy balance was renewable. According to the energy balance, the 'other energy' category encompasses renewable energy, waste, recovery and cogenerated steam/heat.

Table 20: Total consumption by technology in the industrial sector (GWh)

[41] This value includes the share of heating from off-site wood-fired boilers, i.e. 2.29 GWh.

Step 3: Identifying needs covered by energy produced off-site

The table below presents an overall view of the primary characteristics of district heating networks in Wallonia.

Information	Value
Number	57 district heating networks operating in Wallonia[42]
Total installed capacity	81 744.5 kW
Total length	52 374 m (of trenches)
Heat (th) distributed (useful heat)	237 119 MWh

Table 21: Data on district heating networks

District heating networks in Wallonia distribute a total of 237.12 GWh in heating. This breaks down into 66.07 GWh (27%) for the residential sector, 92.99 GWh (38%) for the service sector and 83.48 GWh (35%) for the industrial sector.

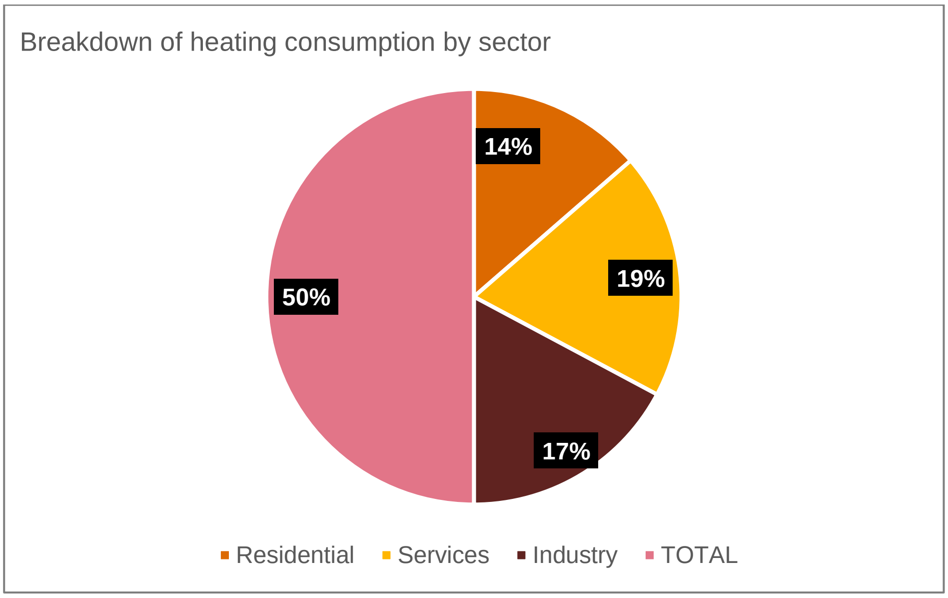


Figure 13 Breakdown by sector of heating distributed by district heating network

[42] There are certainly more district heating networks in Wallonia than the number indicated below. This number is based on data taken from the *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, p. 29 and 30, to which additional district heating networks identified by those involved in the exercise were added. At present, there is no systematic reporting to the Walloon authorities regarding the district heating networks in operation.

Decentralised heating production is mainly based on dry-biomass-powered steam turbines. This technology generates 65.87% of off-site heating production. There are four projects which provide this. Cogeneration and wood-fired boilers generate 31.61 GWh and 32.89 GWh respectively. The production and consumption figures for heating distributed by district heating network in Wallonia are summarised in the table below.

	Residential	Services	Industry	TOTAL (GWh)
Steam turbine	48.35	41.90	71.05	**161.30**
Geothermal[43]	8.35	8.35	0.00[44]	**16.70**
Cogeneration[45]	2.09	19.52	10.00	**31.61**
Wood-fired boiler	7.14	23.36	2.39	**32.89**
Wood gasification with cogeneration	0.00	0.03	0.00	**0.03**
TOTAL	**65.93**	**93.16**	**83.44**	**242.53**

Table 22: Characteristics of heating distributed by district heating networks

[43] For each of the 57 district heating networks recorded, the sectors to which heating is distributed (i.e. residential, services, industry) were identified. However, there is only limited information available on each district heating network which enables the exact share distributed to each sector to be identified. The methodology we followed was therefore to assume that for each district heating network, the distribution of heating breaks down equally between the three receiving sectors identified. For example, if a district heating network supplies residential and service-sector buildings, we considered that 50% of the heating went to the residential sector and 50% to the service sector. Where there is only one receiving sector, 100% was attributed to that sector. Likewise, if three sectors were identified, 33% was attributed to each sector. This approach of course has its limitations. However, it helped to mitigate the lack of information.

[44] Figures do not include the drilling site at Ghlin, which was opened by IDEA (Inter-municipal Economic Development and Town Planning Agency) in 2019 and which supplies the industrial sector.

[45] Cogeneration encompasses gas and biomass cogeneration.

Step 4: Cross-referencing the results to achieve the required degree of detail for the reporting

To clearly present the results, two tables have been produced. The first contains the values for on-site production and the second contains the values for off-site production. Both tables distinguish between heating produced from renewable energy and heating produced from fossil fuels[46].

	Residential	Services	Industry	TOTAL
RES	**3 789**	**240**	**6 579**	**10 607**
Boiler	-	-	-	**-**
Cogeneration	4	88	3 165	**3 256**
Heat pump	190	14	38	**242**
Other	3 595	137	3 376	**7 109**
Fossil	**22 652**	**6 689**	**23 062**	**52 403**
Boiler	19 878	6 699	5 722	**32 299**
Cogeneration	(0)	46	2 688	**2 733**
Heat pump	94	7	17	**119**
Other	2 680	(63)	14 635	**17 252**
TOTAL	**26 441**	**6 928**	**29 641**	**63 010.57**

Table 23: Details of on-site heating needs (GWh)

	Residential	Services	Industry	TOTAL
RES	**56**	**76**	**83**	**226**
Boiler	7	22	4	**-**
Cogeneration	2	3	10	**15**
Heat pump	-	-	-	**-**
Other	47	22	69	**211**
Fossil	**0**	**17**	**-**	**17**
Boiler	-	-	-	**-**
Cogeneration	-	17	-	**17**
Heat pump	-	-	-	**-**
Other	-	-	-	**-**
TOTAL	**56**	**93**	**83**	**242.53**

Table 24: Details of off-site heating needs (GWh)

46 The values indicated do not take into account backup energy production from fossil fuels.

III.2.3. *Results – Current cooling supply*

In the light of Annex VIII to Directive 2012/27/EU in conjunction with Article 14 thereof, and due to the characteristics of Wallonia, the analysis of the current cooling supply is relatively simple.

- There is no decentralised cooling in Wallonia.
- Annex VIII does not indicate any specific cooling technology. As a result, only the 'Other' category has been taken into account.
- The assumption is made that the share of cooling from renewable energy is similar to the share of renewable energy within Wallonia's energy mix[47] given that cooling is almost exclusively produced from electricity.

	Residential	Services	Industry	TOTAL
RES	147	134	125	406
Fossil	850	780	727	2 357
TOTAL	**997**	**914**	**852**	2 763

Table 25: Breakdown of on-site cooling needs in terms of renewable energy and fossil fuels (GWh)

III.3. *Summary*

The following table presents the heating production for each sector by energy source (fossil – RES) and location (on-site – off-site).

Sector	On-site heating production		Off-site heating production	
	Fossil (GWh)	RES (GWh)	Fossil (GWh)	RES (GWh)
Residential	22 652	3 789	0	56
Services	6 689	240	17	76
Industry	23 062	6 579	0	83

Table 26: Summary of heating production sources by sector

The figures presented here differ from those taken from the *Compilation des données sur les installations produisant de l'électricité et/ou de la chaleur à partir de sources renouvelables d'énergie et les cogénérations aux énergies fossiles* (data presented in detail in Chapter 5). Additional assumptions were incorporated here, namely:

- the share corresponding to 'green electricity' is taken into account (+/- 350 GWh)
- the energy balance shows a value of 1 458.4 GWh for the 'Other biomass' vector. This was seemingly not taken into account in the aforementioned compilation but has, however, been integrated here.

Consequently, although Chapter 5 of this assessment indicates a figure of 8 906.74 GWh for heating production from RES, the estimate here is 10 833 GWh.

47 https://www.iweps.be/indicateur-statistique/part-denergie-renouvelable-consommation-energetique/, [visited on 8 May 2020]. Net renewable electricity production represents 14.7% of total net electricity production.

Chapter 4
Identification of waste heat sources

IV. Identification of installations producing waste heat and cooling

IV.1. *Recap of Annex VIII*

Point 2(b) of Part I of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling requires the following:

> Identification of the current heating and cooling supply:
>
> b. Identification of installations that generate waste heat or cold and their potential heating or cooling supply, in GWh per year:
>   i. thermal power generation installations that can supply or can be retrofitted to supply waste heat with a total thermal input exceeding 50 MW;
>   ii. heat and power cogeneration installations using technologies referred to in Part II of Annex I with a total thermal input exceeding 20 MW;
>   iii. waste incineration plants;
>   iv. renewable energy installations with a total thermal input exceeding 20 MW other than the installations specified under point 2(b)(i) and (ii) generating heating or cooling using the energy from renewable sources;
>   v. industrial installations with a total thermal input exceeding 20 MW which can provide waste heat.

IV.2. Thermal power generation installations (>50 MW)

This paragraph is intended to identify the thermal power generation installations that can supply or be retrofitted to supply waste heat with a total thermal input exceeding 50 MW. The heating potential which can be exploited by these installations is estimated as zero. Given the price of gas and the number of operating hours of those installations, heat recovery by those operators would seem economically impossible. According to experts in the sector, no heat recovery projects are currently being examined. Furthermore, combined cycle gas turbine (CCGT) technology already uses cogenerated steam to produce even more electricity.

Name of installation	Type of installation	Installed capacity	Additional useful heat
Saint-Ghislain	Combined cycle gas turbine	350 MW	0 GWh
Marcinelle	Combined cycle gas turbine	450 MW	0 GWh
Amercoeur	Combined cycle gas turbine	451 MW	0 GWh
Seraing	Combined cycle gas turbine	485 MW	0 GWh
Angleur 4	Open cycle gas turbine	126 MW	0 GWh
Angleur 3	Open cycle gas turbine	50 MW	0 GWh
Awirs 4	Biomass-powered steam turbine	80 MW[48]	0 GWh

Table 27: Identification of thermal installations[49]

IV.3. Cogeneration installations

The following analysis concerns the additional useful heat from cogeneration installations operating in 2018. The database used for this purpose was taken from Wallonia's green certificates market[50]. As green certificates are obtained on the basis of electricity production, the heating component determined from this probably does not entirely reflect reality. However, the analysis does allow us to determine a percentage for additional heating use. In some cases, this comes from unused production at a given site or from an installation's poor efficiency. The exercise was carried out in such a way that installations with an installed capacity exceeding 20 MW were distinguished from installations with a lower capacity.

The data used concerns installations for which meter readings were taken only for the periods in 2018. Furthermore, some installations were analysed but their unused thermal generation was estimated on the basis of a thermal efficiency of 50% and an electrical efficiency of 35%. The unused heating for those installations is therefore an estimate. However, they only account for a small share of the total capacity considered (75 MW of

[49] Figures based on the 2016 primary production and recovery balance, p. 19-20, and on the **Adequacy and flexibility study for Belgium 2020–2030**, p. 51, produced by Elia in 2019.
[50] From the Green Certificates Management Database - SPW-DOMRE – 25.10.2020

a total of 2 029 MW, i.e. just under 4%). The information for those installations is limited, as only the contribution accounted for by ‘electricity’ is included in their data.

The chosen methodology therefore consisted in comparing the used production as identified for each installation in 2018 with its theoretical production (calculated on the basis of operating hours and the net capacity of the installation). In this way, a difference could be established between identified production and theoretical production. That difference corresponds to potentially useful waste heat.

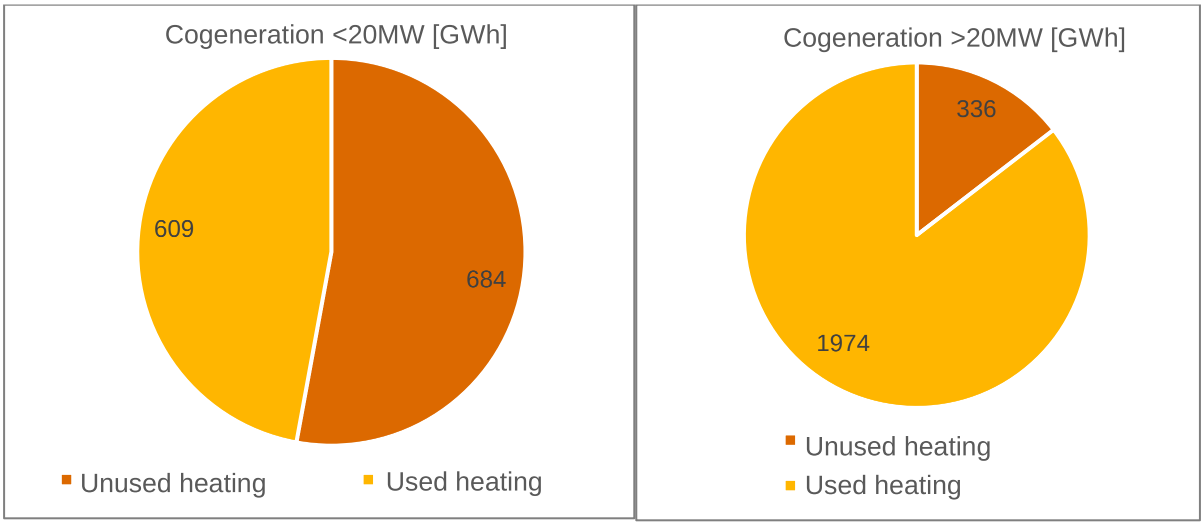


Figure 14: Unused share of heating produced

For cogeneration exceeding 20 MW capacity, it is therefore possible to recover an additional **336 GWh**, whereas for cogeneration below 20 MW, **684 GWh** is possible. This represents 14.5% and 53% respectively of waste heat loss. Overall, this amounts to 1 020 GWh of waste heat.

If the data is considered in terms of the type of fuel used, for all capacities combined, these losses come mostly from biomass-powered installations.

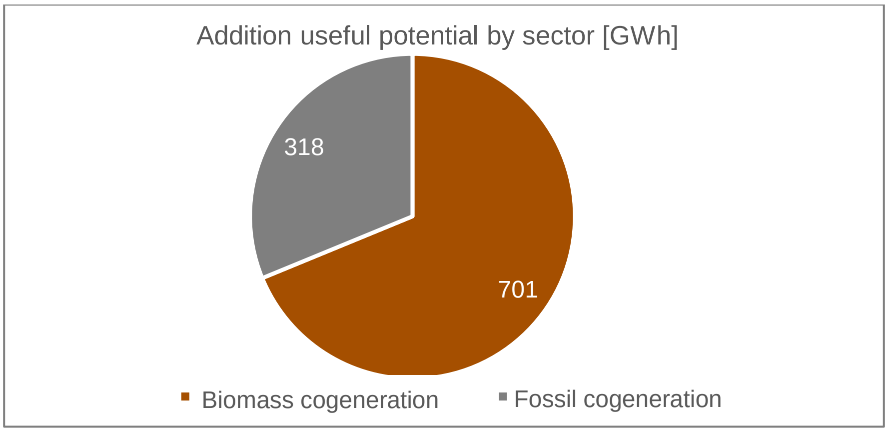


Figure 15: Waste heat by used fuel type

A second database was used to analyse the cogeneration sector. This database offers a broader overview of the sector but does not mention its effective production. This has therefore been estimated on the basis of figures published in Wallonia’s 2016 primary production and recovery balance.

For cogeneration exceeding 1 MW_{th}[51], the total cogeneration capacity in Wallonia is 1 398 MW_{th}. Fossil fuel-powered cogeneration accounts for 90% of those installations. The remaining 10% are biomass-powered installations. 12 installations have a capacity exceeding 20 MW. They account for 1 187.48 MW or 85% of total installed capacity. Most installations have a capacity of less than 10 MW.

On the basis of Wallonia's 2016 **primary production and recovery balance**, it is possible to produce 6 143.9 GWh of heating from an installed thermal capacity of 1 191. 8 MW_{th}[52]. By applying this ratio to the installed capacity mentioned above, the heating produced should slightly exceed 7 200 GWh. Installations with a capacity exceeding 20 MW_{th} should, on their own, produce approximately 6 125 GWh of heating (85% of 7 200 GWh).

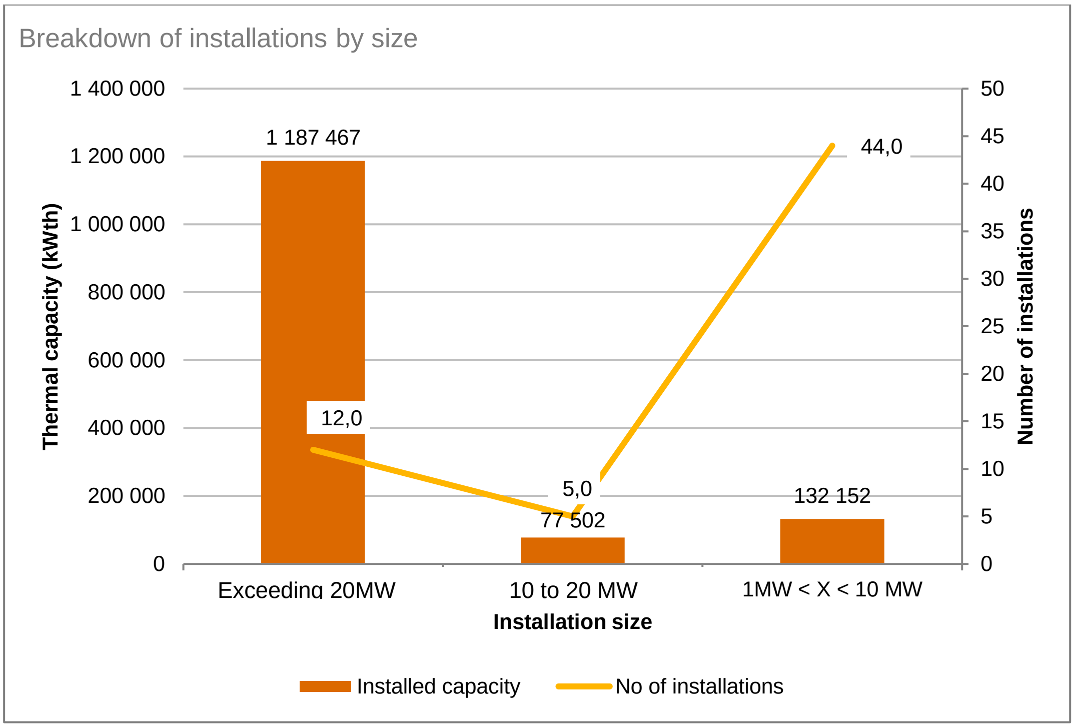


Figure 16: Cogeneration installations exceeding 1 MW

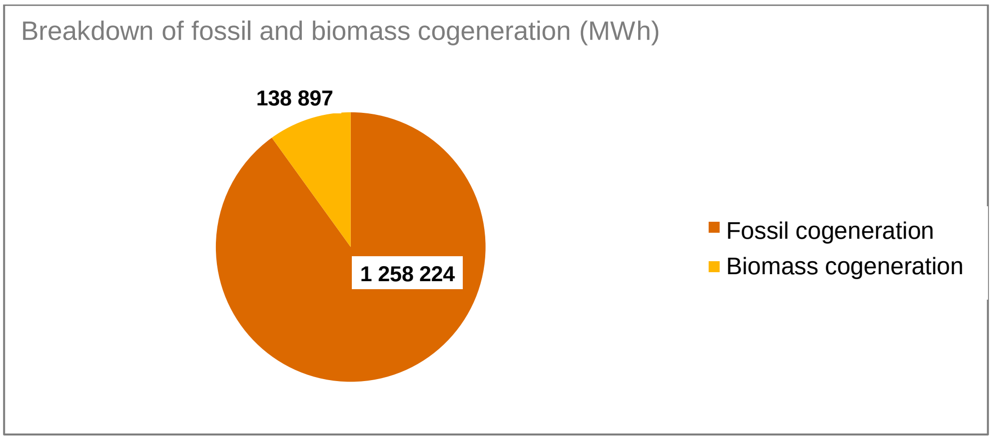


Figure 17: Breakdown of fossil fuel and biomass-powered cogeneration

[51] According to the 2016 primary production and recovery balance, 124 installations have a thermal capacity of less than 1 MW_{th}, accounting for a total of 24.1MW_{th}.
[52] *Bilan de production primaire et récupération 2016*, p. 41.

IV.4. *Waste incineration plants*

On the basis of the figures provided by BW2E[53] (the federation of Belgian installations processing residual domestic waste and similar in the form of energy recovery), 1 500 000 MWh of electricity is produced each year from waste in Belgium, supplying 430 000 households. Annual heating production amounts to 1 000 000 MWh, of which 350 000 MWh is intended for industrial uses or for heating buildings.

There are four waste incineration sites in Wallonia. The image below presents the main figures for waste recovery at each of those sites. Walloon incinerators are estimated to have a total thermal potential of:

Incinerator in Aiseau-Presles[54]: 22.8 GWh_{th};
Incinerator in Herstal[55]: 60 GWh_{th};
Incinerator in Beloeil[56]: 192.70 GWh_{th};
Incinerator in Ittre[57]: 39.4 GWh_{th};

Currently, only the energy recovery units in Herstal and Aiseau-Presles have projects which are ongoing/under development. The values for the two other energy recovery units therefore correspond to additional potential.

Beloeil energy recovery unit

- Number of furnaces: 4
- Capacity: 48.4 tonnes of waste per hour
- Turbine capacity: 18.5 MW + 19.1 MW
- Electricity production: 314 GWh, i.e. 75 000 households

Herstal energy recovery unit

- Number of furnaces: 2
- Capacity: 42.0 tonnes of waste per hour
- Turbine capacity: 34 MW
- Electricity production: 240 GWh, i.e. 51 000 households

→ Development of thermal capacity for a district heating network yet to be determined.

Ittre energy recovery unit

- Number of furnaces: 2
- Capacity: 14 tonnes of waste per hour
- Turbine capacity: 2*4.5 MW
- Electricity production: own-consumption + 5 000 households

Aiseau-Presles energy recovery unit

- Number of furnaces: 2
- Capacity: 16 tonnes of waste per hour
- Turbine capacity: 4.5 + 1.4 MW
- Electricity production: 27 GWh

→ Development of thermal capacity for a district heating network yet to be determined.

Image 2: Waste incineration

[53] http://www.bw2e.be/fr/a-propos-de-bw2e/, [visited on 16 April 2020].
[54] On the basis of a study carried out by Ph. Deplasse et Associés.
[55] https://www.intradel.be/qui-sommes-nous/les-outils/le-pole-recyclage-et-valorisation/uvelia.htm?lng=fr
[56] Data provided by the operator. Although this figure could technically be achieved, it would not appear to be the most balanced from a technical-economic perspective.
[57] Estimate based on conservative assumptions derived from the other three cases.

IV.5. *Renewable energy installations (> 20 MW)*

This paragraph is intended to identify the renewable energy installations with additional useful heating potential. The following three technologies are considered:

- Solar thermal
- Biomass
- Geothermal

Currently, there are no solar thermal installations with a capacity exceeding 20 MW. The additional useful potential is therefore 0.

With regard to biomass, only one installation with a capacity exceeding 20 MW was identified. However, as we do not have sufficient information about it, we were unable to assess the installation's useful waste heat. It was therefore considered to be 0.

Likewise, we did not have sufficient information about the geothermal installation operating in Saint-Ghislain. The installation's waste heat was therefore also considered to be 0.

IV.6. *Waste heat*[58]

The waste heat potential of Walloon industry was quantified taking into account the five sectors with the greatest energy needs. Together, those sectors account for more than 90% of the energy needs of Walloon industry[59]. This assumption in the interests of simplification reduced the complexity of the exercise whilst guaranteeing that the results obtained were sufficiently exhaustive.

The figures presented below are based on the effective consumption of companies subject to Sector Agreements. As shown in the table below, energy consumption covered by Sector Agreements accounted for 95%[60] of the energy consumption identified in Wallonia's 2016 energy balance in respect of the five sectors selected as being exhaustive.

	Sector Agreements			**Energy balance**			**% of balance**
	Fuel	Electricity	Total	Fuel	Electricity	Total	
IRON AND STEEL	3 197	1 832	5 029	3 380	1 916	5 297	95%
CHEMICALS	6 843	2 067	8 910	5 524	2 933	8 457	105%
NON-METALLIC MINERALS	9 647	1 257	10 903	11 139	1 733	12 872	85%
FOOD	4 057	777	4 834	4 058	1 305	5 363	90%
PAPER	3 982	252	4 234	3 076	720	3 797	112%
TOTAL	27 726	6185	33 911	27 178	8 608	35 786	95%

Table 28: Comparison between Sector Agreements and the energy balance (GWh)

In Walloon industry there are three different sources of recoverable thermal heating:

1. Thermal heating from electricity
2. Thermal heating from fuel
3. Renewable heating not accounted for in energy balances

[58] The assumptions and figures presented in this section were provided by the industry facilitator appointed by Wallonia. The request for this formed part of the tasks assigned to the energy facilitator for industry and carried out for SPW-Énergie.
[59] This percentage was deducted from the data available from Wallonia's energy balances for the industrial sector.

Thermal heating from electricity

This is heating which results from the use of electricity for thermal needs (steelworks, furnaces, electric drying ovens), but also recoverable heating from compressor cooling units or compressed air. The table below presents, first and foremost, heating needs catered for by electricity in the chosen industrial sectors. On the basis of sectoral electricity consumption under Sector Agreements ('Elec. consum.' column), we estimated either ('Process elec.' column) a percentage of that consumption for electricity needs (e.g. extruder, electrolysis, freeze-drying, drying ovens, melting kettles, etc.) or the heating needs of the three electric steelworks in Wallonia. For the iron and steel sector, recoverable heating is based on a heat exchange analysis at a steelworks. For the other sectors, it is based on a 10% recovery potential. The table also presents recoverable heating, which is estimated to be 188 GWh.

	Elec. consum.	Process elec.	Heating needs	Recoverable heating	Assumptions
IRON AND STEEL	1 832		817	100	Heating needs are real heating needs in the sector
CHEMICALS	2 067	35%	723	72	Heating needs are the assumed heating needs for extruders and electrolysis. Recoverable heating is considered to increase by 10% from smoke at 200°C.
NON-METALLIC MINERALS	1 257	-	-	-	Unavail.
FOOD	777	20%	155	16	Heating needs are the assumed heating needs for freeze-drying, drying ovens, melting kettles. Recoverable heating is considered to increase by 10% from smoke at 200°C.
PAPER	252	-	-	-	Unavail.
TOTAL	**6 185**		**1 696**	**188**	

Table 29: Thermal heating from electricity (Part I – GWh)

The table below presents, first and foremost, the share of electricity used in air compressors and compressor cooling units. Secondly, it quantifies the share of recoverable heating from those compressors. For all sectors combined, an efficiency of 50% was chosen for counter flow compressors. Recoverable heating was assessed as 1 513 GWh.

	Compressors	Compressor heating	Recoverable heating	
IRON AND STEEL	5%	366	50%	183
CHEMICALS	15%	1 240	50%	620
NON-METALLIC MINERALS	5%	251	50%	126
FOOD	35%	1 088	50%	544
PAPER	8%	80	50%	40
TOTAL		**3 027**		**1 513**

Table 30: Thermal heating from electricity (Part II – GWh)

Thermal heating from fuel

The following table presents the heating consumption (i.e. useful heat) and recoverable heating in each of the industrial sectors. The following assumptions were made for this analysis:

- **Iron and steel**: '69%' is based on the efficiency of preheating furnaces without recovery and '50%' on high-temperature recoverable heating;
- **Chemicals**: Recovery is estimated at 25%, as a significant proportion of steam is already used to generate electricity;
- **Non-metallic minerals**: '93%' is based on the efficiency of rotary furnaces and '10%' – for recoverable heating – on the fact there are very limited heating needs nearby;
- **Food**: '70%' is based on the seasonal efficiency of boilers; 50% of recoverable heating is heating at less than 100°C.

Recoverable heating from fuel consumption amounts to 2 987 GWh.

	Fuel consum.	Heating consumption		Recoverable heating	
IRON AND STEEL	3 197	69%	2 206	50%	496
CHEMICALS	6 843		3 290	25%	888
NON-METALLIC MINERALS	9 647	93%	8 971	10%	68
FOOD	4 057	70%	2 840	50%	609
PAPER	3 982		2 129	50%	927
TOTAL	**27 726**		**19 436**		**2 987**

Table 31: Thermal heating from fuel (GWh)

Renewable heating not accounted for in energy balances

The table below presents the renewable heating potential in industry which is currently unused. The figures are based on 400 audits of Sector Agreements. The results of those audits were consolidated by the 14 sector federations under the Sector Agreements[61].

	Renewable potential (GWh)
IRON AND STEEL	0
CHEMICALS	155
NON-METALLIC MINERALS	24
FOOD	150
PAPER	9
TOTAL	**338**

Table 32: Renewable heating not accounted for in energy balances (GWh)

[61] The results were presented in the sector reports, which have been partly published. https://energie.wallonie.be/servlet/Repository/adb2-rapport-public-2016.pdf?ID=51070

Consolidated results

Total waste heat is estimated to be 5 026 GWh/year. The chemicals sector has the highest waste heat potential (1 736 GWh), followed by the food sector (1 318 GWh). Thermal heating from fuel accounts for the majority of the potential (59%) and is estimated to be 2 987 GWh/year.

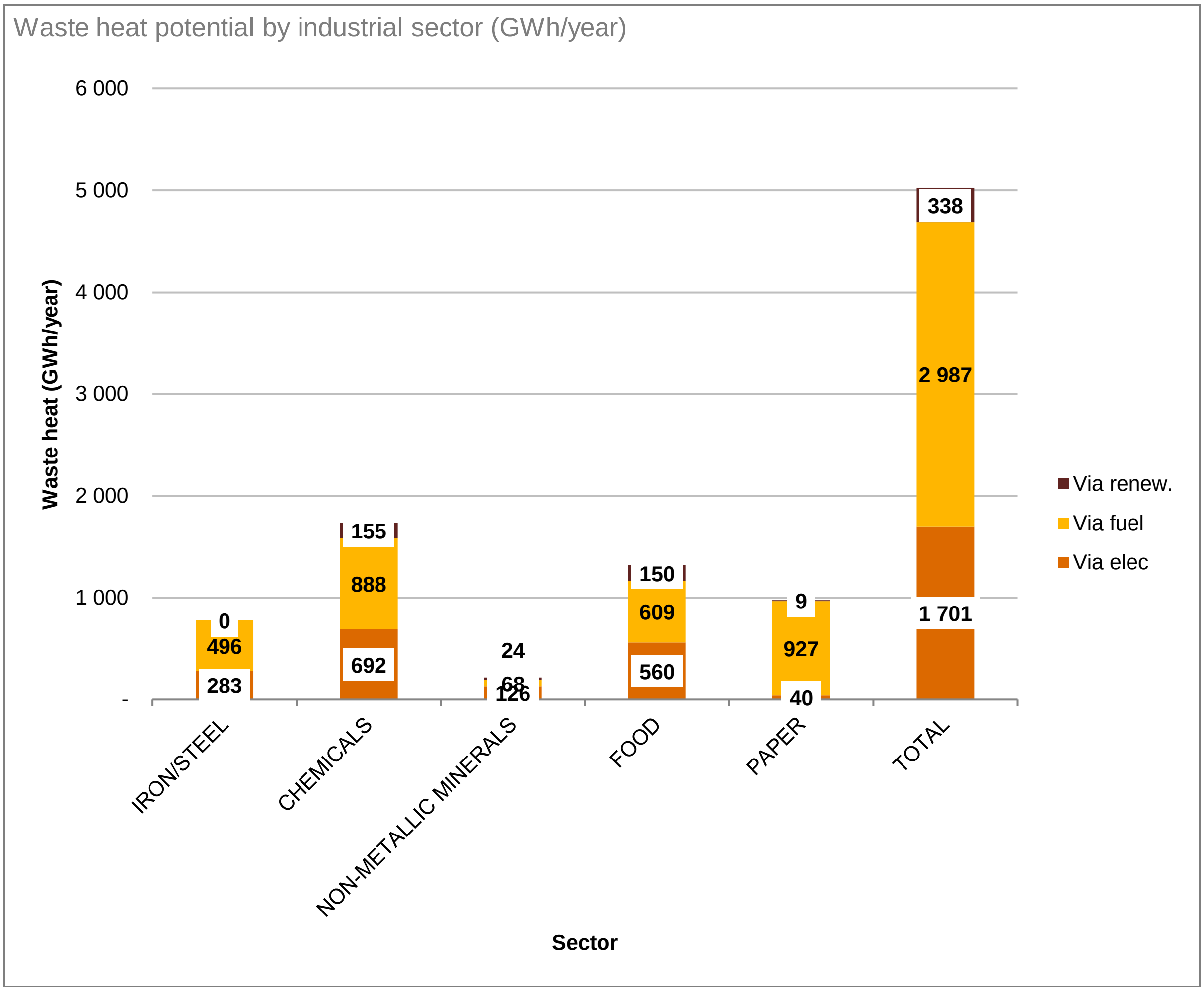


Figure 18 Waste heat potential

IV.7. *Summary*

The table below presents the useful waste heat for each type of installation.

Type of installation	Useful waste heat (GWh)
Thermal power generation installations (>50 MW)	0
Cogeneration installations	336 (>20MW); 684 (<20MW)
Waste incineration plants	315
Renewable energy installations (> 20 MW)	0
Industrial waste heat	5 026
Total	**6 361**

Table 33: Summary of useful waste heat by installation type

Chapter 5: Renewable energy

V. Share of heating needs met by renewable sources

V.1. *Recap of Annex VIII*

Point 2(c) of Part I of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling requires the following:

> Identification of the current heating and cooling supply:
>
> c. Share of energy from renewable sources and from waste heat or cold in the final energy consumption of the district heating and cooling sector over the past 5 years, in line with Directive (EU) 2018/2001.

V.2. *Identification of the share of heating needs produced from renewable sources*

V.2.1. *Sources and methodology*

The data presented in this section was taken from the *Compilation des données sur les installations produisant de l'électricité et/ou de la chaleur à partir de sources renouvelables d'énergie et les cogénérations aux énergies fossiles*, produced by the ICEDD for SPW-Énergie in 2018[62]. 2016 is still the reference year for this section. Annex VIII in conjunction with Article 14[63] states that the data on renewable heating must be presented for the past 5 years. However, data is only available until 2018. The following section therefore covers the period from 2012 (i.e. 5 years prior to 2016) to 2018 (most recent data available). As a longer period offers more to analyse, trends in renewable heating have been studied for the period 2012-2018.

V.2.2. *Overall results*

On the basis of the definition for 'renewable energy' (see glossary), heating produced in Wallonia from renewable energy comes from the following sources (in descending order by annual production): household and commercial biomass, biomass cogeneration, alternative fuels, heat pumps, solar thermal energy, charcoal and deep geothermal energy.

In 2016, **H-RES production reached 8 907 GWh**, meeting more than **13.5% of overall heating needs in Wallonia**. By comparison, H-RES production in 2012 was 7 568 GWh, meeting 11.3% of heating needs in Wallonia. Between 2012 and 2018, the share of heating produced from renewable energy rose from 11.3% to 13.14% in Wallonia. This growth can be explained by an overall reduction in heating needs and by an increase in the production capacity for renewable energy sources. Installed capacity grew **by an average of 3% each year** over the period 2012-2018.

	Unit	2012	2013	2014	2015	2016	2017	2018
H-RES installed capacity	GW	4.97	5.18	5.28	5.52	5.69	5.69	5.95

[62] *Compilation des données sur les installations produisant de l'électricité et/ou de la chaleur à partir de sources renouvelables d'énergie et les cogénérations aux énergies fossiles* (ICEDD, 2018).
[63] Article 14 of Directive 2012/27/EU (point 2(c)).

H-RES production	GWh	7 568.62	8 635.53	7 872.09	8 333.19	8 906.74	8 857.25	8 558.61
Share of H-RES in total	%	11.30%	12.43%	12.85%	12.69%	13.56%	13.46%	13.14%
Total heating production	**GWh**	**66 988.9**	**69 462.2**	**61 247.8**	**65 693.2**	**65 689.1**	**65 789.8**	**65 135.2**

Table 34: Change in H-RES installed capacity, H-RES production and share of H-RES in total heating production between 2012 and 2018 (GWh)

Article 23 of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources lays down that each Member State must endeavour to increase the share of renewable energy in the heating and cooling sector. The increase must amount to an indicative 1.3 percentage points as an annual average calculated for the periods 2021 to 2025 and 2026 to 2030, starting from the share of renewable energy in the heating and cooling sector in 2020, expressed in terms of national share. A limit of an indicative 1.1 percentage points applies to Member States where waste heating and cold is not used. **Over the period 2012-2018, the share of heating produced from renewable energy increased by an average of 0.3 percentage points each year**.

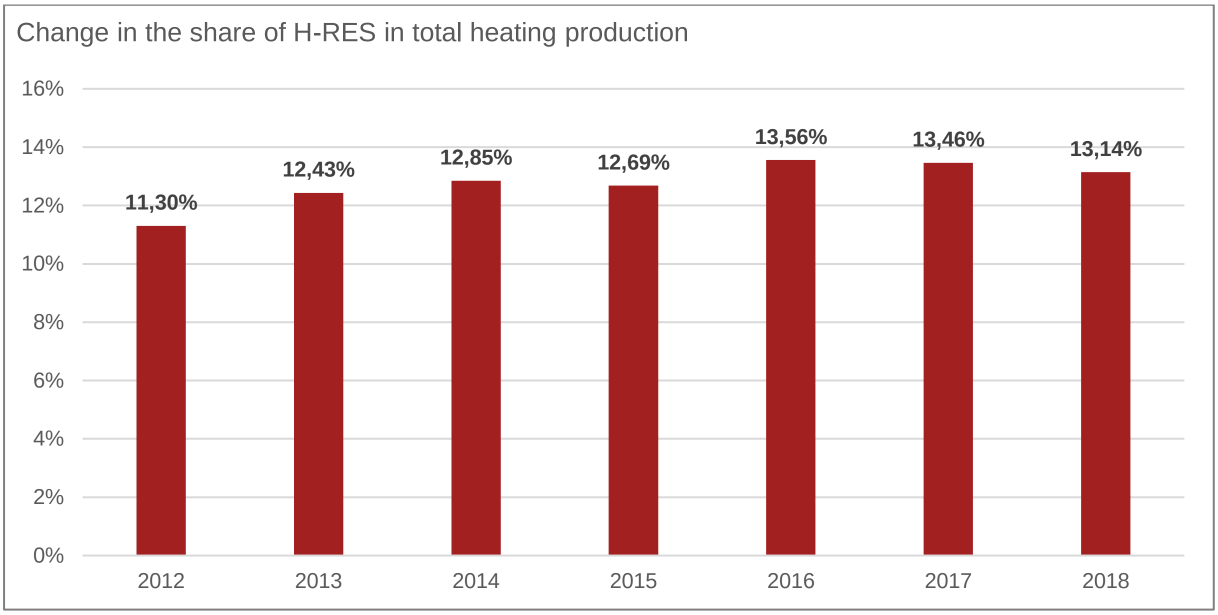


Figure 19: Change in the share of H-RES in total heating production

Figure 20 presents the change in H-RES installed capacity in Wallonia over the period 2012-2018. Installed capacity increased from 4.97 GW in 2012 to 5.95 GW in 2018, i.e. by almost 20% or an average of 3% each year. Figure 21 presents the change in H-RES production in Wallonia. H-RES production increased from 7 569 GW in 2012 to 8 556 GW in 2018, i.e. by almost 13% or an average of 2% each year. Importantly, heating production depends on the climate (degree days). Consequently, for the renewable heating production presented in this section, the fluctuations visible in the graph can be partly explained by variations in the climate from one year to the next.

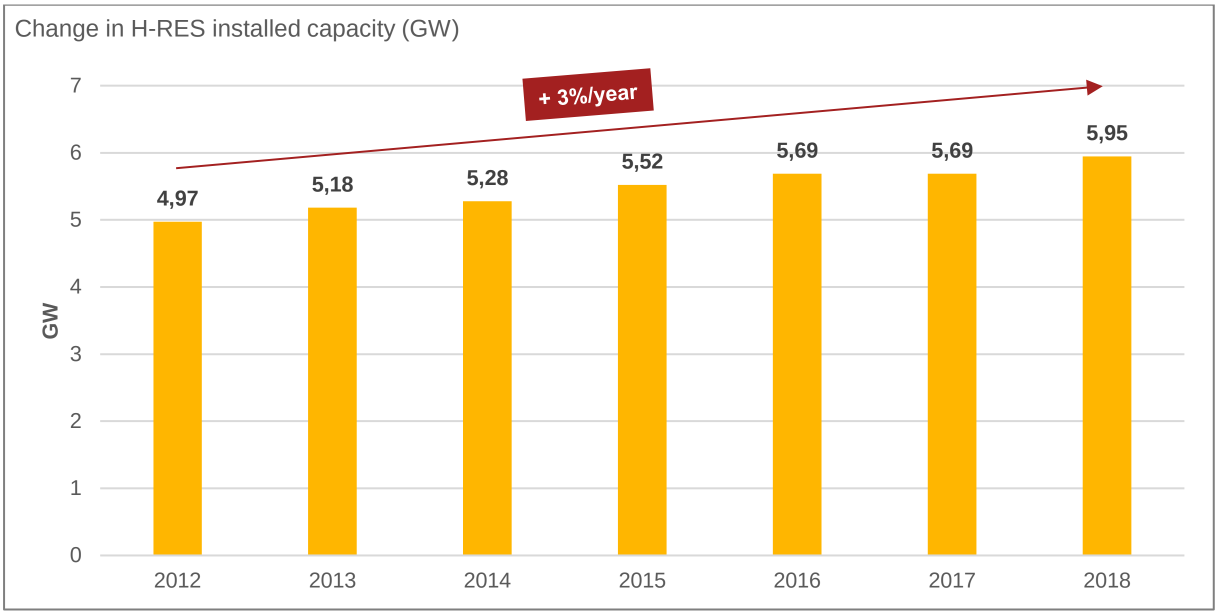


Figure 20: Change in H-RES installed capacity (GW)

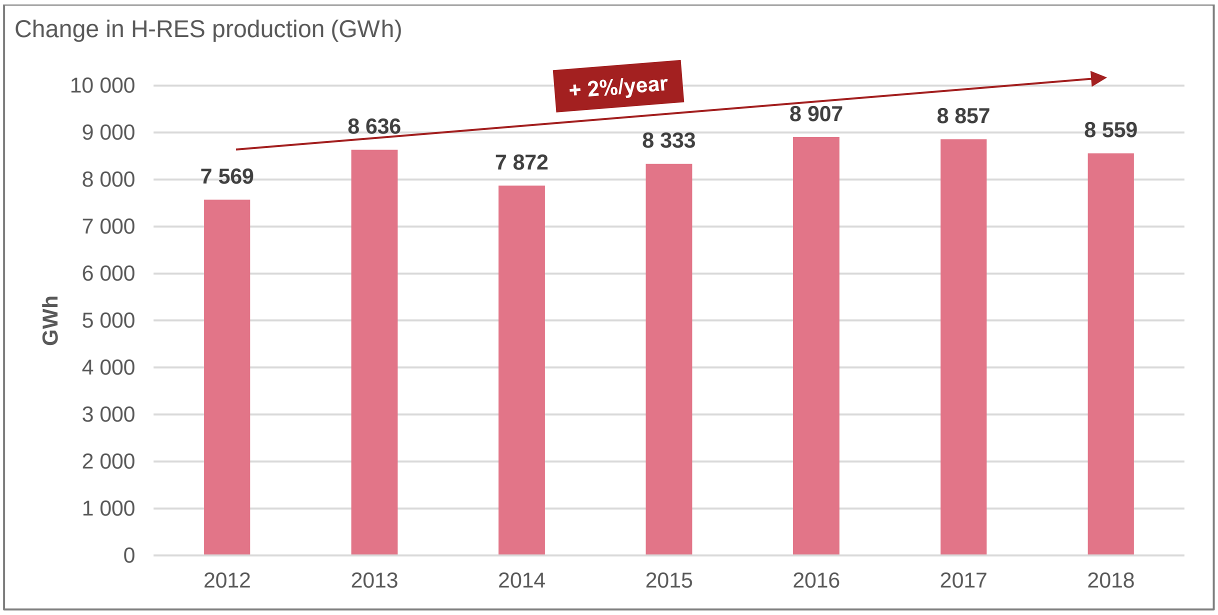


Figure 21: Change in H-RES production (GWh)

Presentation of different technologies

The table below presents the change in H-RES production over the period 2012-2018 by technology. In 2018, the three main H-RES sources in Wallonia, which accounted for 93% of H-RES, were household and commercial biomass (40%), cogeneration (37%) and alternative fuels (16%). Heat pumps recorded the greatest increase over the period under consideration, increasing by 110% in 6 years or an average of approximately 13% each year. The graph below presents the H-RES production of each technology in 2012 as compared to 2018.

Technology	Unit	2012	2013	2014	2015	2016	2017	2018	Annual increase[64]
Biomass cogeneration	GWh	2 991.12	3 358.08	3 616.91	3 392.88	3 424.67	3 575.69	3 161.48	**0.9%**
Household biomass	GWh	2 525.33	3 064.24	2 120.20	2 669.59	3 103.54	2 884.80	2 849.58	**2.0%**
Alternative fuels	GWh	1 300.09	1 356.73	1 297.03	1 374.09	1 340.14	1 291.13	1 416.64	**1.4%**
Commercial biomass	GWh	440.77	452.34	457.70	430.50	555.11	584.76	595.19	**5.1%**
Heat pump	GWh	153.17	188.74	181.73	213.56	242.84	244.76	323.68	**13.3%**
Solar thermal energy	GWh	83.41	84.96	92.04	100.22	95.12	96.80	113.60	**5.3%**
Charcoal	GWh	58.93	112.56	92.36	137.23	129.49	164.10	82.74	**5.8%**
Deep geothermal energy	GWh	15.80	17.89	14.11	15.11	15.82	15.20	15.70	**-0.1%**
H-RES production	**GWh**	**7 568.6**	**8 635.5**	**7 872.1**	**8 333.2**	**8 906.7**	**8 857.3**	**8 558.6**	**2.1%**
Share of H-RES in total	**%**	**11.30%**	**12.43%**	**12.85%**	**12.69%**	**13.56%**	**13.46%**	**13.14%**	**2.5%**
Total heating production	**GWh**	**66 988.9**	**69 462.2**	**61 247.8**	**65 693.2**	**65 689.1**	**65 789.8**	**65 135.2**	**-0.5%**

Table 35: Change in H-RES production by technology between 2012 and 2018

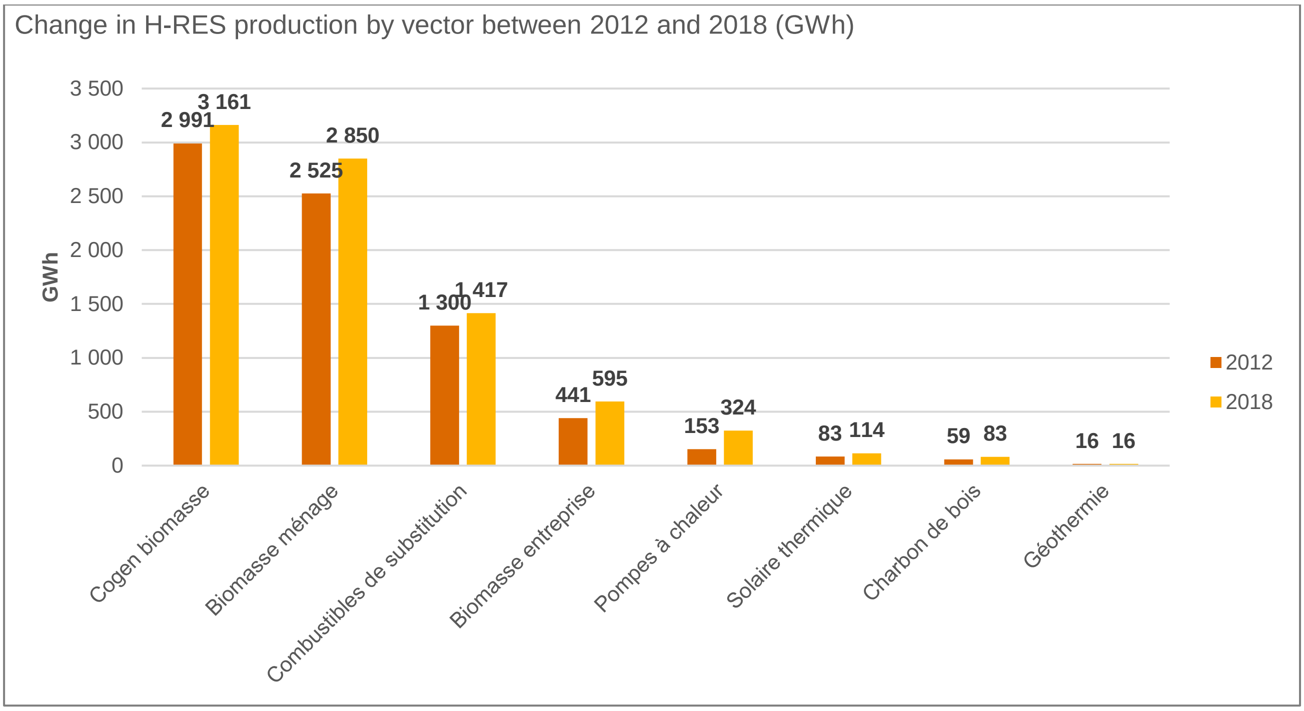


Figure 22: Change in H-RES production by vector between 2012 and 2018 (GWh)

[64] Average annual rate of increase over the period 2012-2018.

V.3. Renewable energy installations (> 20 MW)

This paragraph is intended to identify the renewable energy installations with a total thermal capacity exceeding 20 MW. Three technologies are analysed:

- Solar thermal energy
- Biomass boilers
- Geothermal energy

V.3.1. Solar thermal energy

In 2016, there were 34 421 thermal solar panel installations in Wallonia, accounting for a total surface area of 235 363 m². They generated 95 121 MWh, of which 90% came from the residential sector. In view of those figures and the 'residential' nature of the installations, there were seemingly no thermal solar energy installations with a capacity exceeding 20 MW_{th}.

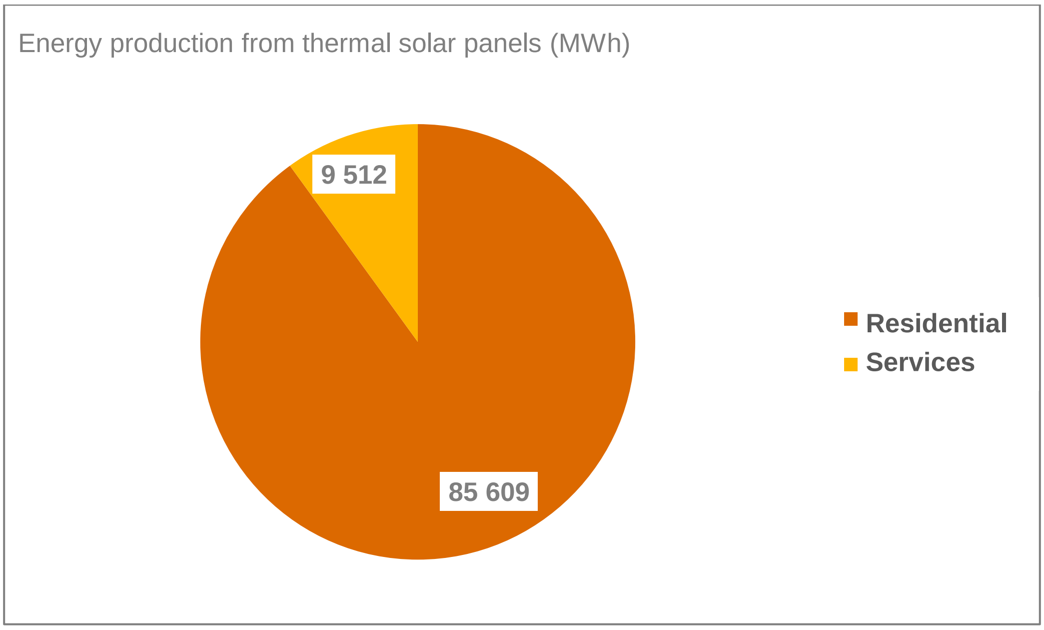


Figure 23: Energy production from thermal solar panels (MWh)

V.3.2. *Biomass boilers*

21 biomass boilers with a thermal capacity exceeding 1 MW_{th} were identified in Wallonia. Their combined capacity is 113.23 MW_{th}. **Only one installation had a capacity exceeding 20 MW_{th}.** 6 installations had a capacity exceeding 5 MW_{th}. Their total capacity accounted for 82% of the total installed capacity of the biomass boilers identified. The estimated total production of those installations is approximately 1 500 MWh_{th}.

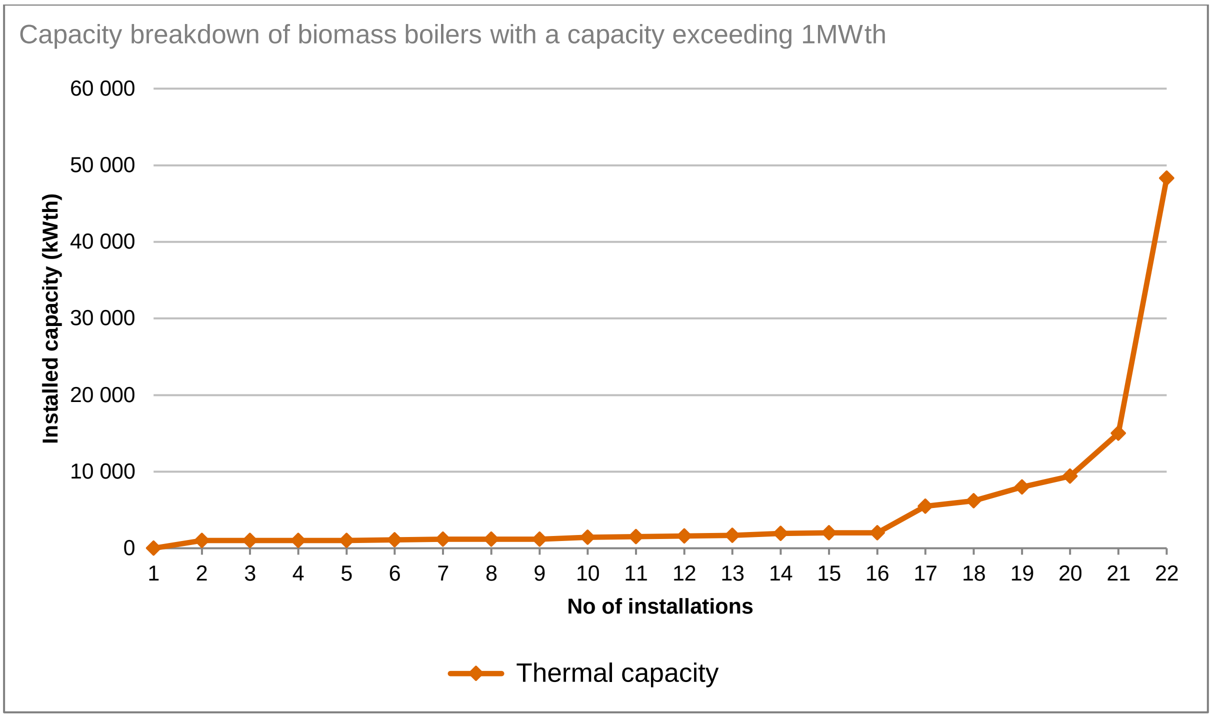


Figure 24: Capacity breakdown of biomass boilers with a capacity exceeding 1 MW_{th}

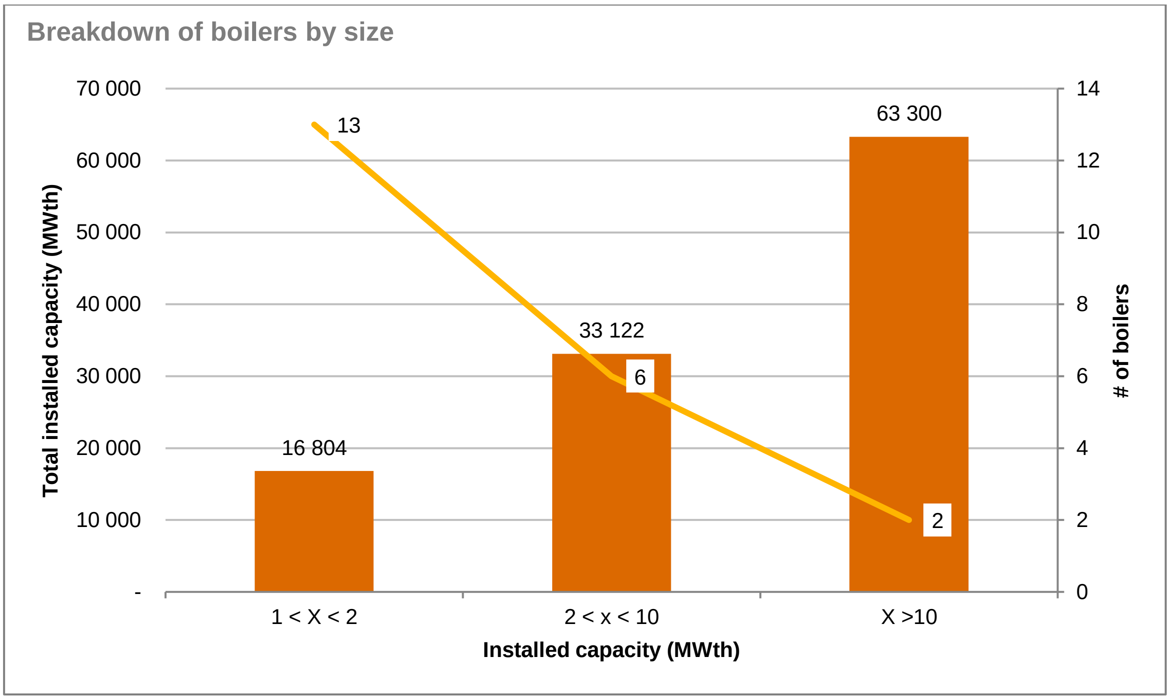


Figure 25: Breakdown and number of biomass boilers by size class

V.3.3. *Geothermal energy*

Historical background

Data provided by COMPIL-SER (version 2020 -1) shows that 15.8 GWh of heating was used from the two wells in operation in 2016, of which 11.9 GWh was sold. The remainder represents own-consumption. The graph below shows used and sold heating from the two wells in operation, for the period 1990-2016. The Saint-Ghislain well has a net installed capacity of 6 000 kW_{th}. The unit at Douvrain has an installed capacity of 3 000 kW_{th}.

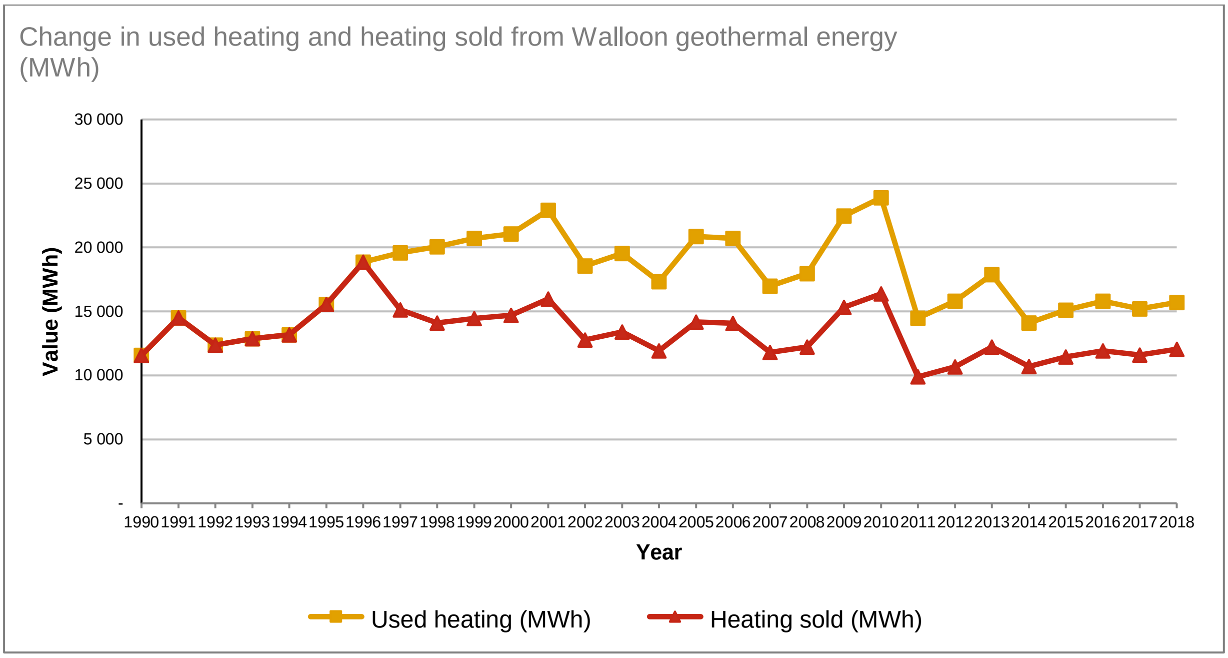


Figure 26: Production and use of heating sourced from Walloon deep geothermal energy (MWh)

In addition to the two aforementioned wells, a geothermal plant at a third well – dug in 1981 but remaining unused for more than 20 years – was opened in February 2018. This plant will supply heating to businesses in the surrounding commercial areas. The well has a depth of 1 500 m, and allows water to be used which, at the surface, has a temperature of 65°C. The geothermal plant has a capacity of 7 MW.

Finally, in June 2016, the Walloon Government approved the Géotherwall project by IDEA, financed by Wallonia and the ERDF (European Regional Development Fund). Two wells of a depth of some 2 500 m will be dug in 2021, one of which will be used for pumping hot water, the other for re-injecting the water into the subsoil after it has passed through heat exchangers. A geothermal plant will then be built and connected to the Ambroise Paré hospital district heating network in mid-2023, in order to provide the hospital with heating and domestic hot water. The anticipated flow rate is 150 m^3/hour, with water at a temperature of 73°C. This means a capacity of 7 MW. Between 10.5 and 14 GWh of heating could be distributed each year via insulated pipes.

Deep geothermal energy potential

In 2011, SPW-Énergie[65] launched a study seeking to determine geothermal potential in Wallonia – *Cartographie des Cibles géothermiques potentielles en Wallonie*. The aim was to determine the quality potential and areas suited to exploitation for deep geothermal energy in Wallonia.

[65] All information on the subject of geothermal energy in Wallonia can be found on the SPW's dedicated web page, https://energie.wallonie.be/fr/la-geothermie-profonde.html?IDC=6173

In 2015, SPW-Énergie launched a further study aimed at establishing the technical potential for deep geothermal energy in Wallonia. A statistical analysis of this potential was carried out, taking every precaution due to the lack of drilling sites in Wallonia. Assumptions were made when estimating the heating potential. Only the deep geothermal reservoir (depth of between 1 and 5 km) in Carboniferous (Dinantian) limestones was taken into account.

The assessment of the geothermal potential of Carboniferous limestones was calculated solely in terms of production and direct use of heating.

- The ground surface corresponding to the deep Carboniferous limestone deposit, as the main reservoir for deep geothermal exploitation, covers an area of 3 075 km^2 or almost 18% of Wallonia.
- The reference basis for calculating thermal energy production was the Saint-Ghislain (Mons) drilling site, which supplies water at 70°C, at a flow rate of 150 m^3/h, and which re-injects used water at 30°C. In other words, the geothermal plant has an installed capacity of 7 MW and produces 12 000 MWh per year per pair of boreholes, with an average use-efficiency rate of 20%.

The study estimated **the technical potential to be 1 536 GWh** and assumed 128 borehole pairs to be in operation by 2050. This roughly equates to an annual production of 228 GWh.

Geothermal mine energy potential

In January 2019, SPW-Énergie launched a study seeking to determine the technical geothermal energy potential of Wallonia's old disused mines. Based on the initial results, four coalfields in Wallonia were identified as having apparent material geothermal potential, namely the Couchant de Mons, Centre, Charleroi and Liège coalfields. The geothermal potential of the four coalfields was estimated on the basis of the volumes extracted and the exploitation depths. By analysing the combination of these key parameters, an initial estimate of the local potential could be obtained, namely 1 690 GWh. The data in the table below shows that the greatest potential can be found in the Couchant de Mons, Charleroi and Liège coalfields. The results of the analysis are presented in the table below.

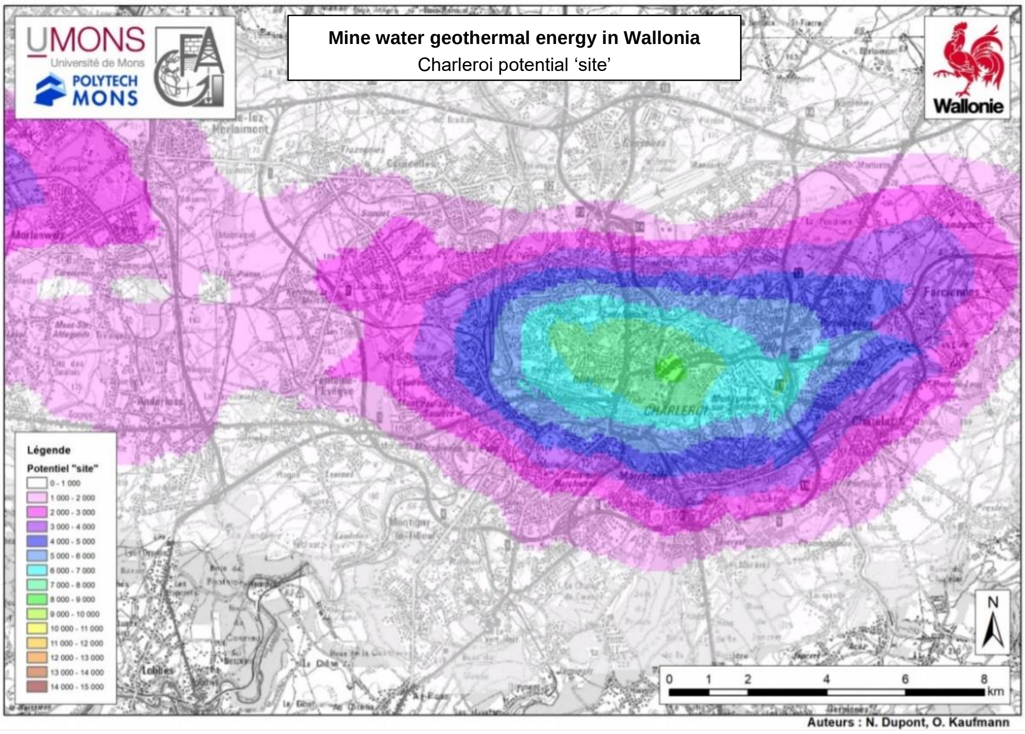
Region analysed	Estimated potential
Mons	486 GWh
Centre	259 GWh
Charleroi	501 GWh
Liège	444 GWh
Total	1 690 GWh

Table 1: Technical potential for geothermal mine energy

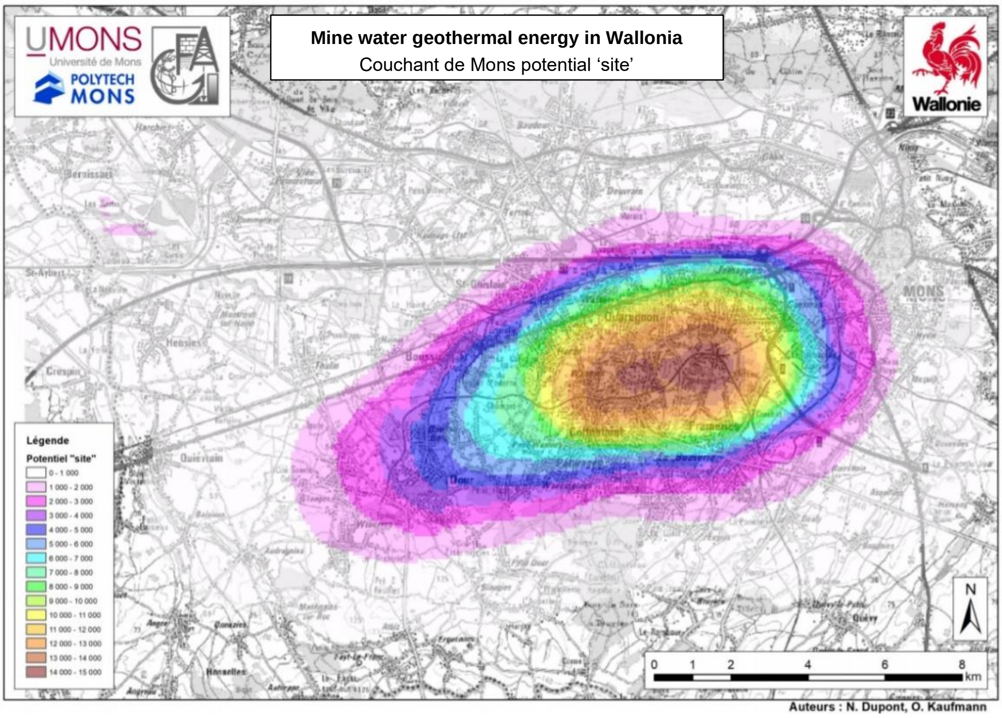
The study looked into identifying old mining sites with good low-energy geothermal potential in Wallonia. Maps of old mines and archives provided the basis for this, making it possible to identify seams which could be exploited, exploitation depths and the volume of water in those seams.

The geothermal potential of the three coalfields was estimated on the basis of the ore volumes extracted and the exploitation depths. By analysing the combination of these key parameters, an initial estimate of the local potential could be obtained.

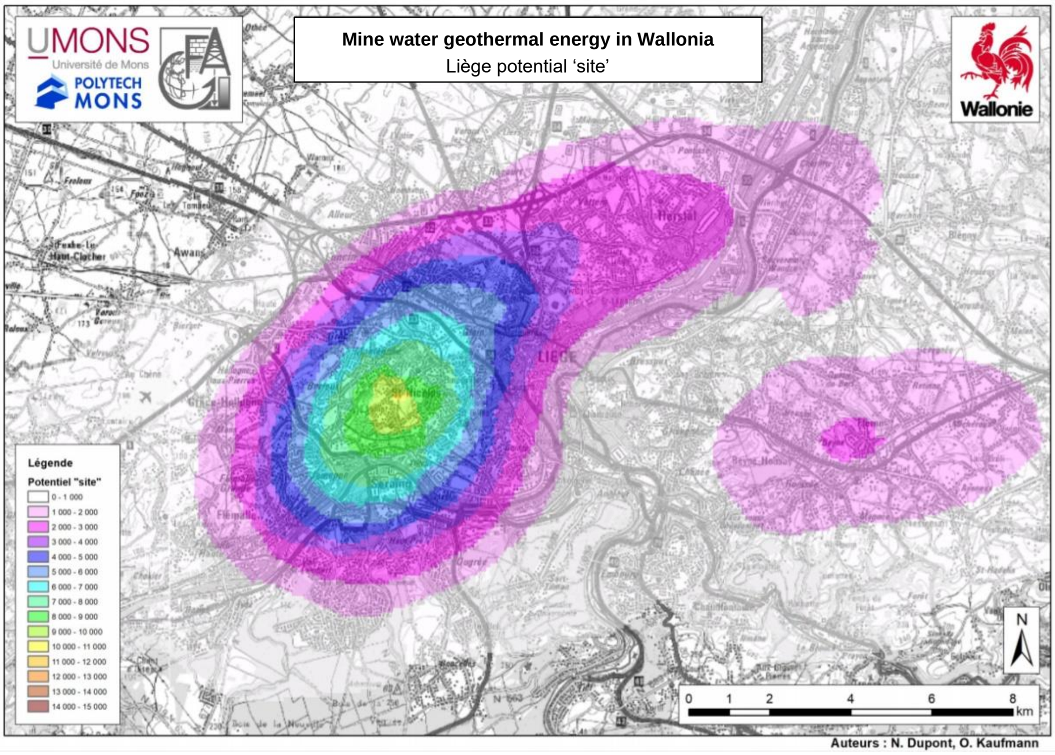
The study enabled three maps to be produced, presenting the three areas with high geothermal potential in the Charleroi, Couchant de Mons and Liège districts. These are reproduced below.



Map 1: Map of GWh potential at Charleroi 'site'



Map 2: Map of GWh potential at Couchant de Mons 'site'



Map 3: Map of GWh potential at Liège 'site'

The results show that the estimated thermal capacity of the different mining areas is 1 690 GWh. This represents real heating potential which would be useful to exploit in Wallonia. A pre-feasibility study is due to be launched for the Charleroi mining area in 2021. The aim of the study is to lay down the framework for a pilot project in line with current heating and cooling needs in the vicinity of the deposits, future development projects and the synchronisation of those needs (in terms of space and time). This would be a first for Wallonia. Positive experience in this field from the city of Heerlen (the Netherlands) has indicated that the exploitation of mine geothermal heat is a real resource not to be ignored.

V.4. Identification of the share of heating needs supplied by district heating networks produced from renewable sources

V.4.1. Sources and methodology

The data presented in this section is taken from Chapter 3 (section 3) and from the inventory of district heating and cooling networks produced by the ICEDD[66]. That document identifies the source fuel of the heating distributed by each heating network.

V.4.2. Overall results

In Wallonia, nearly all heating distributed by district heating network is produced from renewable energy (nearly 93% of the heating distributed). The remaining 7% comes from natural-gas powered cogeneration. More than 86% of H-RES distributed by district heating network is produced from dry biomass. The remainder is obtained from deep geothermal energy and wet and gaseous biomass.

	Production distributed	Share of total
District heating network – RES	220 GWh	92.9%
District heating network - Fossil	17 GWh	7.1%
District heating network - Total	237 GWh	100%

V.5. Summary

For 2016, the key figures for the production of heating from renewable energy sources are as follows:

- H-RES production of 8 907 GWh, i.e. 13.5% of heating consumption.
- The main source of energy is biomass, which provides 80% of H-RES (from biomass cogeneration (38%), household biomass (35%) and commercial biomass (6%)).
- The heating distributed by district heating networks in Wallonia mainly comes from renewable energy sources (nearly 93%).
- Over the period 2012-2018, the share of heating produced from renewable energy increased by an average of 0.3 percentage points each year.

[66] *Inventaire Réseaux de chaleur et de froid*, (ICEDD, 2017)

V.6. *Summary tables of Chapters 1 to 5*

For each sector, the table below presents the total energy needs, the heating and cooling needs (specifying substitutable heating and cooling needs) and the heating supply by production source (fossil/renewable and on-site/off-site) For each sector, it is worthwhile comparing substitutable heating needs with off-site heating production, as it shows that there is significant development potential for off-site heating production given the difference between the share of substitutable heating and the small share of off-site heating production.

2016 energy needs				2016 heating supply		
Residential sector	Total: 30 442 GWh				**Fossil**	**RES**
	HN: 26 507 GWh	CN: 997 GWh	Other: 2 938 GWh	On-site production	22 652 GWh	3 789 GWh
	SHN: 25 690 GWh	*SCN: 116 GWh*	-	Off-site production	0 GWh	66 GWh
Service sector	Total: 13 020 GWh				**Fossil**	**RES**
	HN: 6 985 GWh	CN: 914 GWh	Other: 5 121 GWh	On-site production	6 689 GWh	240 GWh
	SHN: 6 980 GWh	*SCN: 532 GWh*	-	Off-site production	17 GWh	76 GWh
Industrial sector	Total: 39 674 GWh				**Fossil**	**RES**
	HN: 29 724 GWh	CN: 852 GWh	Other: 9 098 GWh	On-site production	23 062 GWh	6 579 GWh
	SHN: 11 639 GWh	*SCN: 129 GWh*	-	Off-site production	0 GWh	83 GWh

The following table presents the quantity of useful waste heat for each waste heat source in Wallonia (in GWh).

Type of installation	Useful waste heat (GWh)
Thermal power generation installations (>50 MW)	0
Cogeneration installations (>20 MW)	336 (>20MW); 684 (<20MW)
Waste incineration plants	315
Renewable energy installations (> 20 MW)	0
Industrial waste heat	5 026
Total	**6 361**

Chapter 6: Change in heating and cooling consumption

VI. Change in heating and cooling consumption

VI.1. *Reminder of Annex VIII*

Point 4 of part I of Annex VIII to Directive 2012/27/EU on the content of comprehensive assessments of national heating and cooling potentials requires:

> a forecast of trends in the demand for heating and cooling to maintain a perspective of the next 30 years in GWh and taking into account in particular projections for the next 10 years, the change in demand in buildings and different sectors of the industry, and the impact of policies and strategies related to the demand management, such as long-term building renovation strategies under Directive (EU) 2018/844.

VI.2. *Introduction*

This chapter sets out separately the projected change in heating and cooling consumption for the residential, service and industrial sectors. Those estimates are based on the evaluation of heat consumption in 2016 and incorporate the prospective change in various key parameters on the basis of existing projections (carried out by the Federal Planning Bureau, for example), the historical evaluation of certain parameters or strategic targets. The baseline energy data for the model, i.e. the data for 2016, is taken from the 2016 energy balance[67] and is presented in chapters 1 and 2 of this report. **This projection must take into account the impact of policies and strategies that aim to improve the energy efficiency of heating and cooling demand.**

It should be noted that the projections presented here do not include the potential impact of the Covid-19 health crisis (impact on the economy, the financial capacity of investors, public budgets, the price of fossil fuels, etc.).

The results of the projections are presented below for each sector in terms of heating and cooling.

VI.3. *Methodology*

The various methodologies are set out in the annex to Chapter 6.

[67] Wallonia Energy Balance 2016 – District heating and cooling, ICEDD (2019)

VI.4. Projections for the residential sector

VI.4.1. Projections of heating consumption

Overall, it appears that heating consumption in the residential sector will decrease over the period 2016-2050, and at a higher rate from 2030 onwards. For the residential sector, the development of three variables determining heating needs is estimated:

- Number of dwellings;
- Average area of dwellings;
- Energy performance of dwellings (including improvements to equipment).

The development of this latter variable is based on the objectives of the renovation strategy (2017 version)[68] for 2030 and 2050 and assumes that they are achieved. As required by the Directive, the projections must take into account the strategies drawn up and policy measures used.

In 2016 the consumption of heating in the residential sector was 26 031 GWh. Based on the projections, **heating consumption in the residential sector is expected to amount to 14 448 GWh in 2050**, corresponding to an **average annual decrease of 1.22% between 2016 and 2030 and 2.62% between 2030 and 2050**.

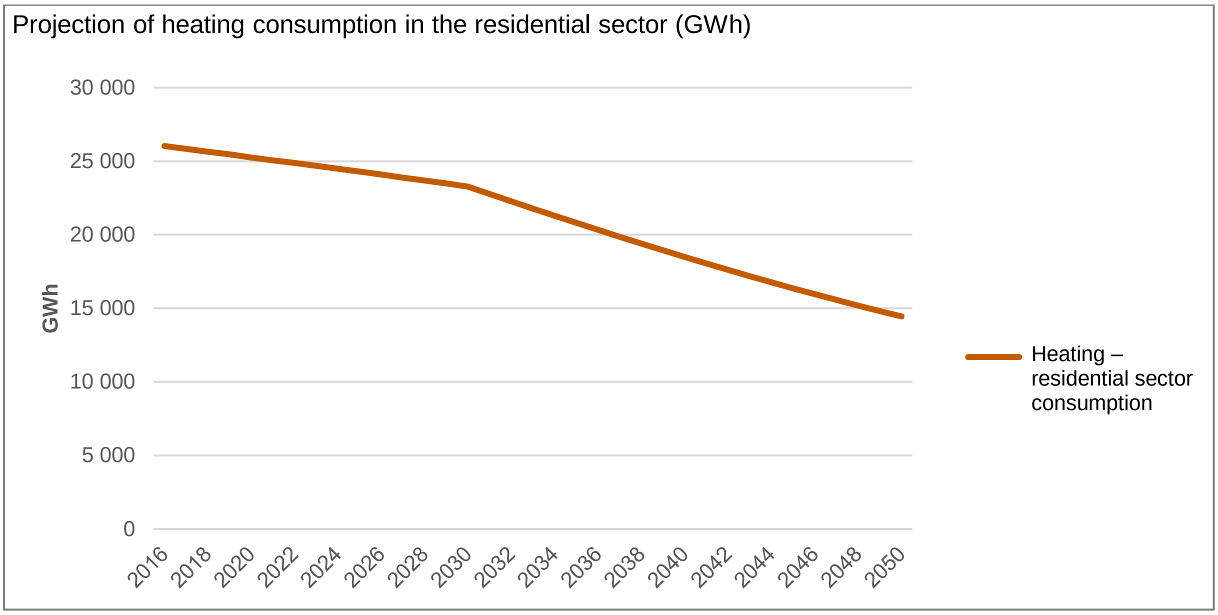


Figure 27: Projection of heating consumption in the residential sector (GWh)

[68] Walloon strategy for the long-term energy improvement of buildings, SPW (2017).

VI.4.2. *Projections of cooling consumption*

Overall, it appears that cooling consumption in the residential sector will increase over the period 2016-2050. For the residential sector, the development of variables determining cooling consumption is estimated:

- The need for air conditioning, which depends on:
  - the energy performance of buildings;
  - the share of dwellings equipped with air-conditioning systems;
- The need for refrigeration, which depends on:
  - the number of dwellings.

The development of the variable 'energy performance of buildings' is based on the objectives of the renovation strategy[69] for 2030 and 2050 and assumes that they are achieved, as for the heating projections.

In 2016 the consumption of cooling in the residential sector was 998 GWh. Based on the projections, **cooling consumption in the residential sector is expected to amount to 1 190 GWh in 2050, corresponding to an average annual increase of 0.52% between 2016 and 2050**. This is primarily due to the sharp rise in demand for air conditioning equipment.

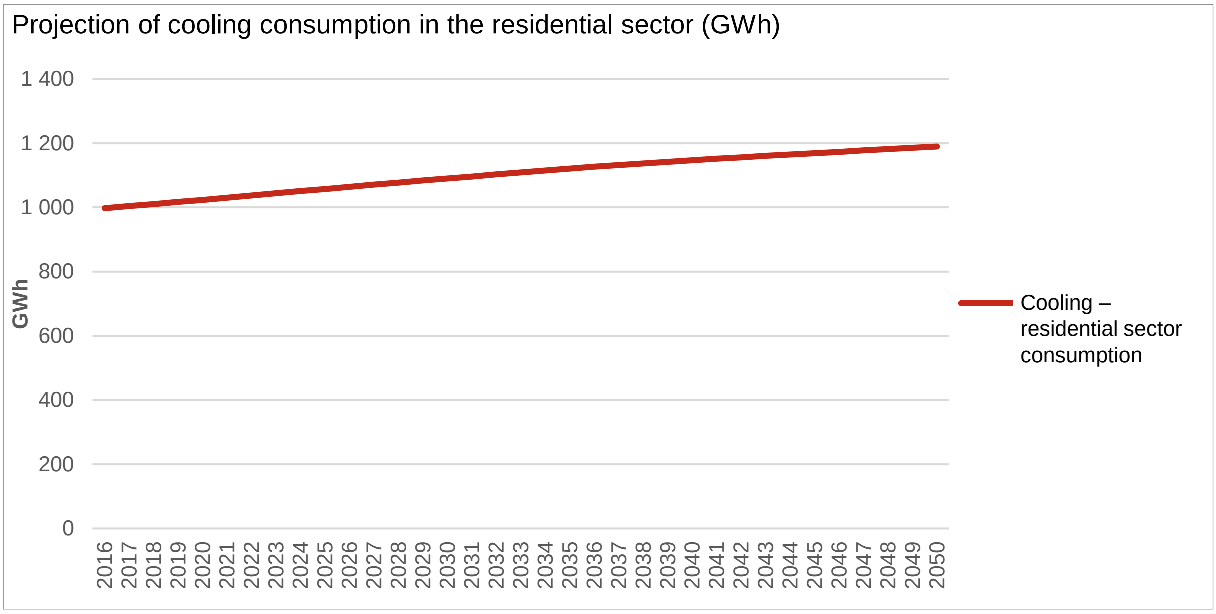


Figure 28: Projection of cooling consumption in the residential sector (GWh)

[69] Walloon strategy for the long-term energy improvement of buildings, SPW (2017).

VI.5. *Projections for the service sector*

VI.5.1. *Projections of heating consumption*

Overall, it appears that heating consumption in the service sector will decrease on average by 0.13% a year, from 7 021.61 GWh in 2016 to 6 895.51 GWh in 2030. Between 2016 and 2050 heating consumption is expected to fall by 5% (an annual decrease of 0.15%), reaching 6 669.44 GWh in 2050. Education and administration are the sectors with the most significant reductions in heat consumption (average annual decrease of 0.53%). The healthcare, culture and sport sectors and those sectors in the category 'other' show an increase in their heat consumption.

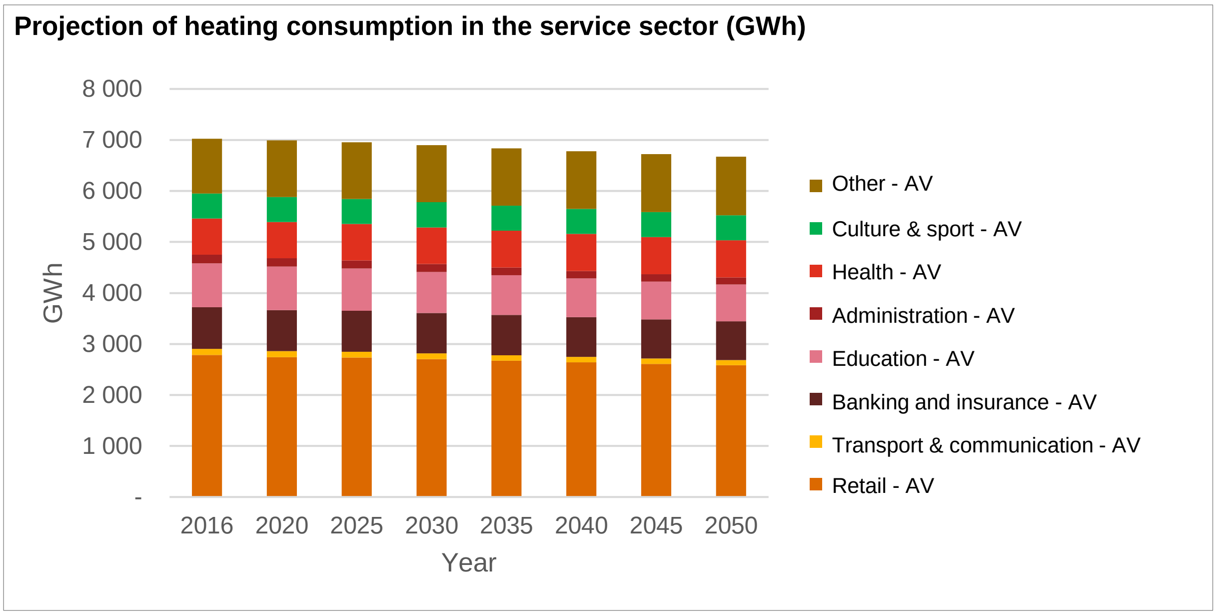


Figure 29: Projection of heating consumption in the service sector (GWh)

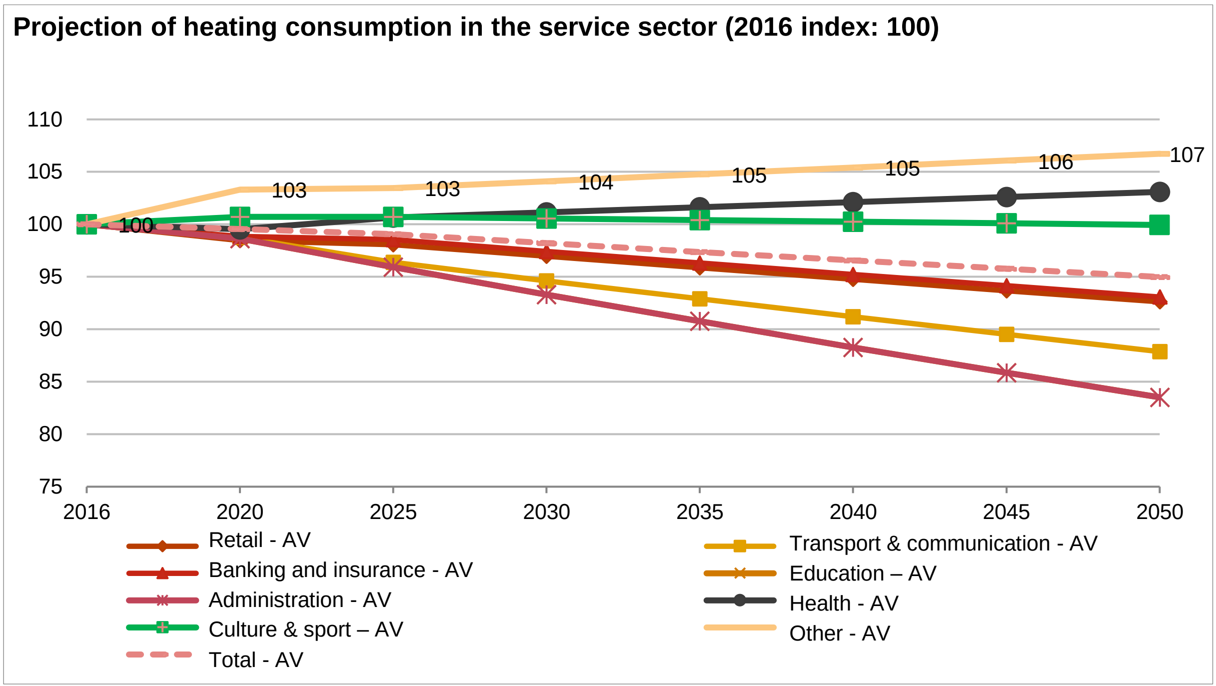


Figure 30: Projection of heating consumption in the service sector – 2016 index

Regional policy context

The region has a clear ambition for the energy efficiency of the service building stock in 2050: an energy-neutral building stock with regard to heating, domestic hot water, cooling and lighting. These buildings will produce as much energy as they consume, taking into account that part of the renewable energy production may be decentralised[70].

Based on this political ambition, the value of 'g' (energy intensity) measured by the Federal Planning Office and used in the analysis above should be challenged. In order to achieve its objectives, the region will have to both undertake to put in place measures aimed at maximising the energy efficiency of the building stock, and install the decentralised renewable production facilities needed to meet residual demand.

Heating consumption in the service sector in the Walloon Region in 2050 could range from 4 400.1 GWh to 8 775.9 GWh, giving an energy intensity factor of -0.5% and -2.5% respectively. Taking into account the results obtained in the analysis of the changes in heating consumption in the service sector, it appears that a residential building stock with PEB A would reduce annual energy consumption per m² by 0.89% to 2.05%. Based on the principle that improving the energy performance of the service building stock would achieve the same level of reduction in energy consumption as that of the residential building stock, it would be possible for heat consumption in the service sector to be between 5 200 GWh and 7 400 GWh (see grey rectangle on graph). The lower range (5 200 GWh) should be chosen to reflect the ambitious regional policies.

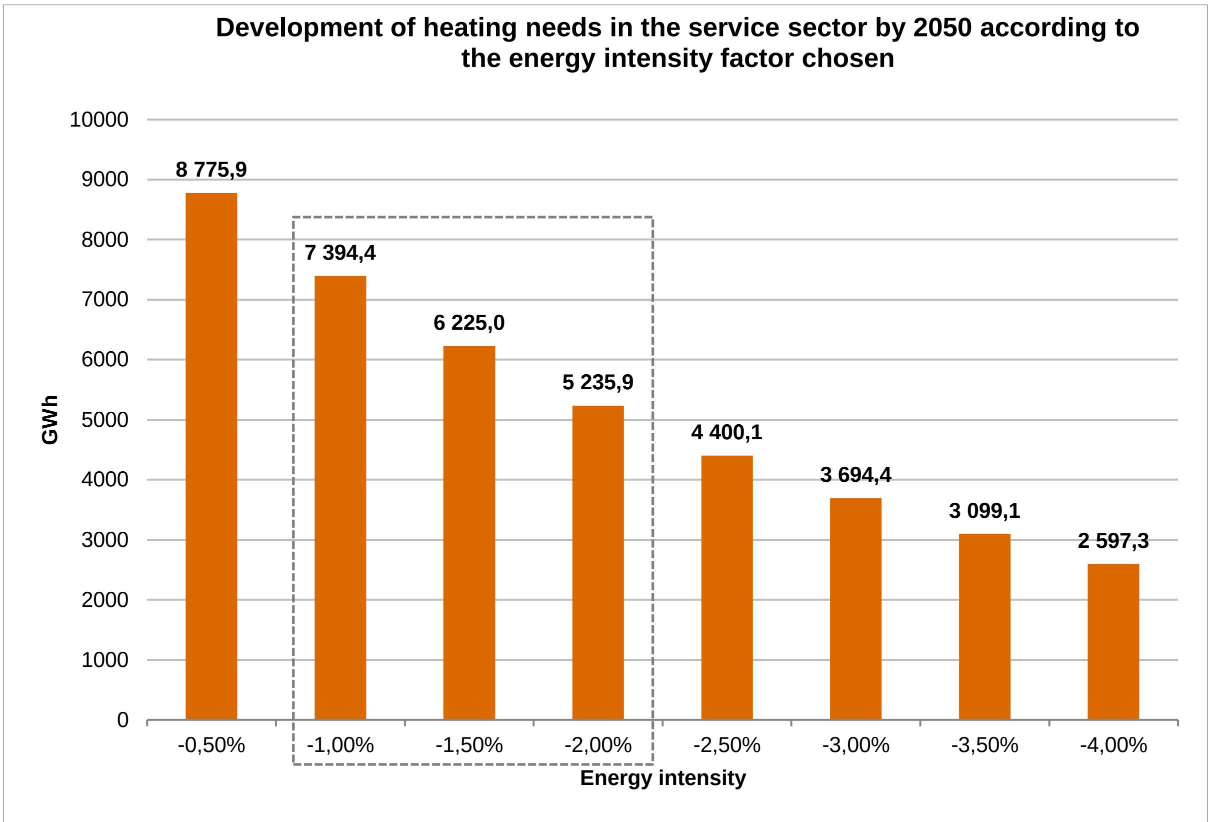


Figure 31: Development of heating needs in the service sector by 2050 according to the energy intensity factor chosen

[70] Walloon strategy for the long-term energy improvement of buildings – adopted by the Walloon Government on 20 April 2017, p. 26.

VI.5.2. *Projections of cooling consumption*

'Best-case' scenario

Based on the analyses carried out, cooling consumption in the service sector is expected to fall slightly in Wallonia by 2050, from 913.90 GWh to 859.79 GWh, corresponding to an annual decrease of 0.18%. This development is largely attributable to the retail sector – the service sector where cooling consumption was the highest in 2016. Between 2016 and 2050 the annual reduction in cooling consumption in the retail sector is estimated at 0.23%, largely due to energy efficiency improvements.

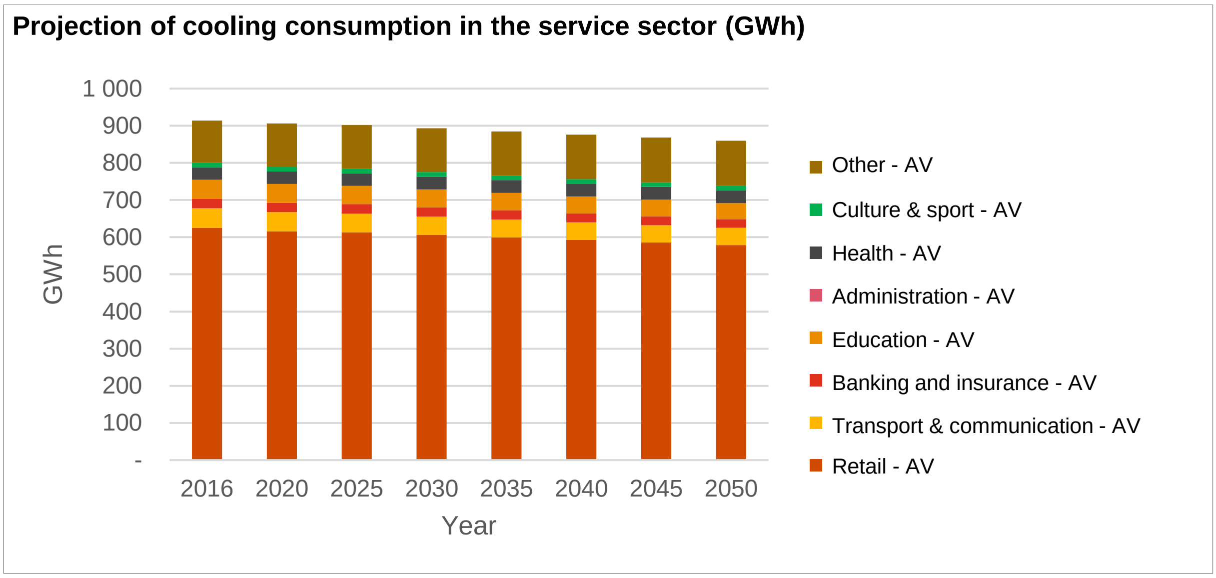


Figure 32: Projection of cooling consumption in the service sector (GWh)

'Realistic' scenario

Cooling consumption in the service sector in the Walloon Region in 2050 could range from 1 800 GWh to 3 100 GWh, giving an energy intensity factor of 0.5% and 2.5% respectively. Taking into account the results obtained in the analysis of the change in cooling consumption in the service sector, energy consumption per m² is expected to increase by between 1.04% and 2.23% a year depending on the scenario chosen. Based on the principle that the cooling consumption of the service building stock will follow the same trend as for the residential building stock, it would be possible to have cooling consumption in the service sector of between 1 900 GWh and 2 700 GWh (see grey rectangle on graph).

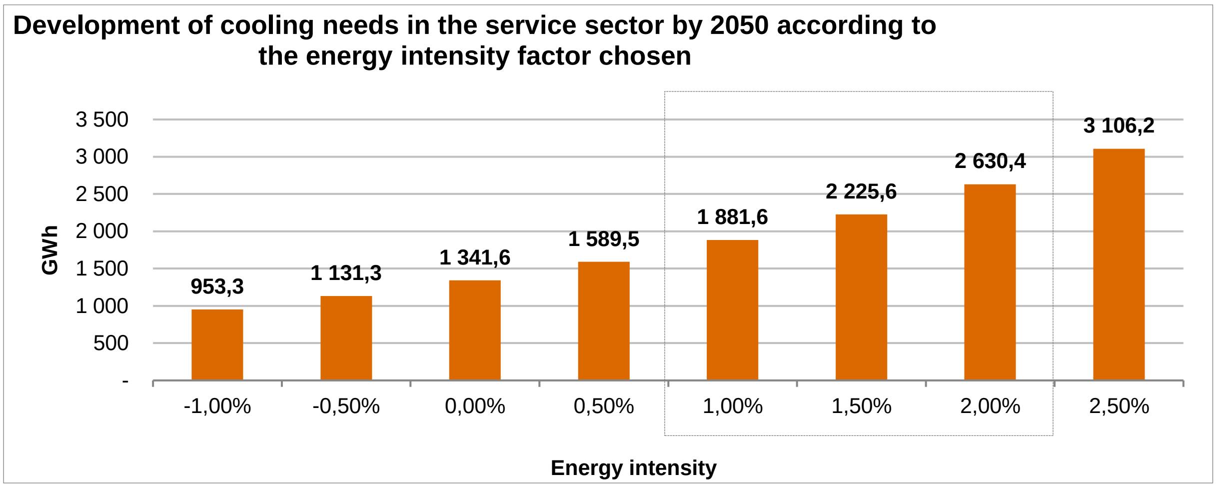


Figure 33: Projection of cooling consumption in the service sector – worst-case scenario (GWh)

VI.6. Projections for the industrial sector

VI.6.1. Projections of heating consumption

Overall, the analyses set out and detailed in the annex to Chapter 6 support an average annual increase in heating consumption of 0.07% between 2016 and 2030, rising from 29 724.48 GWh in 2016 to 30 001.53 GWh in 2030. This trend will then reverse from 2030 onwards, with an average annual decrease of 0.4% until 2050, reaching heating consumption of 27 710.66 GWh. For the period from 2016 to 2050, this translates into a reduction in heating consumption of 0.4% a year.

This trend is mainly influenced by the non-metallic minerals sector. Its heating demand accounts for 37% of industrial consumption in Wallonia. Its consumption will increase by 0.6% annually between 2016 and 2030. From 2030 heating demand will decrease by 0.41% a year until 2050.

For the industrial sector, the development of variables determining heating consumption is estimated:

- Heating needs per unit of value added
- Added value

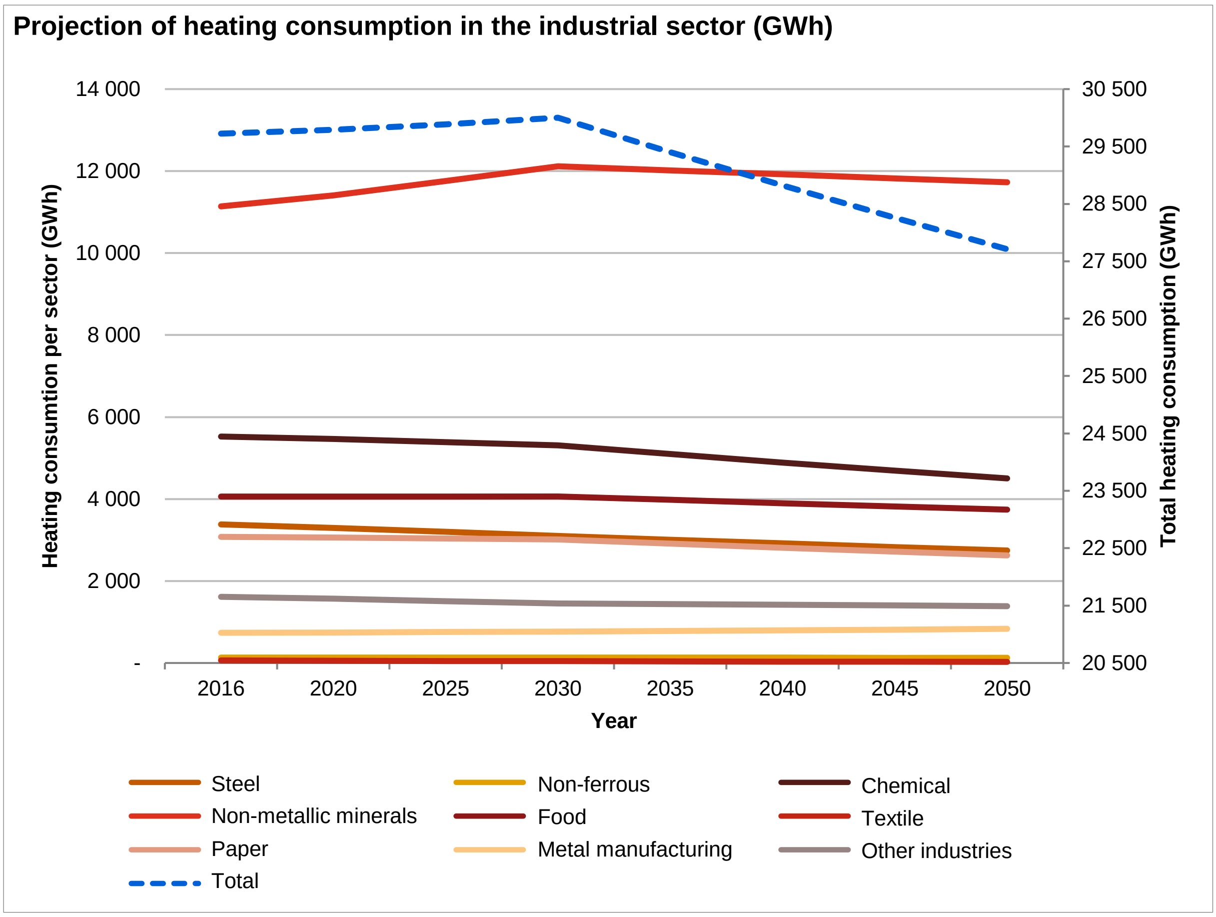


Figure 34: Change in heating consumption in industrial sectors in Wallonia

Among the other sectors, it is important to emphasise that:

- The **chemical** sector is expected to see a slight annual decrease in its heat consumption until 2030 (-0.28%). This is expected to increase thereafter to -0.82% for the period from 2030 to 2050.
- The textile industry will experience an annual decrease in heat consumption of 2.51% from 2016 to 2050. Even though these figures are significantly above the trend in other sectors, it is important to point out that the share of industrial heat consumption in Wallonia attributable to the textile industry is minimal (< 1.00%). The reduction is mainly due to a decrease in its added value over the period.

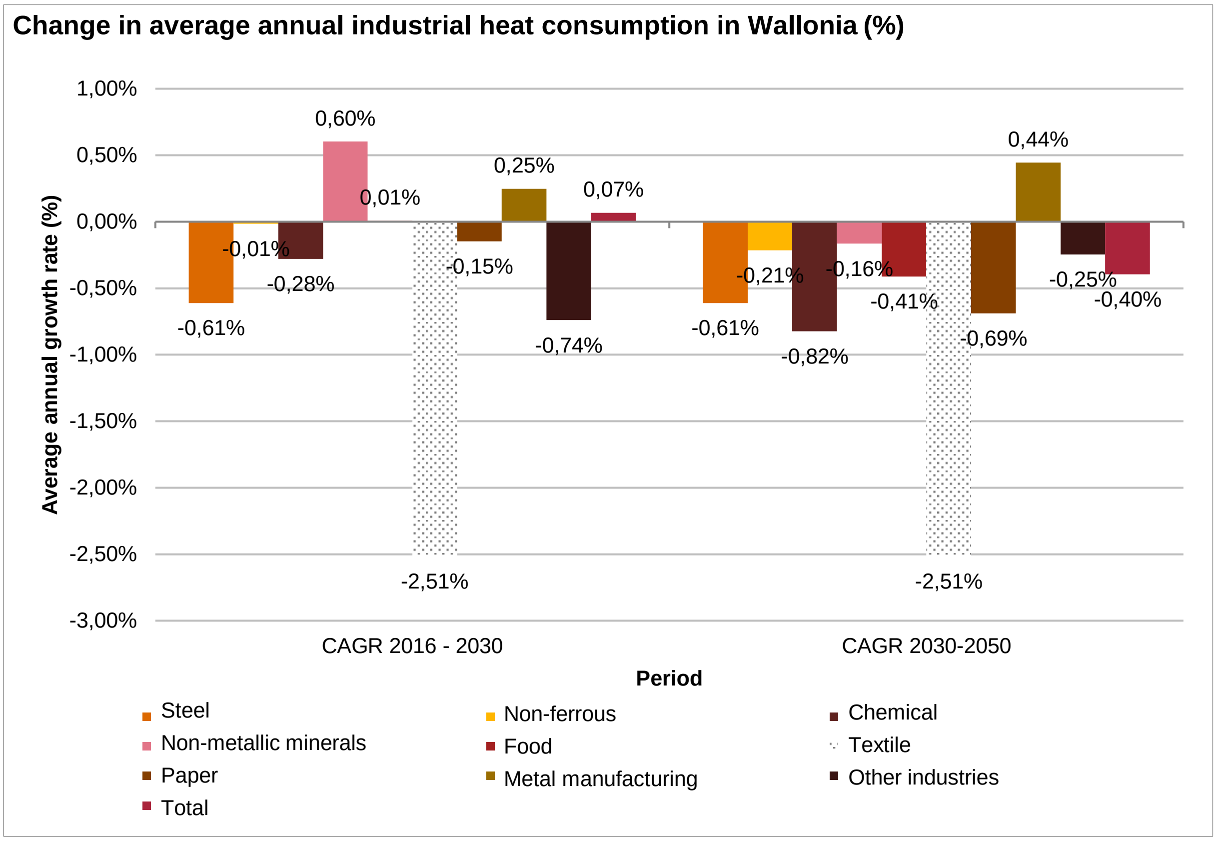


Figure 35: Change in average annual industrial heat consumption in Wallonia (%)

Regional policy context

The energy ambitions of industry in Wallonia are reflected in sectoral agreements. These are voluntary agreements between the region and businesses to improve energy efficiency and reduce CO_2 emissions from industrial processes. They are part of the European commitment to reduce greenhouse gas emissions by 80 to 95% by 2050 compared to 1990 levels. The industrial sector is also influenced by the EU emissions trading scheme.

Taking into account the upcoming expiry of the second-generation sectoral agreements (2023) and the time frame of this study, it is proposed that the 'g' factor (energy intensity) measured by the Federal Planning Bureau be compared with the sectoral roadmaps[71] produced by each of the federations and companies which are signatories to an agreement with the Walloon Government on sectoral agreements.

[71] These roadmaps can be found on the website https://energie.wallonie.be/fr/roadmaps-2050.html?IDC=9643.

The table below shows the energy efficiency potentials identified in the roadmaps drawn up by the federations. Although these figures are not binding on the various industries[72], they make it possible to identify potential developments in terms of energy efficiency.

Sector	Federation	Potential reduction by 2050[73,74]
STEEL INDUSTRY	GSV	undefined
NON-FERROUS	AGORIA	32%
CHEMISTRY	ESSENSCIA	undefined
NON-METALLIC MINERALS		
Cement	INDUSTRIE CIMENTIERE BELGE	20%
Lime/carr/dolomite[75]	LHOIST & CARMEUSE	0%
Glass	FEDERATION DE L'INDUSTRIE DU VERRE	10%
Other[76]	FEDERATION DE L'INDUSTRIE EXTRACTIVE	3%
FOOD	FEVIA	27%
TEXTILE	FEDUSTRIA	10%
PAPER[77]	COBELPA	47%
METAL MANUFACTURING	AGORIA	32%
OTHER INDUSTRIES	undefined	undefined

Table 36: Energy efficiency potentials identified

[72] Summary of the objectives of a roadmap: 'to help the federations and their member companies to anticipate changes and turn future constraints to advantage. It is intended as a tool for the federations but also for businesses.'
73 For sectors that have not quantified potential reductions, the percentage used will be the same as that used in the previous step.
74 The roadmaps were generally published in 2017 and 2018. The percentages highlighted assume a reduction in consumption between the years of publication and expiry, or 2050.
75 **Energy/CO_2 sectoral agreements with industrial sectors in Wallonia – public report on the sectoral roadmaps**, April 2018, p. 10: 'No major technological progress is expected with regard to the energy efficiency of lime production.'
76 **Energy/CO_2 sectoral agreements with industrial sectors in Wallonia – public report on the sectoral roadmaps**, April 2018, p. 8: 'The remaining potential for improvement is very small (2 to 3%) because the energy needed to break the rock is unchangeable and the various stages of processing are purely mechanical.'
77 Taking into account the ambitious scenario.

Based on these figures, it appears that the industrial sector in Wallonia could reduce its heat consumption by 25% between 2016 and 2050. The difference between the results of the analysis based on the figures published by the Federal Planning Office (BFP) and the results of the analysis based on the sectoral agreements is explained by the more ambitious figures for non-metallic materials (-1 702 GWh), food (-778 GWh) and paper (-998 GWh).

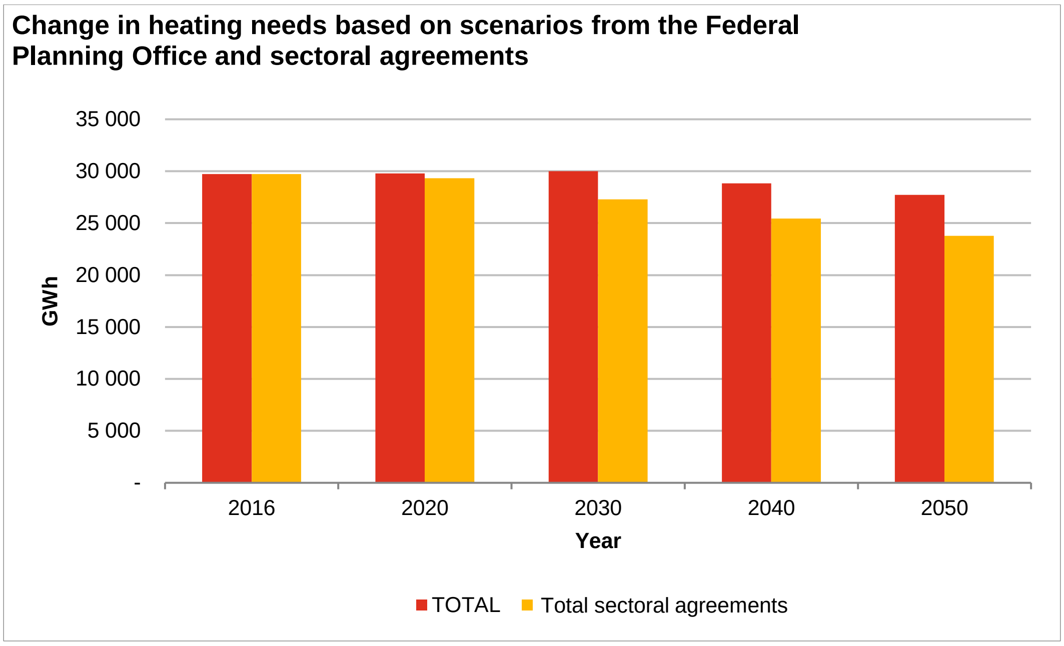


Figure 36: Change in heating needs based on scenarios from the Federal Planning Office and sectoral agreements

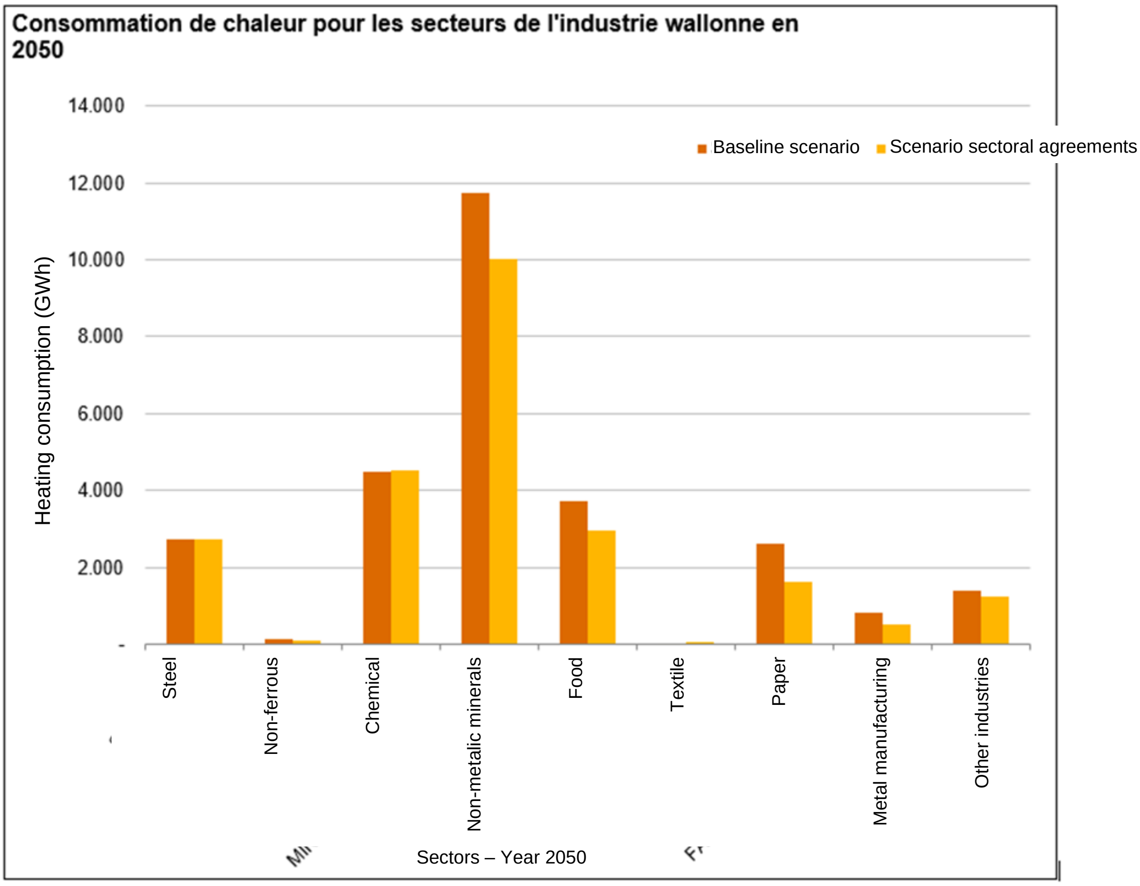


Figure 37: Heating consumption for the sectors of Walloon industry in 2050

VI.6.2. *Projections of cooling consumption*

'Best-case' scenario

Based on the analyses carried out, it appears that cooling consumption in the industrial sector should fall slightly in Wallonia by 2050, from 797.90 GWh to 690.66 GWh, corresponding to an average annual decrease of 0.42%. This development is largely attributable to the chemicals sector – the industrial sector where cooling consumption was the largest in 2016. Between 2016 and 2050 the annual reduction in cooling consumption in the chemicals sector is estimated at 0.6%.

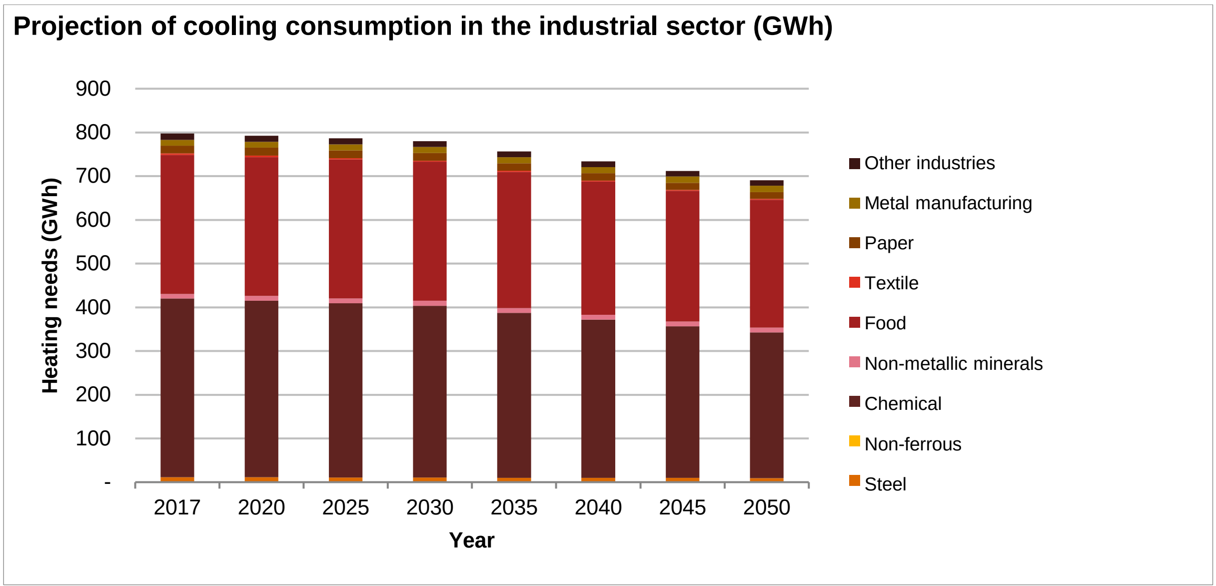


Figure 38: Change in cooling consumption in the industrial sector in Wallonia – best-case scenario (GWh)

'Realistic' scenario

Based on the analyses carried out, it appears that cooling consumption in the industrial sector should increase in Wallonia by 2050, from 797.9 GWh to 1 243.7 GWh, corresponding to an average annual increase of 1.12% and a total increase of 46%. Despite there being a larger increase for air conditioning, it should be noted that the current associated cooling consumption is low. Therefore the strong increase only has a minor impact on the final result, the majority of the increase being due to the need for 'process' cooling.

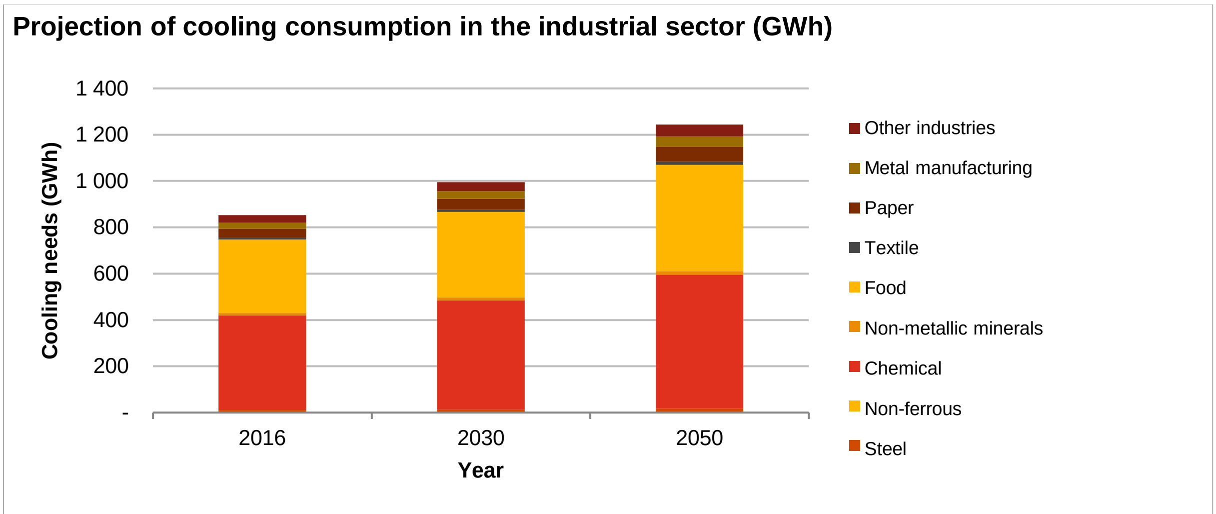


Figure 39: Change in cooling consumption in industry – realistic scenario (GWh)

VI.7. *Summary*

The graph below shows the expected change by 2050 in heating and cooling consumption for each sector, based on the above analyses.

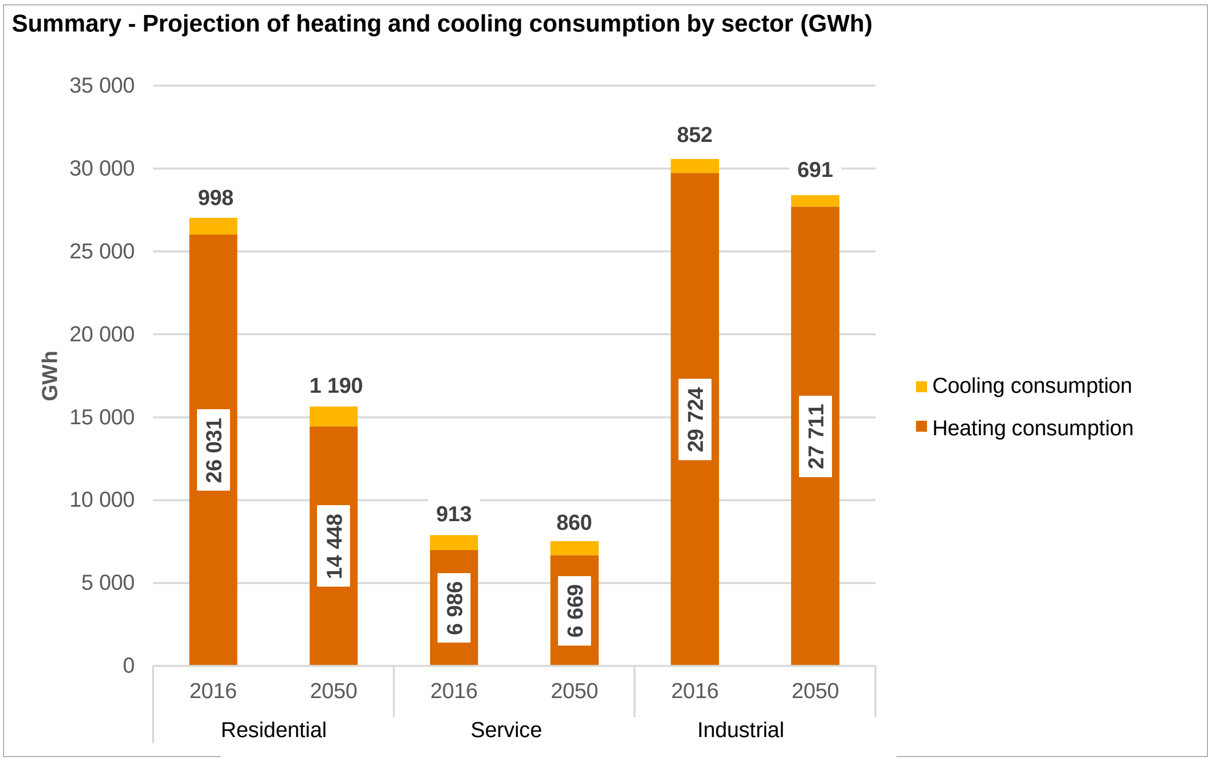


Figure 40: Projection of heating and cooling consumption by sector (GWh)

Chapter 7: Mapping

VII. Mapping

VII.1. *Introduction*

In accordance with the provisions laid down by the European Commission, this chapter provides an overview of the fourteen maps listed below.

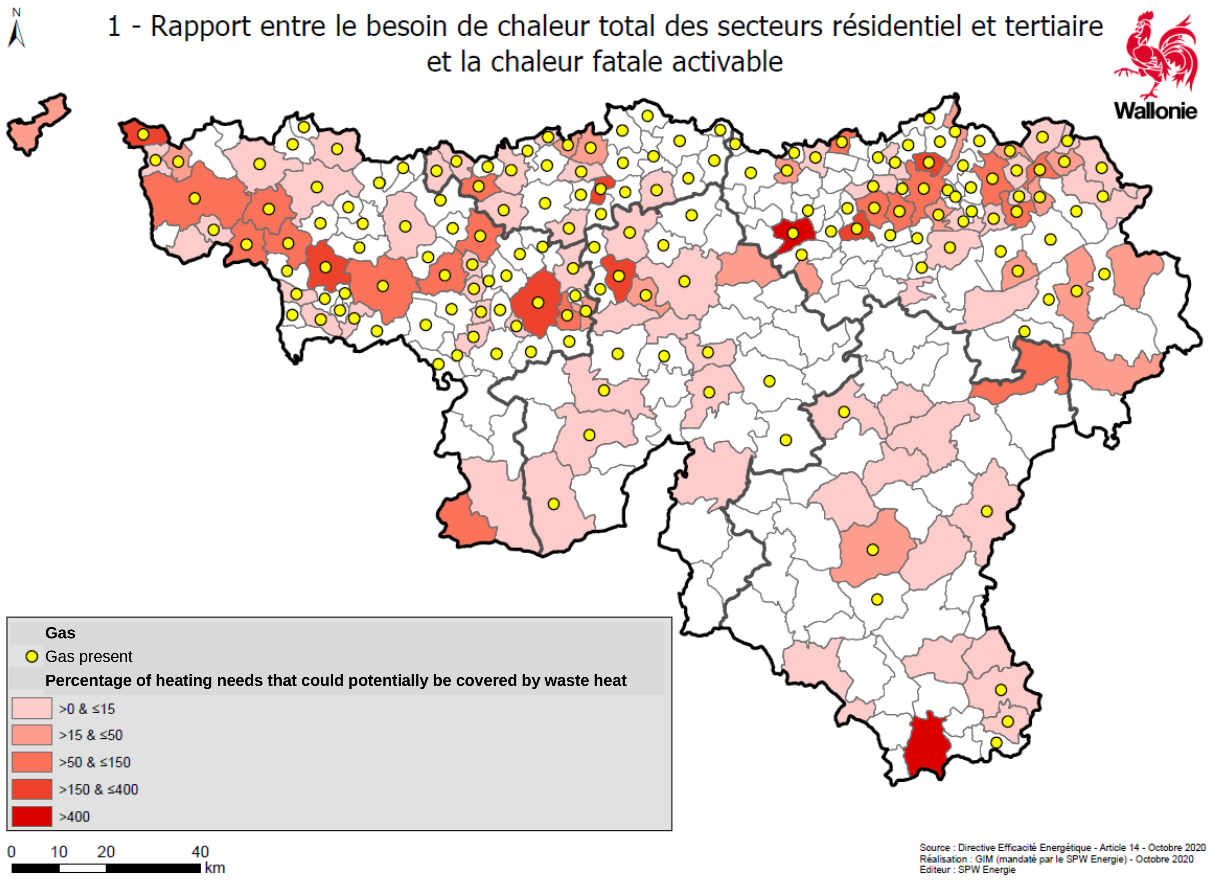
1. Relationship between the heating needs of the residential and service sectors and the waste heat that can be activated
2. Areas of interest for the establishment of district heating
3. Cogeneration plants with primary power of more than 1 MW
4. Renewable thermal energy – solar thermal
5. Renewable thermal energy – cogenerated heat (biomass)
6. Renewable thermal energy – non-cogenerated heat (biomass)
7. Renewable thermal energy – deep geothermal
8. Renewable thermal energy
9. Renewable electricity – biomass cogeneration
10. Renewable electricity – fossil fuel cogeneration
11. Renewable electricity – pumped storage
12. Renewable electricity
13. Total waste heat available
14. Map of known district heating networks

VII.2. *Methodology*

In order to represent graphical and geographical information (discussed in the previous chapters) on a map, the data to be processed had to be linked to a geographical attribute in GIS (geographical information system) data format.

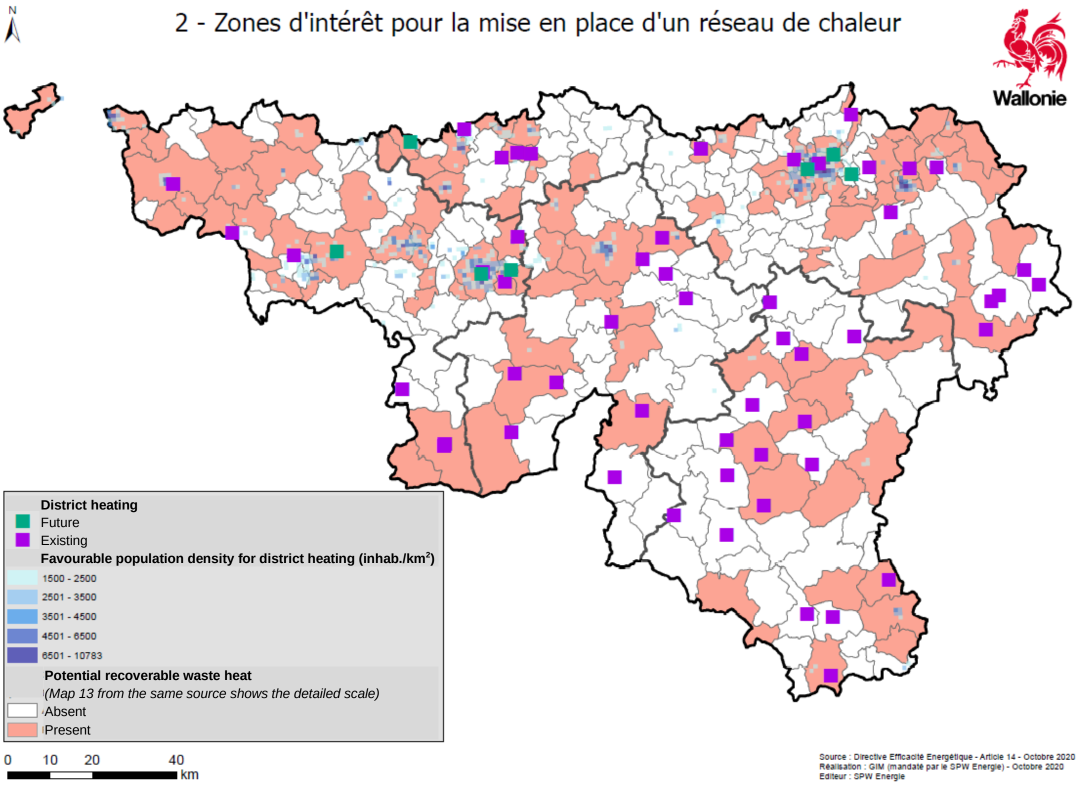
Very often, the information previously processed was available in an .xls file containing information in the display format, such as the address (categorised as a 'point') or the municipality, province, etc. (categorised on a 'multiline'). It was therefore necessary to match this display format with the geographical attribute in order to obtain the automatic geo-referenced display on each of the maps. The various maps were drawn up so as to be able to geolocalise the information needed to compile the maps.

VII.3. *Maps*[78]

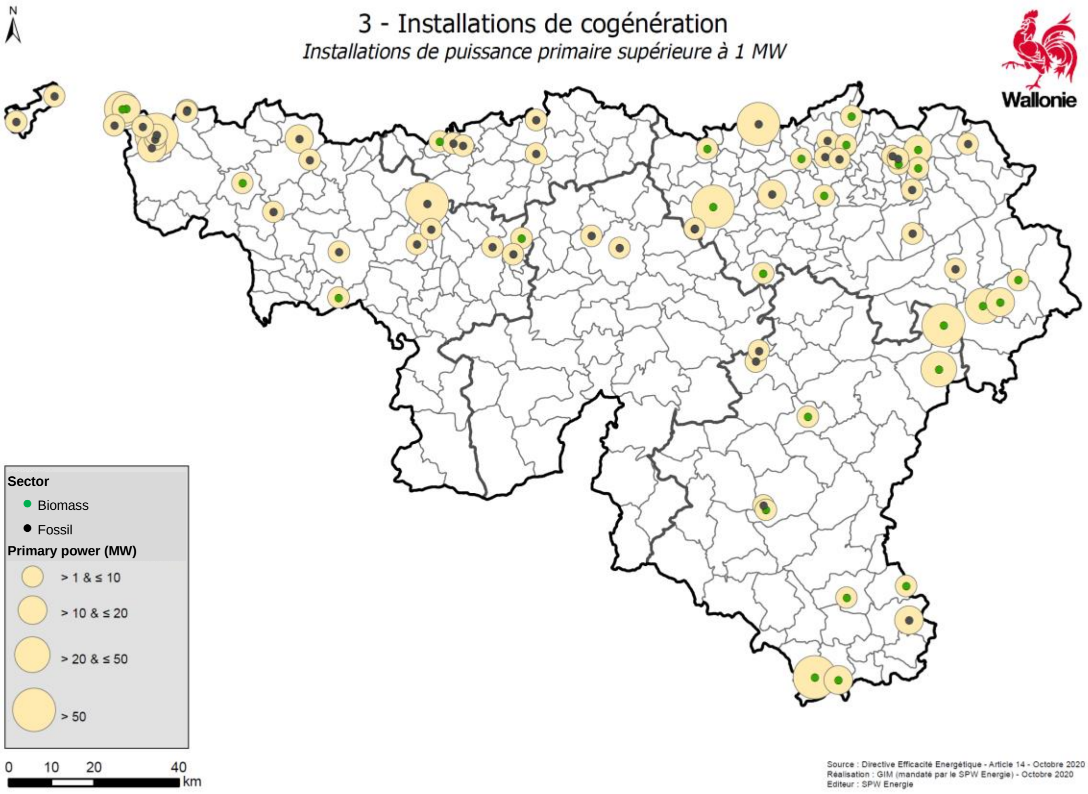


Map 4: Relationship between the heating needs of the residential and service sectors and the waste heat that can be activated

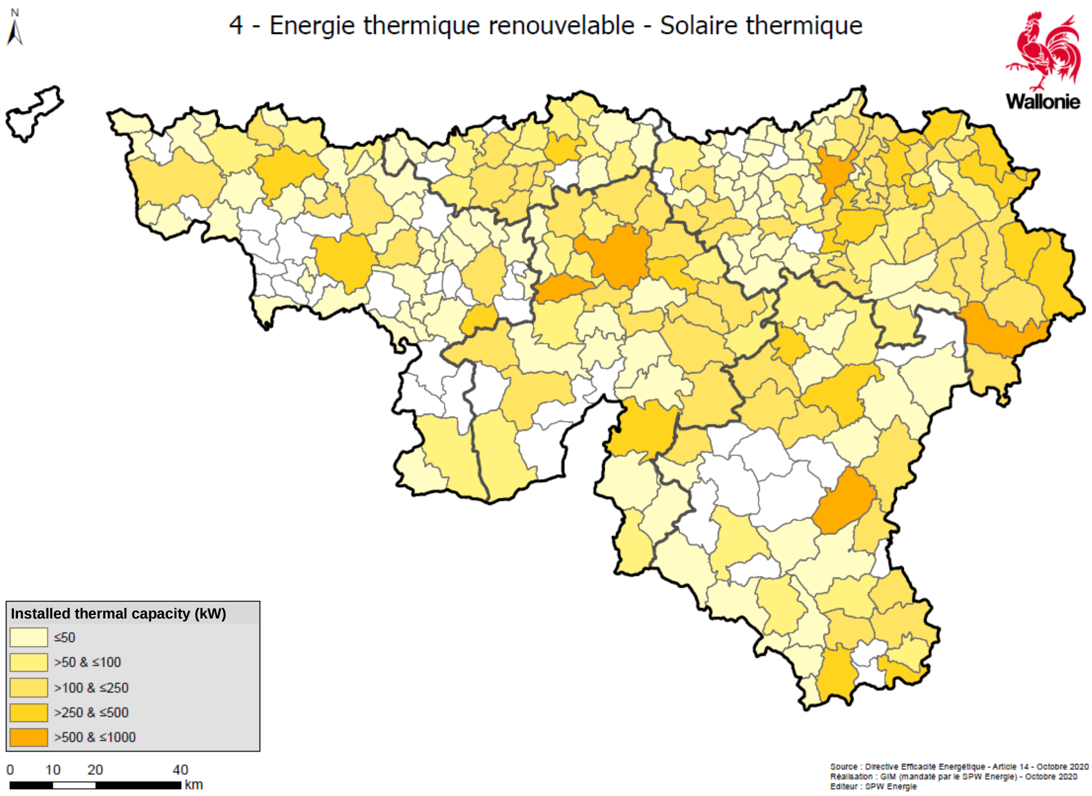
[78] Data used to draw up the maps:
- SPF Finances-AGPD, Limites administratives belges CadGIS [Belgian administrative boundaries, CadGIS] (2019)
- SPW Energie, Bilan énergétique [Energy balance] 2016 (2019)



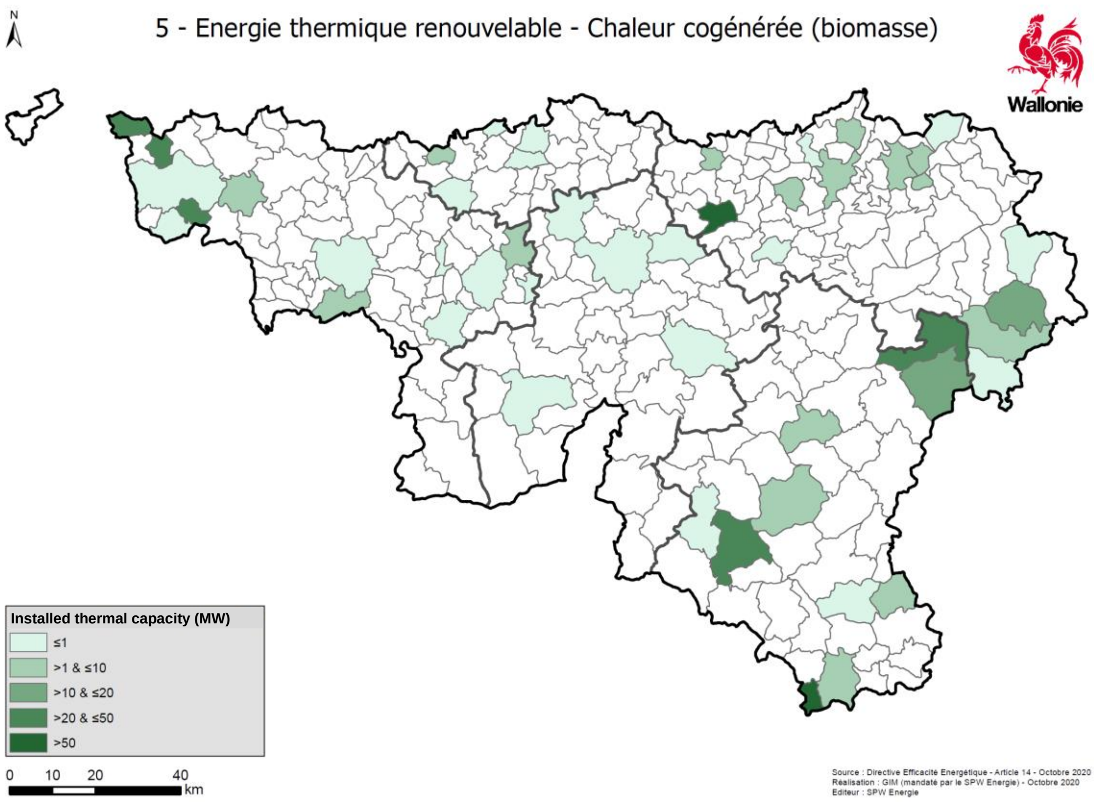
Map 5: Areas of interest for the establishment of district heating



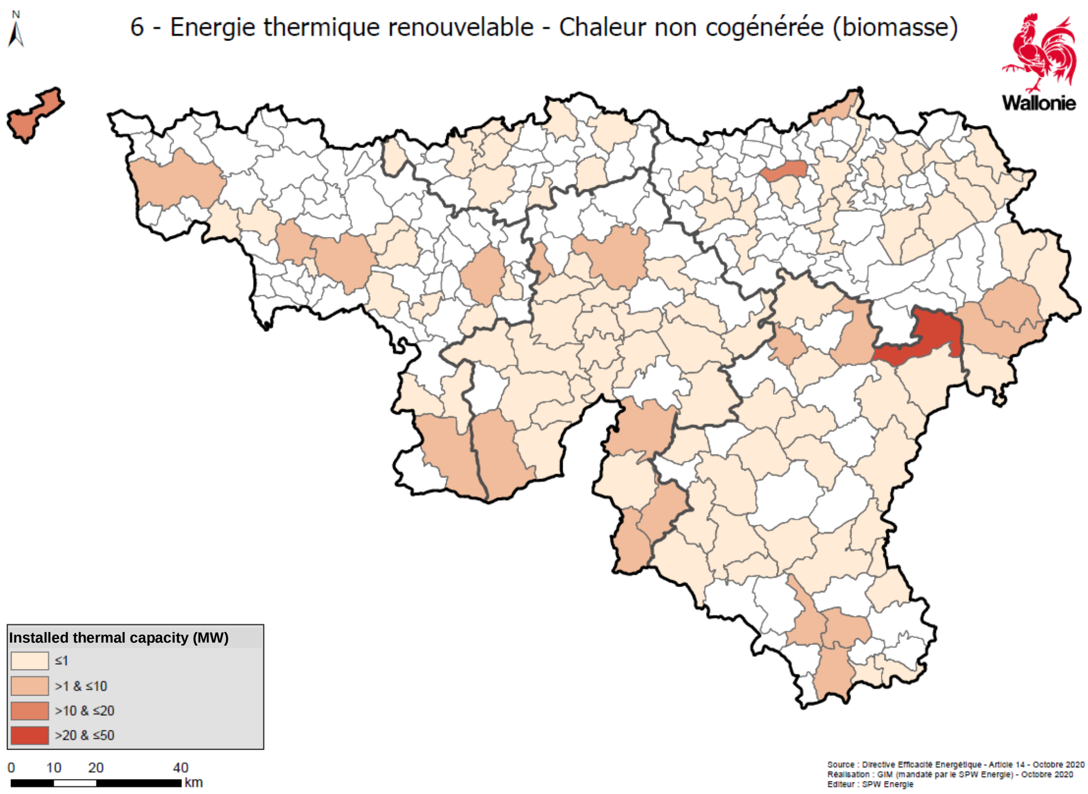
Map 6: Cogeneration plants with a primary power of more than 1 MW



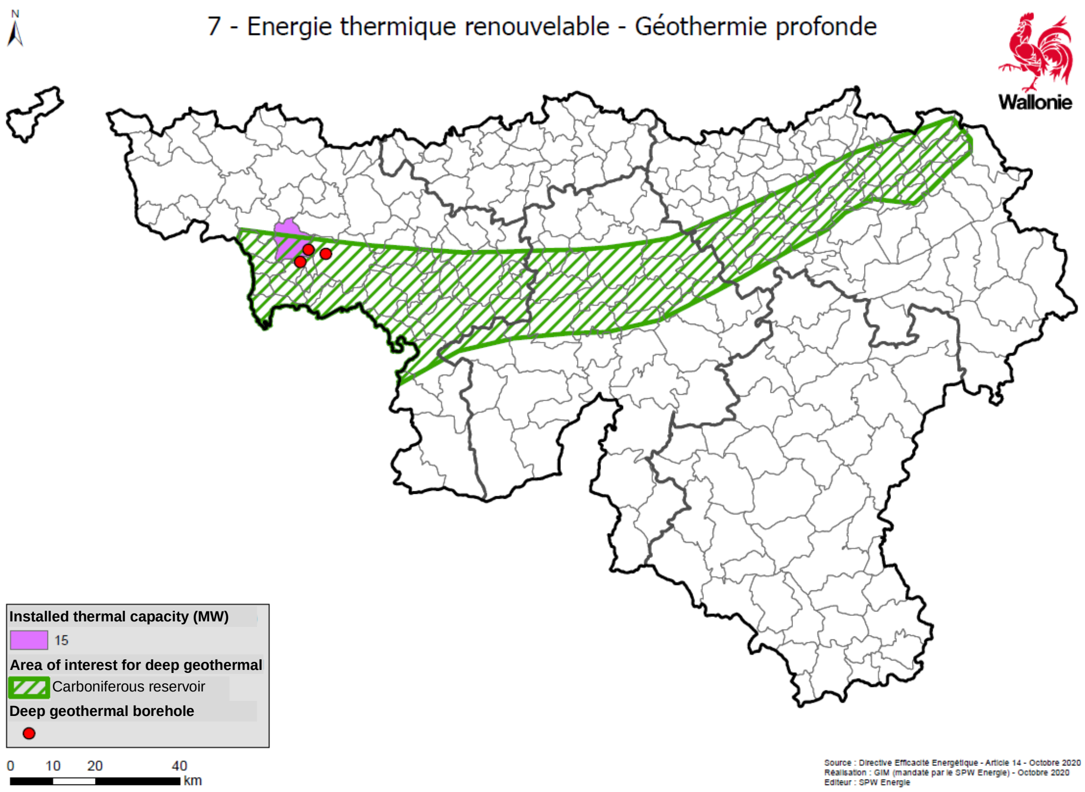
Map 7: Renewable thermal energy – solar thermal



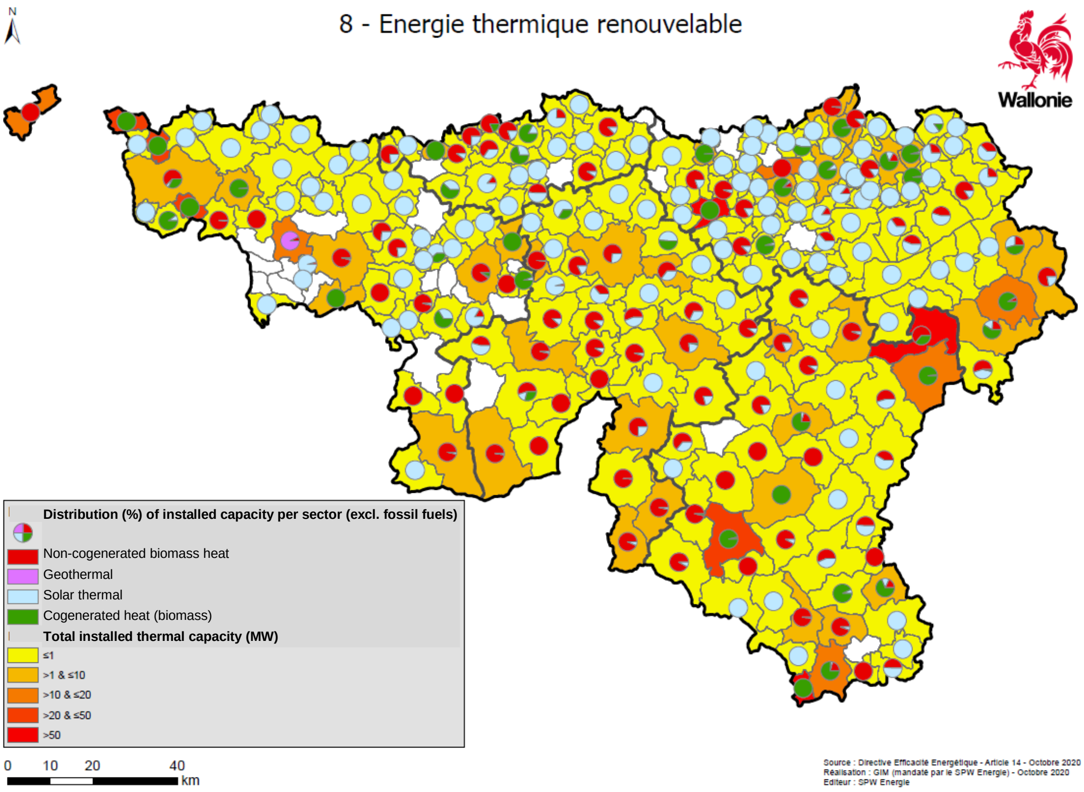
Map 8: Renewable thermal energy – cogenerated heat (biomass)



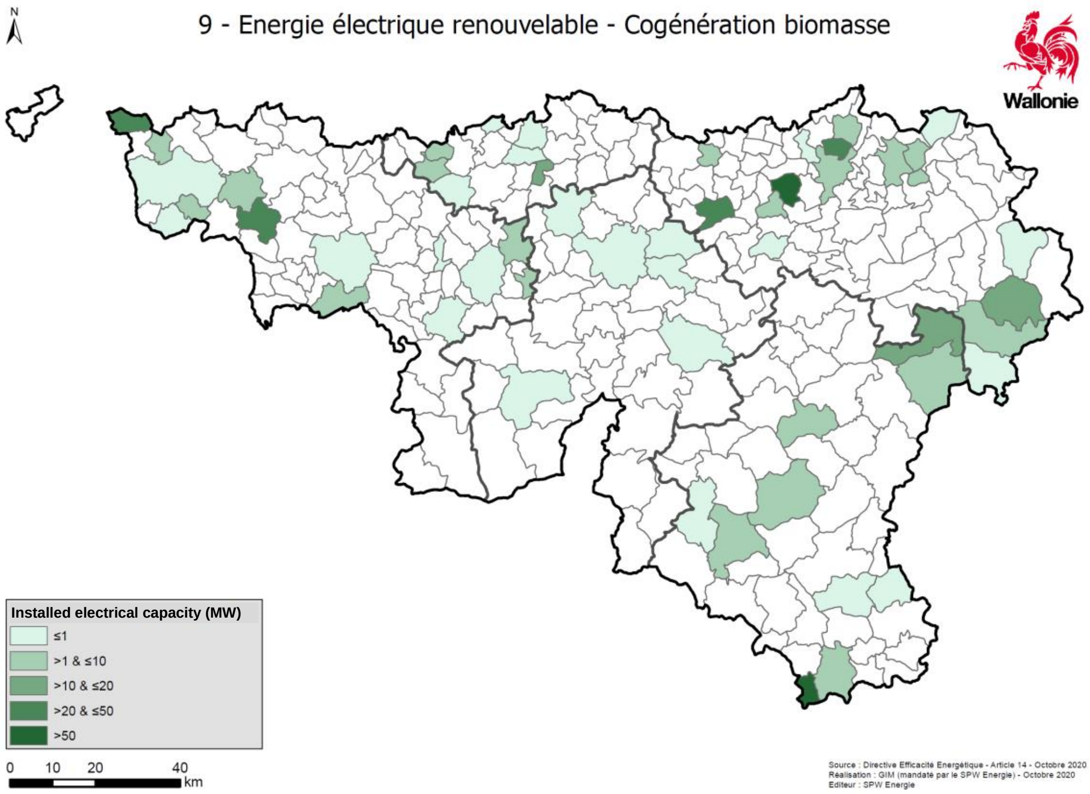
Map 9: Renewable thermal energy – non-cogenerated heat (biomass)



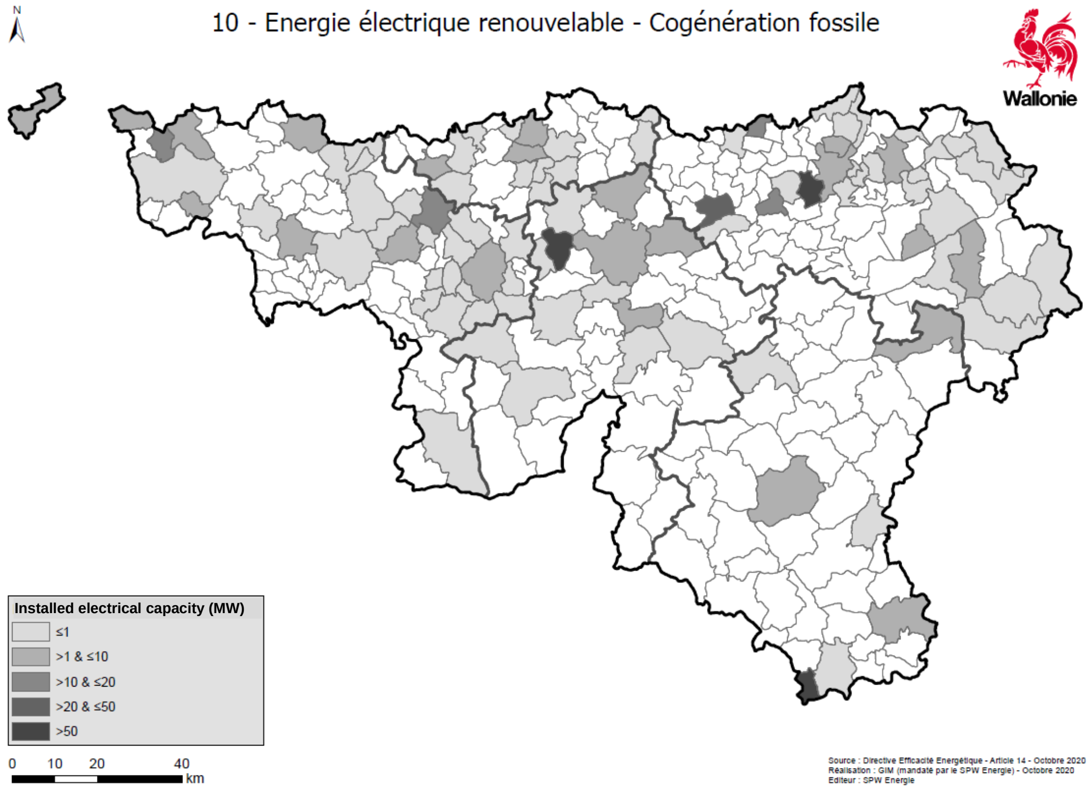
Map 10: Renewable thermal energy – deep geothermal



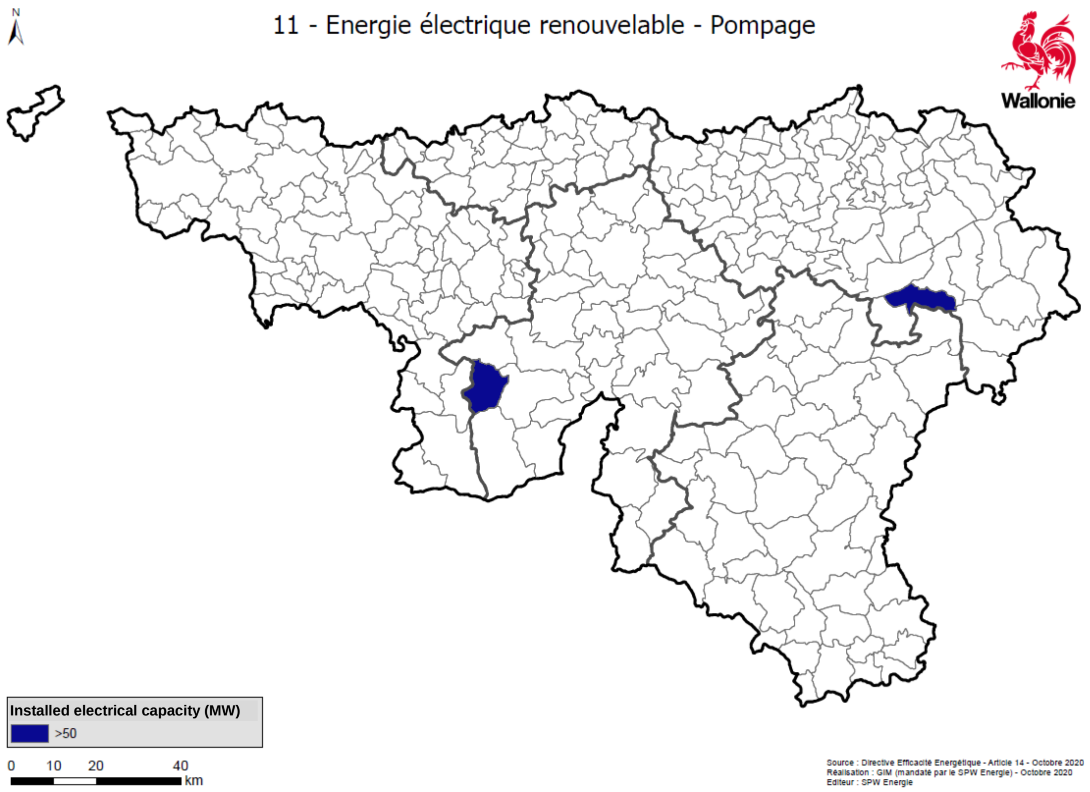
Map 11: Renewable thermal energy



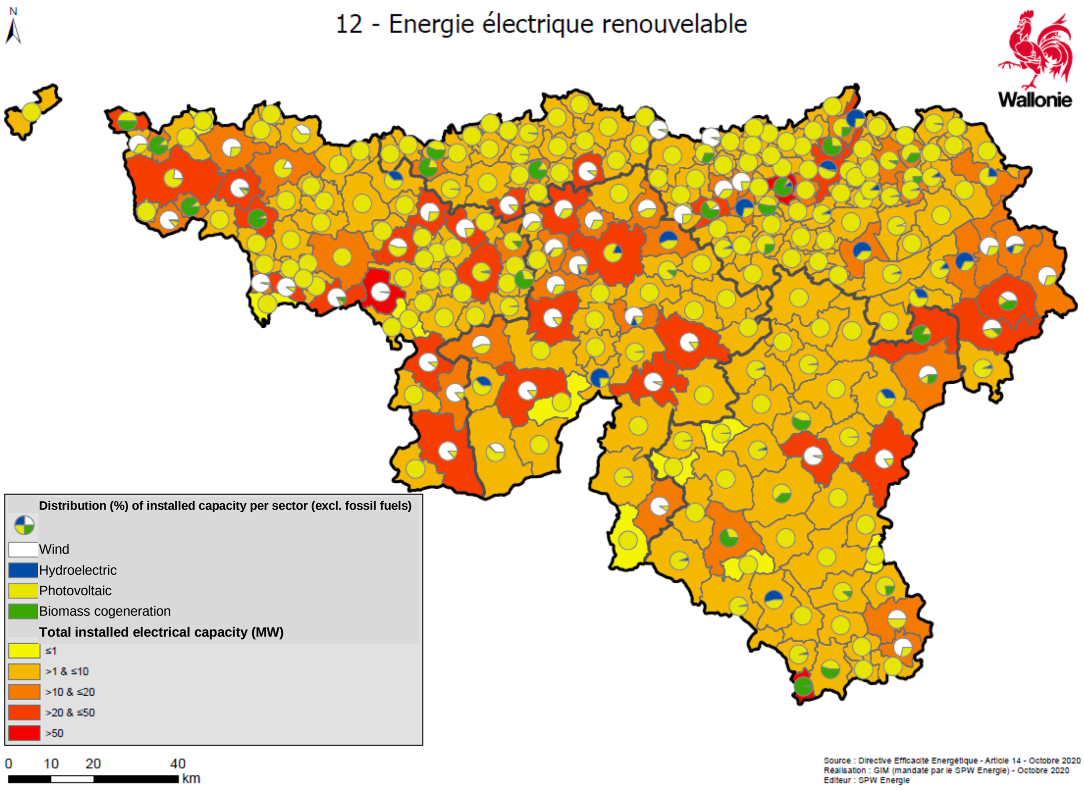
Map 12: Renewable electricity – biomass cogeneration (solid and biogas)



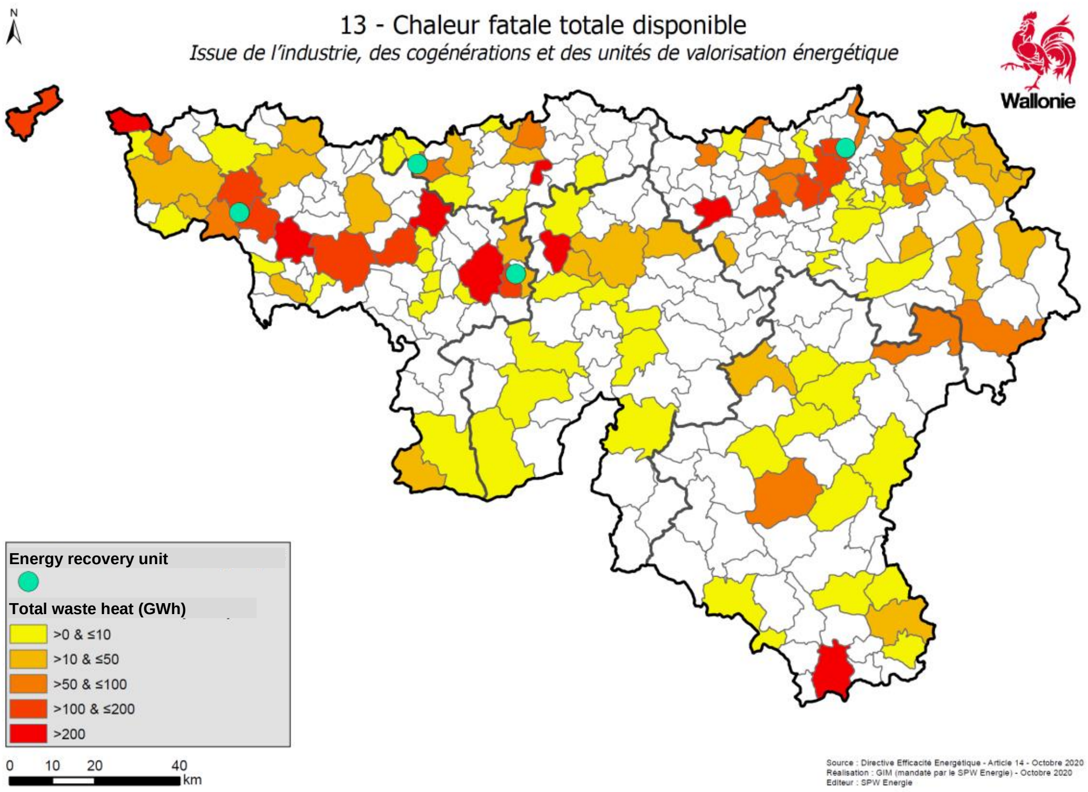
Map 13: Renewable electricity – fossil fuel cogeneration



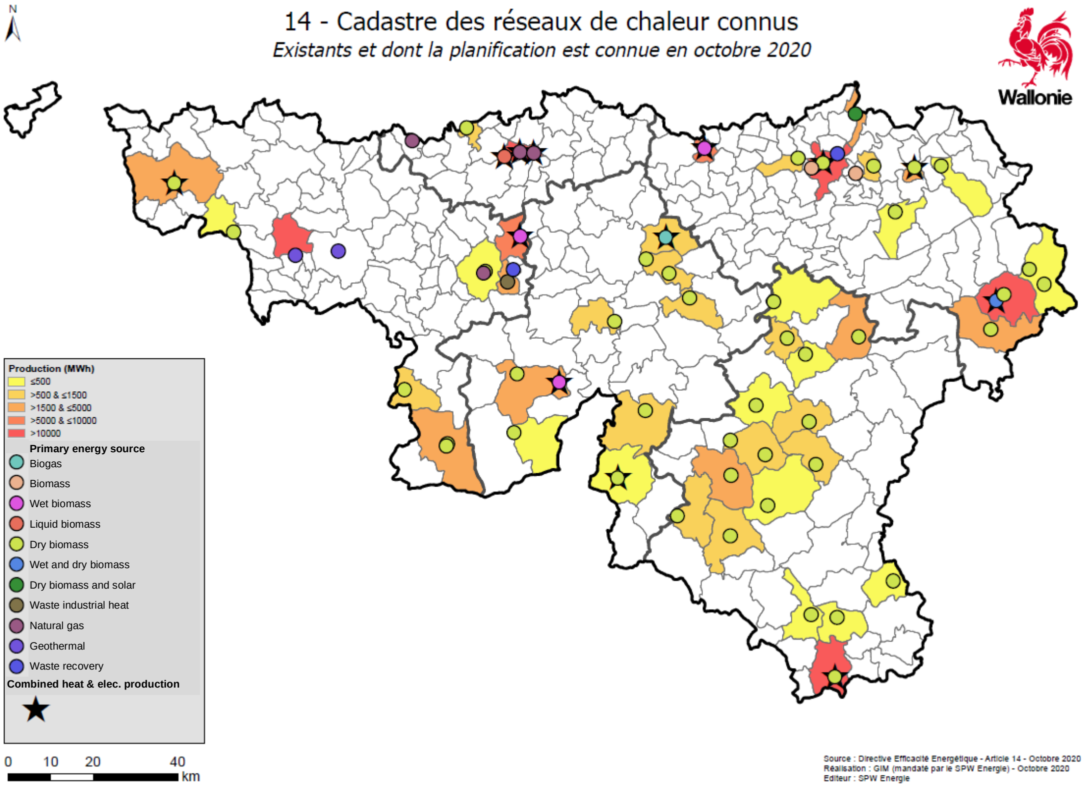
Map 14: Renewable electricity – pumped storage



Map 15: Renewable electricity



Map 16: Total waste heat available



Map 17: Map of known district heating networks (existing and planned as of October 2020)

Chapter 8: General description of current policies and measures regarding heating and cooling in Wallonia

VIII. General description of current policies and measures regarding heating and cooling in Wallonia

VIII.1. *Recap of Annex VIII*

Points 5 and 6 of part II of Annex VIII to Directive 2012/27/EU on the content of comprehensive assessments of national heating and cooling potentials require:

> Objectives, strategies and policy measures:
>
> - planned contribution of the Member State to its national objectives, targets and contributions for the five dimensions of the energy union, as laid out in Article 3(2)(b) of Regulation (EU) 2018/1999, delivered through efficiency in heating and cooling, in particular related to points 1 to 4 of Article 4(b) and to paragraph (4)(b) of Article 15, identifying which of these elements is additional compared to integrated national energy and climate plans;
>
> - general overview of the existing policies and measures as described in the most recent report submitted in accordance with Articles 3, 20, 21 and 27(a) of Regulation (EU) 2018/1999.

VIII.2. *Introduction*

In accordance with the European guidelines[79], this section presents an overview of existing policies on efficient heating and cooling in the Walloon Region. These measures have been structured around the five pillars of European energy policy: Decarbonisation; Energy efficiency; Energy security; The internal energy market; and research, innovation and competitiveness. The following plans and strategies were taken into account in compiling this information:

- Le Plan Air Climat Energie 2016-2022 [Air, Climate and Energy Plan 2016-2022], (PACE 2016-2022);
- Wallonia's contribution to the Plan National Énergie Climat 2030 [National Energy and Climate Plan 2030], 2019 (PWEC 2030);
- La Stratégie wallonne de rénovation énergétique à long terme du bâtiment [Walloon strategy for the long-term energy improvement of buildings], 2017 (SWR);
- Le Plan wallon de lutte contre la pauvreté [Walloon Anti-Poverty Plan], 2018 (PLCP);
- L'Alliance Emploi-Environnement recentrée – Plan pluriannuel 2016-2019 [The refocused Employment-Environment Alliance – Multi-year plan 2016-2019], 2016 (AEER);
- La 2ème Stratégie de Développement Durable [2nd Sustainable Development Strategy], 2016 (SDD);
- The Marshall Plan 4.0, 2015 (PM4).

[79] Annex I to Article 14 of Directive 2012/27/EU (point 3).

VIII.3. *Overview of existing policies and measures in Wallonia*

	Policy measure	Content of measure	Type of measure	Status	Source
Pillar 1: Decarbonisation					
Promoting the use of more environmentally neutral fuels, renewable energy and/or cogeneration					
1	Maintaining investment premiums for installations that use renewable energy	• Continue investment premiums for the purchase of renewable installations such as energy premiums for private individuals and a whole package of aid for economic investment in the service and industrial sectors (such as the sustainable energy use (UDE) programme).	Financing	Completed	PACE 2016-2022
		• Continue the standard UREBA programme for the renovation of public sector and public non-profit buildings.	Financing	Completed	PACE 2016-2022 AEER SWR
2	Adopting a biomass and energy strategy	• Draw up a 'biomass and energy' strategy document aimed at removing regulatory and financial barriers to the development of the industry and promoting the sustainable use of biomass by paying attention to the conflict between its different uses (energy, materials). The Cross-Functional Biomass Committee, set up in 2018, is responsible for implementing and monitoring this measure.	Communication/promotion	Ongoing	PACE 2016-2022 PWEC 2030
3	Supporting renewable heat generation	• Promote and support renewable energy sources for heat generation, in particular by offering appropriate premiums to be linked to the labelling of companies. This measure is aimed at private individuals.	Financing	Completed (residential sector)	PACE 2016-2022 SWR
		• Removal of all forms of support for fossil fuel boilers where alternatives exist.	Financing		PWEC 2030
		• Implementation of a renewable heat transition plan listing technological alternatives for multiple applications, in particular for replacing heating using petroleum products with lower carbon alternatives (heat pumps, solar thermal, district heating, geothermal, pellets/chips, biogas, biofuel,	Tool	Ongoing	PWEC 2030

	Policy measure	Content of measure	Type of measure	Status	Source
		small-scale gas grids, etc.). This plan will be drawn up alongside the updated report under Article 14 of the Energy Efficiency Directive.			
4	Encouraging the public to switch to less polluting fuels	• Incentivise the choice of renewable energy sources for heating, paying particular attention to the type of fuel used.	Communication/promotion		PACE 2016-2022
		• Set up an awareness campaign on the use of firewood, led by the SPW Energie. The 'Fire Management' information campaign is an example of an activity carried out.	Communication/promotion	Completed	PACE 2016-2022
		• Encourage the residents of buildings still fuelled by oil to connect to the natural gas grid in areas served.	Communication/promotion		PACE 2016-2022
5	Promoting renewable energy	• Implement the Regional Development Code (Code du développement territorial – CoDT) to facilitate the establishment of renewable energy production sites.	Obligation/regulation		SDD
		• Amend the conditions for the wind sector to facilitate the establishment of renewable energy production sites.	Obligation/regulation	In progress	SPW-ARNE and SPW TLPE
		• Further integrate renewable energy sources other than photovoltaic solar panels into business parks, such as wind turbines, biomass or geothermal energy, depending on the natural resources of the location.	Project development		SDD PWEC 2030
		• Allow and promote the injection of biogas into the natural gas grid	Obligation/regulation	Completed	SDD PWEC 2030
		• Require the implementation of sustainable energy and climate action plans (PAEDC) by municipalities (POLLEC campaigns) in line with the region's long-term objectives.	Obligation/regulation		PACE 2016-2022 SDD SWR
Taking action on energy consumption					
6	Encouraging the replacement of the most polluting boilers	• Require all boilers to meet performance and efficiency criteria as set out in Annex II to the 2009 AGW [1]. The main potential consequence is the need to replace a significant number of old boilers. The aim of the measure is to speed up the replacement of boilers fired with liquid and gaseous fuels.	Obligation/regulation		PACE 2016-2022

	Policy measure	Content of measure	Type of measure	Status	Source
		• Grant premiums for the purchase of a condensing boiler, a biomass boiler, a heat pump, solar thermal panels, or gas-fired micro-cogeneration.	Financing	Ongoing	PACE 2016-2022
7	Legislating on solid fuel heating systems, domestic hot water systems and decentralised systems.	The AGW of 29 January 2009 only partially regulates heating systems. • Include systems not currently covered in the scope of this regulation. • Clarify certain provisions. • Require maintenance of air discharge pipes.	Obligation/regulation	Ongoing	PACE 2016-2022 SWR
		• Put in place tools for monitoring compliance with the legislation on systems maintenance.	Obligation/regulation		SWR
8	Better determining and reducing particulate emissions from solid fuel heaters and improving the heaters' energy efficiency.	• Draw up a catalogue of potential measures to reduce emissions from wood combustion. It will be used to initiate consultation on the best measures to take and will take into account the results of measurement campaigns to determine ambient concentrations of particles from wood combustion and the results of a survey on consumption.	Tool	Completed	PACE 2016-2022 SWR
Pillar 2: Energy efficiency					
Raising public awareness and providing support					
9	Encouraging sustainable energy behaviour	• Communicate to users (private individuals, staff of businesses, etc.) the steps to make optimal use of their building and thus to reduce energy consumption and GHG emissions. • Carry out awareness-raising activities (awareness-raising via the energy website of the SPW-Energie, which provides users with a wealth of tips and tricks to reduce their energy consumption).	Communication/promotion		PACE 2016-2022 PWEC 2030
		• Make information available to citizens through the energy advice points, energy consultants in the municipalities that have them, energy advisers, energy support workers employed by the CPAS, etc. Mobilise local public and community actors, in particular the CPAS and the district authorities, to facilitate contact with local residents.	Communication/promotion		SWR PWEC 2030
10			Communication/promotion	Completed	AEER

	Policy measure	Content of measure	Type of measure	Status	Source
	Arranging group workshops to raise awareness of sustainable housing management	• Arrange group workshops to raise awareness of sustainable housing management, focusing on low-income households and technical and social support workers, without excluding other audiences.			SWR
11	Improving public information on the energy efficiency of household appliances.	• Raise public awareness of how to reduce auxiliary energy consumption. Topics to be addressed: low-energy lighting in dwellings as well as in offices and shop windows, consumption in standby mode, electronic equipment on standby, cooking, minimising or avoiding air conditioning, choice of electrical appliances, etc.	Communication/promotion		PACE 2016-2022
12	Ensuring a structural reduction in the energy consumption of disadvantaged groups	• Make available EUR 2.7 million a year from the Energy Fund to finance specific support and prevention measures aimed at vulnerable groups via the CPAS.	Financing		PLCP SWR
		• Identify ways of specifically helping owner-occupiers on low incomes (for example finding a mechanism to finance work on the homes of isolated elderly people).	Financing		SWR
13	Coordinating the sustainable housing information advisers	• Initiative started to coordinate support structures The aim is to have a 'generalist' posted at each support point, who could refer queries to more specialised staff in the various referral services. Accordingly, establishing and funding 'one-stop-shop' pilot projects (comprehensive support points), including streamlining existing services.	Tool	Completed	AEER SWR
		• Establish and fund one-stop-shop pilot projects (comprehensive support points), including streamlining existing services.	Tool	Ongoing	SWR
	Sharing energy	• Establish a framework to encourage renewable energy communities	Obligation/regulation	Ongoing	PWEC 2030 Decree of 2 May 2019
Making changes to the incentive system					
14	Continuing to reinforce energy standards in line with EU directives	• In order to help meet Wallonia's commitments at EU level, the following action will be taken within the framework of the refocused Employment-Environment Alliance: • Evaluation of the means of monitoring existing standards in order to identify areas for improvement. • Re-evaluation of the intermediate and final requirement thresholds for non-residential nearly zero energy buildings (NZEB) newly covered by the EPB legislation (other than offices, services and education).	Obligation/regulation	Completed	PACE 2016-2022 AEER SWR

	Policy measure	Content of measure	Type of measure	Status	Source
		• Evaluation of intermediate and NZEB requirements to check that they do not deviate from the economic optimum.			
15	Increasing consistency between the various regulations and energy efficiency criteria.	• Improve consistency between the various regulations in order to improve the energy performance of renovations. Different regulations are drawn up by different departments of the Administration depending on the subject matter: spatial planning, housing, energy, heritage, etc.	Obligation/regulation		SWR
		• Extension of the following mechanism to 2030: Article 7 of the European Energy Efficiency Directive (2012/27/EU) requires the Walloon Region to set up a scheme to reduce energy sales (i.e. final consumption) by 1.5% a year over the period 2014-2020.	Obligation/regulation	Ongoing	PWEC 2030
16	Financing renovation	• Establish a specific fund for energy improvements in Wallonia in order to increase the capacity to mobilise financial resources, centralise information and develop the capacity to develop new financial instruments.	Financing		SWR
Action on buildings					
17	Implementing the building passport	• Include means of collecting pre- and post-renovation performance data to evaluate the outcomes of all the renovation support programmes, using a database that allows for the monitoring of building passports.	Tool	Completed	SWR
		• Implement the building passport, which brings together all administrative information related to buildings (location, type of dwelling, permits, applications and award of premiums, energy audits, EPB certificates, reports from public estimators, reports from energy advisers, etc.) and put into effect its energy component.	Tool	Ongoing	AEER SWR
		• Analyse how to tie property tax to buildings' energy performance Determine, possibly on the basis of pilot projects, the elements necessary to update the cadastral income that can be collected in connection with the building passport.	Financing		SWR
		• Promoting the building passport	Communication/promotion		SWR

	Policy measure	Content of measure	Type of measure	Status	Source
18	Promoting the Vade Mecum on Sustainable Buildings	• Helps to guide developers' choices towards the best sustainable building options. The vade mecum is a practical tool in the form of an Excel file, with 104 explanatory factsheets that elaborate different aspects of building sustainability, including energy efficiency. Promotion through communication activities and practical training on how to use it.	Communication/promotion	Completed	AEER
		• Extend the Vade Mecum on Sustainable Buildings to non-residential buildings	Communication/promotion		SWR
19	Defining a framework for 'energy performance contracting' (EPC)	• EPC enables public authorities to conclude a contract with an energy service company which is responsible for guaranteeing the energy performance of a building by financing and carrying out the improvement works and thus guaranteeing a reduction in energy consumption. These companies are remunerated by the financial savings generated. It is therefore a service contract and no longer a works contract.	Financing	Ongoing	PACE 2016-2022 AEER
		• Stimulate energy performance contracting (EPC) to ensure energy savings for users and mobilise private third party financing.	Financing	Ongoing	SWR
20	Defining, updating and communicating a building renovation strategy	• Long-term strategy for mobilising investment in the renovation of the stock of residential and commercial buildings, both public and private	Obligation/regulation	Completed	PACE 2016-2022 AEER PWEC 2030
		• Draw up an annual communication on the results of the strategy	Communication/promotion	Ongoing	SWR
		• Draw up an information guide on the objectives and challenges of the long-term renovation strategy for households and the role of the building passport.	Tool	Ongoing	AEER SWR PWEC 2030
		• Review the resources used for the proper implementation of the strategy on an annual basis and verify their impact on the strategy's indicators in order to adapt the efforts required to achieve the long-term objectives.	Monitoring / knowledge of the buildings	Ongoing	SWR PWEC 2030
21	Implementing and promoting the business quality label	• Implementation of a label to support and promote renewable energy system installation businesses that enrol in a quality scheme, in order to build consumer confidence and ensure the quality of installation. This 'NRQual' label is divided into three parts: 'NRQual PAC' (heat pumps),	Communication/promotion		PACE 2016-2022 AEER PWEC 2030

	Policy measure	Content of measure	Type of measure	Status	Source
		'NRQual PV' (photovoltaic) and 'NRQual SOL' (solar thermal).			
		• Gradually extend the label to construction companies working in the fields of thermal insulation, airtightness, and heating, ventilation and air conditioning (HVAC).	Communication/promotion	Ongoing	AEER
		• Develop the label in consultation with the industry and develop links with the certification of professionals and with training providers.			SWR
		• Promote these labels among individuals and analyse the legal possibility of including them in the 2022 standard building specifications (CCTB).	Communication/promotion		AEER SWR
22	Granting energy and renovation premiums for housing and 'housing cheques'.	• Using energy and renovation premiums as an appropriate lever to guide households' renovation choices.	Financing		PACE 2016-2022 AEER
23	Granting loans for access to housing and for renovation (accesspack/écopack/rénopack).	• Grant social mortgages. In addition, the Ecoloan and then the Ecopack were developed to help households carry out energy improvement work.	Financing		PACE 2016-2022 PLCP AEER
		• Expand the Ecopack scheme, but with changes in particular to the eligibility conditions to make them more favourable to low-income households.			
24	Renovating public buildings and enhancing their role as an example.	• Achieve and monitor the 3% renovation rate in buildings covered by Article 5 of the Energy Efficiency Directive.	Obligation/regulation	Ongoing	SWR
		• Draw up and operate a register of public service sector buildings from June 2018 in order to identify those buildings which would constitute a source of cost-effective energy savings to be renovated as a matter of priority.	Monitoring / knowledge of the buildings	Ongoing	SWR
		• Ensure the energy audits already carried out feed into the renovation plan for buildings managed by the SPW.	Monitoring / knowledge of the buildings		PACE 2016-2022 AEER
		• Carry out new additional energy audits as a matter of priority in connection with major renovations.			
25	Renovation of public housing	• Two successive programmes have made it possible to upgrade almost 47 000 public dwellings, corresponding to 47% of the total, to meet energy standards and health and safety criteria.	Financing	Completed	PACE 2016-2022 AEER SWR
		• By January 2020, perform an inventory of data available for the register of public housing in the region and identify ways of supplementing this register in order to identify and prioritise the buildings most urgently in need of renovation.	Monitoring / knowledge of the buildings	Ongoing	SWR PWEC 2030
			Obligation/regulation	Completed	AEER

	Policy measure	Content of measure	Type of measure	Status	Source
		• Link any new deep renovation programme for public housing with the long-term energy performance objectives.			SWR PWEC 2030
		• By March 2018 set ambitious deadlines for energy improvements to public housing, committing to a renovation plan.	Obligation/regulation	Ongoing	SWR PWEC 2030
		• Draw up a roadmap for improving the energy performance of their buildings. • Establish a targeted renovation strategy based on the roadmap in order to reduce total energy consumption to achieve energy neutrality, with a prioritised action plan. • In connection with any work on a building, study all the measures related to the work that could improve the building's energy performance. As a minimum, the measures from the roadmap must then be implemented that are compatible with the work planned. • Requirement for monitoring and reporting the impact of the measures taken. • Easier use of energy performance contracting	Tool		PWEC 2030
26	Concluding simplified sectoral agreements with SMEs/micro-enterprises, local authorities and the non-profit sector.	• Put in place and propose 'simplified sectoral agreements' to SMEs/micro-enterprises, local authorities and the non-profit sector in order to support them in their efforts to improve energy efficiency and heat their buildings from renewable sources.	Tool	Ongoing	PACE 2016-2022 AEER PM4
27	Optimising the support system for energy studies for SMEs/micro-enterprises, local authorities and the non-profit sector.	• Optimise the energy premium system under the AMURE and UREBA programmes. In order to respond to the need for high-quality audits by approved experts, both for mandatory audits and for those under energy efficiency financing schemes, it will be necessary to strengthen, reform and regulate audits and approval of AMURE and UREBA auditors. • UREBA grants: support for legal persons governed by public law and non-commercial bodies that want to reduce the energy consumption of their buildings. • AMURE grants: the same objective but targeting businesses, the self-employed and liberal professions.	Financing	Ongoing	PACE 2016-2022 AEER
		• Subsidise audits by means of premiums for the service sector not covered by the obligation to carry out an audit.	Financing	Completed	SWR

	Policy measure	Content of measure	Type of measure	Status	Source
		This has been achieved through the energy cheques system under the AMURE scheme.			
28	Launching a new exceptional UREBA programme for the renovation of public buildings	• Launch of a new exceptional UREBA programme (allocation of EUR 40 million already committed from 2017). Action focused on investments in heating and domestic hot water systems using renewable energy sources.	Financing	Completed	PACE 2016-2022 AEER SWR
29	Creating a financing mechanism to promote energy efficiency in public and non-profit buildings (interest-free loans).	• Put in place an interest-free loan instrument in addition to UREBA grants for public and non-profit sector buildings to finance energy efficiency investments.	Financing		PACE 2016-2022 AEER PM4
		• Provide access to interest-free loans for those in the service sector (including the private non-profit sector) who want to invest in improving the energy performance of their buildings. Through the Easy'Green scheme, Walloon SMEs and micro-enterprises are given support to improve the energy efficiency of their buildings or production processes and also to combine their energy consumption with generation of renewable energy.	Financing	Ongoing	SWR
30	Ensuring dynamic energy management of public buildings	• Encourage public authorities responsible for managing a large building stock to adopt dynamic energy management by introducing energy accounting alongside installing smart meters.	Tool		PACE 2016-2022 AEER
31	Encouraging the social lettings agencies (SLAs) to improve the energy efficiency of the buildings they manage.	• Integrate energy performance criteria into the renovation of properties that they manage consistently through their various social welfare organisation offices (social lettings agency or housing promotion association).	Obligation/regulation		PACE 2016-2022 SWR
32	Regulating the relationship between landlords and tenants	• Put in place an indicative rent grid to compensate for the lack of incentives for landlords to renovate their rented properties once the tenants are bearing the heating costs. For example, introduce legislation under which the reduction in energy costs achieved through energy efficiency improvements can be used to justify an increase in the rent, allowing the landlord to gain a return on investment.	Tool	Completed	PACE 2016-2022 SWR
		• Enable and promote a 'warm rent' system, keeping the amount of rent plus heating costs lower or the same as before the energy improvements.	Financing	Completed	SWR

	Policy measure	Content of measure	Type of measure	Status	Source
		• Identify and implement ways of incentivising energy improvements to rented dwellings (public and private) (including promotion of the renovation roadmap).	Tool	Ongoing	SWR
		• Carry out a study on the impact of energy improvements on the risk of rent increases and on the means of managing this risk.	Monitoring		SWR
33	Evaluating and improving the provisions of the Walloon Sustainable Housing Code with regard to energy efficiency criteria.	• The Walloon Sustainable Housing Code contains criteria on health and minimum energy performance linked to insulation and airtightness. These energy health criteria should be updated in line with the new regulatory requirements and be improved continuously by adapting the text of the Code.	Obligation/regulation	Ongoing	PACE 2016-2022 SWR
34	Encouraging and facilitating approaches to renovation covering groups of dwellings.	• Better support complex situations such as co-owned properties by adapting the energy audit tools by September 2018 to allow a comprehensive reflection on the building as a whole (co-owned properties).	Obligation/regulation	Completed	SWR
		• Facilitate group renovation projects.	Obligation/regulation		SWR
35	Implementing the action recommended by the SPW's Sustainable Development Plan.	• Replacement of boilers. • Roof insulation.	Obligation/regulation		PACE 2016-2022
Taking action on spatial planning and town planning rules					
36	Taking action on urban planning rules to remove obstacles to efficient energy improvements to homes.	Include provisions favourable to energy performance and energy improvements in the future regional urban planning guide (certain overly strict urban planning rules and guidelines may lead to additional costs to achieve a given level of energy performance).	Obligation/regulation	Ongoing	PACE 2016-2022 SWR
37	Taking action on spatial planning by increasing terraced construction	• Apply the reform of the Regional Development Code with the aim of improving the energy performance of the building stock. High population density gives rise to forms of urbanisation (terracing, flats, etc.) that lead to savings on heating. The reform of the Regional Development Code aims to combat urban sprawl and encourage logical use of land and resources by providing tools to rebuild the city within the city with appropriate densification. For example, this includes promoting the construction of offices and shops in centres (urban and rural) and encouraging a mix of functions by moving towards terraced buildings that are easier to heat. This measure could be complemented by an	Obligation/regulation	Completed	PACE 2016-2022 SDT SWR

	Policy measure	Content of measure	Type of measure	Status	Source
		adaptation of the tax system to incentivise terraced construction.			
	Promoting the development of renewable thermal energy	• Implementation of a heat decree to remove disincentives to the development of district heating networks and to make the injection of biogas into the networks profitable.	Obligation/regulation	Completed	PWEC 2030
Equipping industry stakeholders to become actors in the transition					
38	Continuing the 'sectoral agreements' approach with second-generation agreements until 2021 and exploring the establishment of a third generation.	• Sectoral agreements are agreements between the regional government and the main industrial sectors to improve energy efficiency and reduce CO_2 emissions from industrial sites. In return, the authorities undertake not to impose additional requirements regarding energy efficiency and specific CO_2 emissions by regulation within their powers.	Tool	Analysis of the establishment of a third generation. Ongoing	PACE 2016-2022 PWEC 2030
39	Extending voluntary agreements to SMEs/micro-enterprises	• Put in place a support mechanism similar to 'simplified sectoral agreements'. The principle of voluntary simplified sectoral agreements should enable each company, independently of a trade association, to carry out a subsidised energy analysis in order to identify possible improvements that would reduce their energy bills. A support system will be developed to implement the investments in energy efficiency and renewable energy production identified in this energy analysis.	Tool	Ongoing	PACE 2016-2022
	Extending voluntary agreements to the food industry	• The measure consists of establishing a voluntary agreement with the food distribution sector to reduce its GHG emissions. The agreement will cover both the use of fluorinated gases and energy consumption. The measure initially takes place in a context of increasing restrictions on the use of HFCs under Regulation (EU) No 517/2014. • At this stage, the objective that could be included in the voluntary agreement can be broken down into three secondary objectives: Take action regarding refrigerant gases in equipment; Improve energy efficiency of commercial food distribution premises; Develop renewable energy sources in order to achieve zero GHG	Tool	Ongoing	PWEC 2030

	Policy measure	Content of measure	Type of measure	Status	Source
		emissions for any new commercial food distribution building from 2025.			
40	Providing financial and technical support to companies	Industrial companies can obtain various types of financial, technical or information support for energy-saving investments from public authorities: • AMURE aid for energy audits and pre-feasibility studies • A specific investment aid scheme exists in order to best support businesses – both SMEs and large enterprises – that make investments to protect the environment or use energy sustainably by reducing energy consumption in their production processes or generating renewable energy or high-quality cogeneration. • Support through clear information on potential energy savings in companies' facilities.	Financing	Completed	PACE 2016-2022
		• A network of energy efficiency facilitators has been set up by the SPW to help SMEs/SMIs without sectoral agreements to invest in energy efficiency.	Communication/promotion	Completed	PACE 2016-2022 SWR
		• Optimise, simplify and harmonise the system of investment aid for SMEs/micro-enterprises.	Financing	Completed	AEER SWR
		• Support for businesses to replace their equipment. The installation of refrigeration equipment using alternative refrigerants is already eligible for investment aid. However: the distribution sector (the main emitter of HFCs) is excluded; the aid calculation principle is complex because the idea is to cover part of the additional investment cost compared to the reference technology (which must therefore be determined).	Financing		PWEC 2030
Implementing training in the construction/sustainable renovation professions					
41	Awareness raising, training and certification of professionals	• Enhance the training on offer for professionals and support recognised training centres in this work. These training courses should focus in particular on innovative insulation techniques, cooling and heat generation techniques (renewable and traditional) that minimise the cost of purchasing fuel, and installation of solar thermal and photovoltaic panels.	Training		PACE 2016-2022
		• Awareness raising and certification of professionals	Training	Operational for PV, solar thermal and heat pumps	PACE 2016-2022 SWR

	Policy measure	Content of measure	Type of measure	Status	Source
		• Identify ways of attracting professionals to training courses.	Training		SWR
		• Train service-sector auditors (AMURE-UREBA) before certifying them: ○ Establish a training course. ○ Establish a test that must be passed in order to obtain certification.	Training	Ongoing	AEER SWR
		• Increase training on the use of alternative refrigerants/technologies.	Training		PWEC 2030
Pillar 3: Energy security					
Reducing energy dependence					
42	Supporting self-generation of energy	• Analyse and adapt regulations relating to self-generation of energy and the expansion of renewable energy for the industrial sector (including completing the reforms already under way).	Obligation/regulation		PM4
		• Adapt the strategy to the renewables mix.	Communication/promotion		PM4
		• Adapt the sustainable energy use aid scheme in order to encourage investments promoting self-generation of electricity and joint projects.	Obligation/regulation		PM4
		• Support research and development in energy generation and storage and the implementation of demonstration plants (experimental pilot units).	Financing		PM4
43	Promoting energy savings	• Develop a tool for quantifying the impact of future construction (districts, towns) and major renovations in relation to the energy consumption of buildings, mobility and grey energy with a view to using the tool to help decide on projects under the Regional Development Code, pursuant to Article 14 of Directive 2012/27/EU on energy efficiency.	Tool		SDD
		• Map heating and cooling demand points, existing heating and cooling generation infrastructure, potential heating and cooling supply points.	Tool		SDD
		• Continue to improve the audit methodology used in the sectoral agreements which makes it possible to identify both energy flows and material flows (including waste).	Tool	Ongoing	SDD
Pillar 4: Internal energy market					
Promoting the use of more environmentally neutral fuels, renewable energy and/or cogeneration					
44		Implementation of a three-pronged approach:	Project development		

	Policy measure	Content of measure	Type of measure	Status	Source
	Doubling electricity generation from waste	• Develop projects to increase the energy efficiency of incinerators (heat recovery from industrial or district heating processes)			PACE 2016-2022
		• Develop wood recovery projects.	Project development		PACE 2016-2022
		• Require the separation of organic waste from raw streams (selective collections or home composting) and prioritise its recovery in the form of soil improvers (biomethanation or composting). This option is reserved for household waste.	Obligation/regulation		PACE 2016-2022 PWEC 2030
45	Supporting the injection of biogas into the natural gas network.	• Set up a working group to encourage the injection of biogas into networks where direct recovery is not possible or not efficient.	Tool	Completed	PACE 2016-2022
46	Expanding the natural gas distribution network.	• Encourage residents to use natural gas in connected areas. For less densely populated areas, studies may be carried out to verify the cost-effectiveness of the extension of the network and to make a comparison with other alternatives such as district heating. An appropriate policy of densification of urban and rural centres could make it easier to develop the connection to natural gas in certain rural municipalities where it is deemed cost-effective.	Communication/promotion		PACE 2016-2022
Pillar 5: Research, innovation and competitiveness					
Improving the energy efficiency of processes					
47	Promoting innovative solutions for the use of renewable energy; supporting R&D.	• Establish an appropriate legal and financial framework for the development of deep geothermal energy in Wallonia and, based on an objective assessment, support the development of operational projects.	Obligation/regulation	Ongoing	PACE 2016-2022 PWEC 2030
		• Continue technology intelligence and make the results available to businesses.	Communication/promotion Tool		PACE 2016-2022
		Support R&D and the development of technologies and pilot projects for the generation of electricity, heat and gas from renewable energy sources.	Financing		PACE 2016-2022

VIII.4. *Summary*

Overall, the analyses set out in the previous section show that various measures have been or are being pursued in Wallonia with a view to encouraging the development of efficient heating and cooling. These measures correspond to the five pillars: 1) Decarbonisation; 2) Energy efficiency; 3) Energy security; 4) Internal energy market; 5) Research, innovation and competitiveness. There are more measures under the first two pillars.

In the final chapter of this report, we set out economic, legal and communication recommendations to add to / reinforce this set of measures. The analyses set out in the following chapters will make it possible to identify which technologies should be encouraged by examining the information on their technical potential in Wallonia, their strengths, weaknesses, opportunities and threats (chapter 9) and the results of economic and financial analyses (chapter 10).

Chapter 9: Identification of technologies available to provide low-carbon energy in the region

IX. Identification of technologies available to provide low-carbon energy in the region

IX.1. Recap of Annex VIII

Point 7 of part III of Annex VIII to Directive 2012/27/EU on the content of comprehensive assessments of national heating and cooling potentials requires that:

> An analysis of the economic potential of different technologies for heating and cooling shall be carried out for the entire national territory by using the cost-benefit analysis referred to in Article 14(3) and shall identify alternative scenarios for more efficient and renewable heating and cooling technologies, distinguishing between energy derived from fossil and renewable sources where applicable.
>
> The following technologies should be considered:
>
> (a) industrial waste heat and cold;
> (b) waste incineration;
> (c) high-efficiency cogeneration;
> (d) renewable energy sources (such as geothermal, solar thermal and biomass) other than those used for high-efficiency cogeneration;
> (e) heat pumps;
> (f) reducing heat and cold losses from existing district networks.

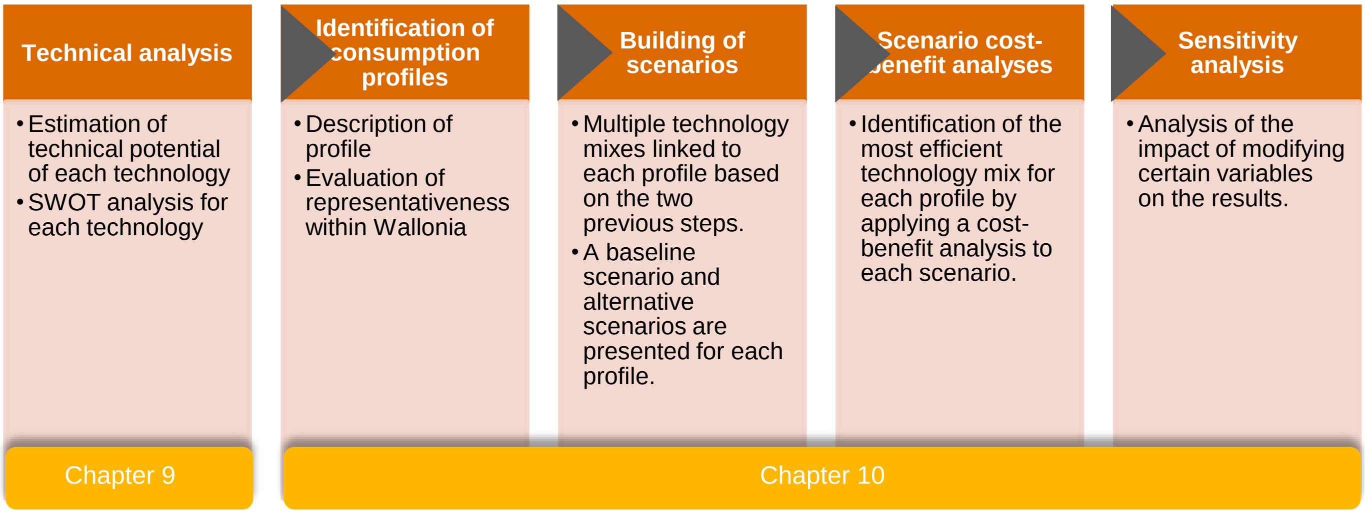
IX.2. Introduction

The aim of this chapter is to carry out an in-depth analysis of the technological and scientific literature with a view to identifying renewable sources of heating and cooling and sources of waste energy potentially available in Wallonia. This chapter responds to point 4.1.3 of Annex I to Article 14, which requires the identification of a range of highly efficient heating and cooling solutions to meet the needs of the region.

The heat generation technologies considered include waste heat from industry and waste incineration, geothermal, solar thermal, cogeneration, heat pumps, condensing boilers (gas/fuel oil), pellet and wood chip boilers. Some of these technologies can provide heat on a centralised or decentralised basis. District heating is discussed as a type of heat distribution technology.

For each technology, the chapter sets out the technical potential (mainly based on the resource), the share of current use in relation to the technical potential, the share of the technical potential in the heating and substitutable heating needs and an analysis of the main strengths, weaknesses, opportunities and threats. The aim of this analysis is to construct the scenarios by allocating the most appropriate technology mix to different consumption profiles. It is important to bear in mind that the different technical potentials per technology are not cumulative as all the technologies are operating on a competitive market.

The table below summarises the various steps taken, from the technical analysis to the definition of scenarios and the carrying out of cost-benefit analyses.



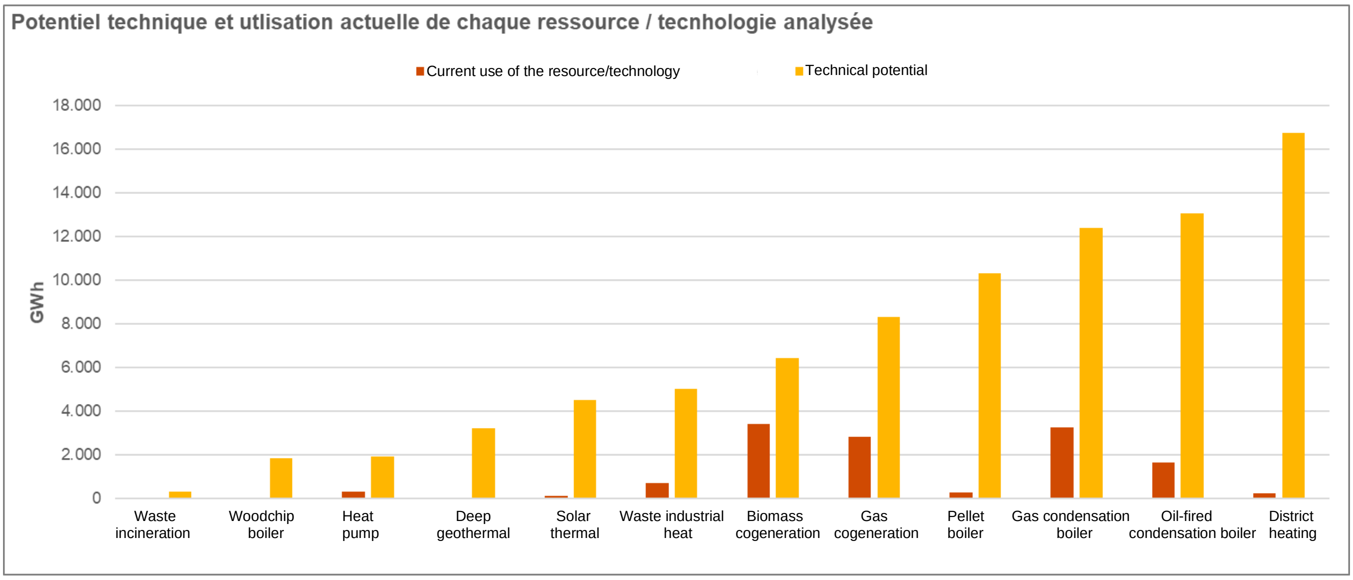


Figure 41: Technical potential and current use of each resource/technology analysed, analysis based solely on heating

IX.3. *Analysis of low-carbon technologies*

The table below sets out the following aspects for each technology:

- Current use of the resource
- Technical potential of the technology
- The share of current use in relation to technical potential (1 in the table)
- The share of technical potential in the heating needs (HN) in Wallonia (2 in the table). SHN stands for 'substitutable heat need'
- SWOT analysis of the technology

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Production technologies					
Waste heat from industry	682 GWh Calculation based on the ratios provided by the industry facilitator	**Technical potential: 5 026 GWh of heat generated by industrial processes** • Calculation based on the five industrial sectors with the highest energy needs (steel, chemicals, non-metallic minerals, food and paper), covering 90% of industrial energy needs. **Location of resource:** • Mainly located along the Sambre and the Meuse, where the majority of Walloon industries are based.	13.5%	7.9% of HN 11.3% of SHN	**Strengths:** • Good technical knowledge of most smoke capture technologies. • Compatible with district heating. **Weaknesses:** • Requires particularly high and variable investment costs depending on the applications concerned. • Proximity to heat demand in the case of thermal recovery. • Few sites concerned but high impact. **Opportunities** • Current low use of this resource, which represents real potential. • Reduction in energy costs for companies making use of this resource. • Integration of cogeneration. **Threats:** • Reduction of the potential in line with the decrease in the sector's energy needs in the projections for 2050.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Waste incineration	0 GWh	**Technical potential: 315 GWh of heat generated by waste incineration** • Data presented in Chapter 4 of Part I. **Location of resource:** • Thumaide (rural – between Tournai and Mons) • Herstal (urban and industrial – Liège) • Virginal (rural – Brabant Wallon) • Point-de-Loup (urban and industrial – Charleroi) This potential does not consider the use of new resources such as solid recovered fuel (SRF), for which availability is at least as great as that of type 'B' biomass (recovered).	0%	0.5% of HN 0.7% of SHN	**Strengths:** • Recovery technologies similar to those presented for industrial waste heat. • Heat generation competitive with fossil fuels. • Compatible with district heating. **Weaknesses:** • Particularly high investment costs. • Proximity to heat demand in the case of thermal recovery. **Opportunities** • Currently untapped resource. • Integration of cogeneration possible. • Few sites concerned but high impact. • Additional SRF resource currently unused. Resource compatible with < 5 MW units with potential for cogeneration. The smaller size of this type of unit enables its use in many locations. **Threats:** • Limited potential for the development of new waste-to-energy plants (WTE). 43% of household waste in Wallonia is incinerated; the rest is recycled. In the waste hierarchy, recycling has a higher value than incineration. The share of household waste currently incinerated can therefore be considered as a ceiling. In line with the objectives of the Walloon Waste Plan, there is a downward trend in the amount of waste produced.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Deep geothermal energy	15.7 GWh Data from the RES compilation[80].	**Technical potential: 3 226 GWh, of which 1 536 GWh from deep geothermal and 1 690 GWh from mine water geothermal.** **Location of resource:** Since the study published in 2011, Wallonia has launched several projects to identify the geothermal potential of Walloon subsoil: • The first study (2015) focused on the potential of deep geothermal energy (medium-energy geothermal). This study estimated that the geothermal potential of the deep geothermal reservoir of carboniferous limestone in Wallonia was 1 536 GWh th. • A second study (2019) aimed to estimate the geothermal potential of mines in Wallonia. The initial results estimated the annual thermal potential of this resource at 1 690 GWh. These results, already presented in a previous section of this	0.5%	5.1% of HN 7.3% of SHN	**Strengths:** • The geological diversity of the region allows for the establishment of all types of geothermal energy except high enthalpy (> 150 °C). • Acceptable environmental impact (smell, soil, atmospheric, etc.) • Small footprint and no impact on the landscape. • Numerous possible applications: Covers all types of use (heating, cooling, heat storage, electricity production if temperature > 100 °C). • Can be adapted to all types of buildings and industrial activities. • Wide variety of techniques available. • Mature technology (reliable and proven techniques). • The low temperature is applicable throughout Wallonia and is profitable when it is at an appropriate scale. • The resource has been demonstrated in the Mons basin in Wallonia at average temperature: Three direct-use plants have been in place since 1985. • Sustainable renewable energy from the ground in Wallonia, strengthening energy security. • Mode of operation with no or very low CO_2 emissions and no pollution. • Energy consumed where it is produced. • No loss of energy or pollution associated with energy transmission. • Energy available 24 hours a day and 365 days a year. • Energy not dependent on weather conditions. • Easily accessible energy at shallow depth (heat pump). • Significant heat source (as an alternative to fossil fuels). • Relatively low, stable production costs not dependent on fossil fuel prices. • Price of geothermal energy not dependent on price of commodities.

[80] Compilation of data on electricity and/or heat generation plants using renewable energy sources and cogeneration with fossil fuels (ICEDD & SPW-Énergie, 2019).

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
		study, divide the potential into four regions: • The Mons region with a potential of 486 GWh • The central region with a potential of 259 GWh • The Charleroi region with a potential of 501 GWh • The Liège region with a potential of 444 GWh In June 2016 the Walloon Government approved the IDEA Géotherwall project, financed by Wallonia and the European Regional Development Fund (ERDF). Two wells approximately 2 500 metres deep are to be drilled in 2021, with one well for pumping hot water and the other for re-injecting the water into the ground after it has passed through heat exchangers. A geothermal power plant will then be built, which is expected to be connected to the Ambroise Paré hospital district heating network in mid-2023 to provide heating and domestic hot water. The expected flow rate is 150 m³/hour, with a water temperature of 73 ºC (i.e. a capacity of 7 MW), and the amount of heat distributed annually via the insulated pipes could reach between 10.5 and 14 GWh.			• Compatible with district heating and other technology (heat pumps etc.). **Weaknesses:** • Lack of visibility of the plants and little media coverage. • No geothermal industry in Wallonia. • No industrial projects in Wallonia as yet. • Local use of deep geothermal energy requires customers close to the resource and heating needs. • Investment costs (CapEx) still high (exploration and drilling). • Insufficient knowledge of the Walloon subsoil at depth. • Absence of a specific legal framework. • Significant financial risk excluding insurance. • Lack of specific public financial support due to the high risk of failure during the exploration phase. **Opportunities** • Utilisation of available underground heat. Depending on the temperature available, the heat itself can be used (for low temperatures), electricity can be generated (for high temperatures), or the two can be combined. • Availability of deep geothermal potential in Wallonia in densely populated areas (Sambre and Meuse valley), but very little exploited. • The energy (heat) in deep carboniferous limestone in Wallonia is estimated at between 1 500 and 2 800 GWh, but ambitious steps are needed to ensure the development of the sector. **Threats:** • Low public awareness. • Public concern due to geological risks.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Solar thermal	113.6 GWh Data from the RES compilation.	**Technical potential: 4 486 GWh** • The method of calculation is as follows. Design capacity: area of roofs with good exposure * yield = 263 km² * 400 = 105 200 GWh. In view of the huge technical potential far exceeding Wallonia's heating needs, a reasonable assumption is to set the upper limit of solar thermal potential to the total domestic hot water needs in the region. To meet current domestic hot water needs with solar thermal energy will require 11.2 million m².	2.5%	7.1% of HN 10.1% of SHN	**Strengths:** • Technology that is easy to install and can be deployed on both new and existing buildings. • Use of an inexhaustible energy source, i.e. solar energy. • No greenhouse gas emissions during operation. • Compatible with district heating. **Weaknesses:** • Overall low and seasonally dependent yields. • Low profitability of the investment in the absence of high and regular demand for domestic hot water. • As regards heating, there is little interest in solar thermal in Belgium because most of the heat generation period is outside the heating season. • Risks linked to development – overnight, temperatures fall below legionella threshold: this bacteria is dangerous when water temperature stagnates between 25 °C and 45 °C. Since solar thermal energy does not heat during the night, such a fall in temperature is inevitable. In addition, in the Belgian climate the temperature does not rise every day to a level that will kill legionella. Possible solutions are to periodically increase the temperature of the stored water in order to kill the bacteria, to use a system that avoids water stagnation, or to store the

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
		• Yield: 400 to 600 kWh of hot water/m²/year[81]. • Average yield in Wallonia (2018): 468 kWh/m²/year (RES compilation) /			water at a sufficiently high temperature[82]**.** In the latter case, however, the efficiency of the collectors would be reduced. • High potential but can be utilised via a large number of installations, especially in the residential sector. • Lifespan of installations and yields determined by good maintenance, which is difficult to control and check in Wallonia's residential sector. **Opportunities** • The area available for this installation is large. The theoretical area is 263 km². • **Assumption 1:** Area of roofs = area of Wallonia occupied by residential buildings[83] = 1 090 km². **Assumption 2:** Even distribution of the surface area of roofs between aspects. Quarter of the area is between south-west and south-east = 272 km². This is a theoretical ceiling because other parameters must be taken into account, such as shadow in urban areas on roofs with good exposure in theory, difficulty of accessing roofs in urban areas, etc. In addition, the area already covered with solar thermal and photovoltaic panels must be deducted – 0.24 km² and 8.7 km² respectively. **Threats:** • As regards the area available, competition with the development of photovoltaic panels (which may nevertheless be partly offset by the installation of hybrid panels). • Low profitability without incentives from Walloon Government.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Cogeneration	Fossil cogeneration (2016): 2 799 GWh of heat	**Technical potential: 8 314 GWh[84]** **Location of resource:** Access to the gas distribution network.	33.6%	13.1% of HN 18.7% of SHN	**Strengths:** • Expertise in cogeneration technology, enabling use of renewable fuels as well. • Generation of cash flows. Gas cogeneration has the advantage of generating cash flows for the customer that can boost other energy-saving investments (for example, roof or gable insulation in co-owned buildings). • Significant production capacity. Suitable for projects with significant heating needs. In practice, it is estimated that cogeneration is useful for projects with heating needs in excess of approximately 100 000 litres of fuel or m^3 of gas per

[81] Energie Wallonie, p. 31: https://energie.wallonie.be/servlet/Repository/cdb-soltherm-2016.pdf?ID=50009
[82] De Herde A., Massart C., 2010. Elaboration d'un outil d'aide à la conception de maisons à très basse consommation d'énergie. Conception de maisons neuves durables. Service public de Wallonie, Jambes, 169p.
[83] Iweps, 2020: https://www.iweps.be/indicateur-statistique/artificialisation-du-sol/
[84] Methodology set out in annex.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
	Biomass cogeneration (2016): 3 231.4 GWh of heat and biogas cogeneration (2016) 189.7 GWh of heat[87]	**Technical potential: 6 422 GWh th of which 5 000 GWh th from biogas and 1 422 GWh from solid biomass[88].** • Hypothesis: The full potential of the energy from 'combustion' presented in the Valbiom report is added to cogeneration, using the same ratio GWh th/GWh as for cogeneration, 1 778 * (1 467 / 3 260) = 800. **Location of resource:** Spread across the various areas of the territory: agricultural, forestry and industrial waste products, household waste, etc. A part of the biomass streams is also exported because it cannot be recovered locally.	Not calculated for biomass cogeneration as it involves imports and as ... 3.8% for biogas cogeneration;	10.2% of HN 14.5% of SHN	year[85]. It is therefore suitable for the following uses: hospitals, hotels, residential homes for the elderly, blocks of flats, swimming pools, industry, urban district heating, etc. • Existing and effective support scheme based on 'green certificates'. • Compatible with district heating. • Contribution by the Cross-Functional Biomass Committee on the aspects 'Hierarchy of Uses' and 'Sustainability'. Allows the administration to give an opinion before the project is launched. **Weaknesses:** • Limited lifespan: the lifespan of internal combustion engines is generally between 50 000 and 60 000 hours, with a requirement for regular maintenance. • Simultaneous need for heating and electricity. The scale of cogeneration depends on net heating needs and also on operating hours that enable all heat produced to be utilised. • Requires a lot of space and potential source of noise pollution. • Regular operation. Operation must be as regular as possible in order to ensure efficiency. In order to ensure the efficiency and cost-effectiveness of a cogeneration unit, it is essential that it operates at constant load for as long as possible to reduce the number of stops and starts. These would not only reduce the overall efficiency of the installation, but also significantly shorten the lifespan of the engine.

[87] Compilation of data on electricity and/or heat generation plants using renewable energy sources and cogeneration with fossil fuels (ICEDD & SPW, 2019).
[88] Cadastre de la biomasse wallonne valorisable énergétiquement – 2015, Valbiom (2016)
[85] EnergiePlus 2015. Website (http://www.energieplus-lesite.be) run by UC Louvain's 'Architecture et Climat' research team.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
					• Secondary producer: cogeneration is generally not intended to cover peak thermal needs and will usually need to be combined with another means of heat generation to cover additional heating needs beyond the yield of cogeneration. The secondary producer usually uses a fossil fuel energy source for financial reasons. • As the technology is more complex than a simple boiler, it requires monitoring and higher and recurrent operating costs. • Management of flue-gas pollutants highly monitored, especially with renewable fuels. • No certification of installers, quality of projects varies widely. **Opportunities** • Collective self-consumption (momentum of Directive (EC) 2018/2001). • Interest within the context of the renewable and citizens' energy communities. • Potential for the development of biomethanation and gasification. • Possibility of injecting biogas into the grid to separate production and use. • Enables better use of the B class wood resource, a significant share of which is sent abroad. • Potential for micro-cogeneration (< 100 kWe) little used. • Emerging replacement market for engines with more than 60 000 hours of operation. Possibility of optimising efficiency and making support conditional on better heat recovery. • The implementation of a policy to support 'private' heating networks would allow the deployment of larger renewable cogeneration plants. **Threats:** • Removal/alteration of support via green certificates (concerns renewable cogeneration). • Reputational damage to cogeneration due to poor suppliers and poor maintenance. • Complexity of administrative procedures means project promoters require support (for example the creation of a Vade mecum). • Lack of large-scale market regulation and long-term visibility of biomass prices.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis

					• Difficulty of financial arrangements due to restrictions on incentives (for example, due to the distinction between an owner and an operator of a building). Thus, the operator of a hotel is rarely the owner. When these two roles are held by the same person, the following support is available for cogeneration for a private actor: green certificates, investment premium, reclaimed VAT (21%). When this is not the case, it is the owner who has to invest (unless there are complex legal arrangements) but he or she then loses the investment premium (not eligible for a real estate company) and the reclaiming of VAT (unless it is a 'business centre', which would never be the case for a hotel). The legal complexity of contracts to avoid losing these benefits often means that the project is not carried out because it is too complex[86].
					• Potential for large-scale natural gas installations already heavily exploited. Developments must therefore target biomass cogeneration and smaller-scale natural gas-fired cogeneration: less favourable effort to impact ratio.
					• For fossil fuel cogeneration: variability of gas and electricity prices.
					• For renewable cogeneration:
					  ○ availability of resources (demand pressure in neighbouring countries);
					  ○ waste/by-product status of inputs;
					  ○ competition between sectors (paper industry, panel producers, wood for energy, etc.);
					  ○ absence of organised and financially attractive ash recovery industry.

[86] https://www.wallonie.be/fr/demarches/demander-une-prime-linvestissement-pme-ou-grande-entreprise

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Heat pumps	323 GWh (2018) (RES compilation)	**Technical potential: 1 914 GWh** • Heat pumps are only suitable for well-insulated buildings (see technical constraints). A reasonable assumption is to set the limit on the potential of heat pumps to the total needs of the residential buildings belonging to EPB categories A++/A+/A/B in the projections. Their heating needs amount to 1 914 GWh. • Based on heat pump efficiency (COP 3), the electricity consumption needed to meet this potential is 638 GWh. This represents 2.7% of current electricity consumption in Wallonia (23.1 TWh). In itself, this load seems sustainable for the grid, as electricity consumption amounted to 24.7 TWh in 2010, i.e. a gap of 1 600 GWh compared to 2017. However, in many distribution areas it may not be possible to meet the level of simultaneous demand and thus peak load. **Location of resource:** The resource is available throughout Wallonia. **Development of the resource:** If the development of heat pump installations follows the historical trend of 13.3% growth a year between 2016 and 2018,	16.9%	3% of HN 4.3% of SHN	**Strengths:** • Runs on electricity, available everywhere. • High energy efficiency. • Takes up little space. • Ease of installation. **Weaknesses:** • The majority of heat pumps run on electricity. The electricity grid is probably not ready to supply and withstand the electrical power that may be required by large-scale use of heat pumps as a heating source for buildings. • Heat pump performance depends on the temperature of the emitter (hot source). • A heat pump performs better if it supplies low-temperature emitters, such as for underfloor heating (with a system at 30-45 °C). Heat pumps can only be used in low-energy, very low-energy or passive buildings or in service or industrial buildings with very low heating needs. Efficient heat pumps are not suitable for existing buildings except where major renovation has been carried out. • Heat pumps are less suitable for domestic hot water. To heat domestic hot water to 60 °C (temperature required to kill legionella), it is necessary to install the tanks in series so that the heat pump can pre-heat the water to 45 °C and then use additional electrical heating. • Heat pumps generate noise which may be a nuisance outdoors or indoors. • Lifespan of installations and efficiency determined by good maintenance, which is difficult to control and check in Wallonia's residential sector. **Opportunities:**

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
		production will be 1 448 GWh in 2030 and 17 600 GWh in 2050. The technical potential of heat pumps will therefore evolve in line with the insulation of buildings, within the limits imposed by the capacity of the electricity grid.			• Improvements to building insulation expected in the coming years. An increasing number will be able to accommodate a heat pump. **Threats:** • Low level of insulation of the building stock in Wallonia limits the potential for the development of heat pumps. • Environmental benefit of the project depends on the renewable mix supplied through the electricity grid.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Pellet boiler	271 GWh	**Technical potential: 10 289 GWh** The technical potential considered combines the heating needs of the service and residential sectors that are currently met by petroleum products and diesel. A factor of 80% is applied to this potential.	2.6%	16.6% of HN 23.7% of SHN	**Strengths:** • Renewable energy source, on the condition that its use as biomass does not exceed its regeneration. It is generally the case in Europe that forests are expanding. Moreover, it is not the demand for energy wood that leads to tree felling, but rather the demand for timber. Energy wood in Europe is largely sourced from forest and forestry residues (first thinning, forest maintenance work, recovery of trees unsuited for sawing, recovery of tree crowns) and residues from first processing (sawdust, chips, cuttings, substandard wood). • Energy independence: a large part of the fuel resource is available locally. • Local industry, strongly integrated into the forestry industry: recovery of by-products of the 'material' sector, helping to maintain local employment and optimise the use of resources by diversifying the income of forest stakeholders. • Natural fuel, storage and transport with very low risk to health and the environment (no soil or water pollution). • Established technology. • Multi-purpose technology: stoves, central heating, industrial heat generation, collective heating, cogeneration, integration with other means of heating (solar). • Production chain mainly in Europe, no need for 'rare' or controversial resources. • Production of low-energy fuel (low embodied energy). • Competitive efficiency. • Stable long-term fuel prices and independence from oil price fluctuations (non-interdependent sector). • 80% of maintenance can be carried out without specific qualifications. • Robust equipment with a long lifespan (20-30 years). **Weaknesses:** • Profitability of the investment very closely linked to the price of fossil fuels. Competitiveness is difficult as long as the real 'carbon cost' is not considered.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
					• Requires an area for storage. Pellets will be the preferred option in urban areas owing to their higher energy density. Wood chips will be favoured in rural areas where they are directly accessible. • More frequent and messy maintenance (psychological barrier). • Wood storage areas classed as ATEX zones, but risk can be limited easily. • Lack of training for many installers and consultancy firms, no existing certification. • Lack of knowledge among users who think they can produce wood chips themselves or who are not familiar with fuel quality concepts and buy the cheapest product. • Lack of uniform fuel quality (especially for wood chips); need for continuous monitoring. • Risk of dust and fine particle emissions in the event of poor maintenance/misuse. • No organised industry for the harvesting and processing/recovery of ash at competitive prices, regulatory disincentives. • Inefficient combustion appliances present in residential buildings. **Opportunities:** • Organisation of a local supply chain, creating sustainable jobs (SRC, miscanthus, agricultural cooperatives, forestry companies). • Local recovery of a forestry by-product in close proximity to the available resource. • The use of wood is already widespread in some parts of Wallonia and is widely accepted. • Replacement of inefficient log burners. • Making wood products more attractive: developing the local wood processing industry also means producing more by-products. • Organisation of an ash recovery industry: close the virtuous cycle of the wood-energy sector through the return of minerals to the soil. • Increasing the use of timber (construction etc.) makes it possible to increase the amount of energy wood from its by-products.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
					Threats: • Different treatment of energy sources: Unlike fossil fuels, biomass is subject to tightening of environmental regulations (flue gas treatment, sustainability (RED II), etc.) • Bioenergy ‘bashing’ by influence groups that are against any form of use of ‘nature’: frequent questioning in the media of the carbon neutrality and sustainability of energy wood. • Deterioration of the primary wood processing industry that generates the by-products (especially in broadleaf: large quantities of logs exported to Asia and disappearance of local sawmills). • Loss of motivation of forest owners who no longer invest in their forests as a result of the growing risks linked to climate change (bark beetles etc.). • Expansion of the natural gas distribution network. • Artificially low fossil fuel prices. • Continued support for fossil fuels. Absence of conditions and evaluation of fossil energy projects (sustainability, environment, resilience, circularity, waste treatment, etc.) equivalent to the Cross-Functional Biomass Committee.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Pellet boiler	43.75 GWh[89]	**Technical potential: 1 819 GWh** Pellets require significant storage space. The assumption therefore covers only the heat requirements of the service sector currently met by petroleum products. A factor of 80% is applied to this potential.	0.6%	11% of HN 15.8% of SHN	Cf pellet boilers

[89] According to the OEWB, consumption is approximately 15 000 tonnes (household only). Given that 1m^3 of loose pellets weighs 300 kg, the heat generated is 875 GWh (0.875 kWh/m^3). Without cogeneration, 43.75 GWh is guaranteed with a pellet boiler.

IX.4. *Analysis of non-renewable reference technologies*

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Gas-condensing boiler	3 233 GWh (total consumption of gas condensing boilers in useful energy calculation tables, part I)	**Technical potential: 12 393 GWh** heating needs of areas with access to the gas distribution network. **Location of resource:** • Connection to the gas distribution network. N.B. Boilers powered by a propane tank are not taken into account in this analysis.	26%	19.6% of HN 27.9% of SHN	**Strengths:** • A gas boiler takes up minimal floor space. • Installation possible both in existing buildings and in new builds or buildings undergoing major renovation. • High efficiency and technology familiar to all stakeholders. • Lifespan of between 20 and 30 years. • Occupants and building managers can monitor consumption easily. • User confidence in the technology. **Weaknesses:** • Requires connection to the gas distribution network. • Works optimally at low temperatures and is therefore more efficient when supplying oversized heat emitters (underfloor heating, oversized radiators). • Requires the installation of a water-tight flue. • Fossil energy source emitting greenhouse gases. • Operational and safety risk in the event of a gas leak. • Online loss on the gas network during transmission. • Dependence on gas imports even if 100% of Wallonia's biogas potential is achieved. **Opportunities:** • Possibility of developing new connections to the distribution network. • Possibility of consumption of 'green' gas produced by biogas units. **Threats:** • Policy to decarbonise energy production. • Energy dependence in a context of resource scarcity. • Increasing awareness of the importance of air quality. • Rising gas prices and difficulty of monitoring market stability (significant external factor).

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
Oil-condensing boiler	1 634 GWh (total consumption of oil condensing boilers in useful energy calculation tables, part I)	**Technical potential**: 13 044 GWh (total of residential and service sector heating needs minus the technical potential of the gas condensing boiler). **Location of resource**: Available everywhere. **Development of the resource**: Dependence on imports and decarbonisation policies.	12.5%	20.6% of HN 29.4% of SHN	**Strengths:** • Cheap to install. • Mature and efficient technology with highly competent and up-to-date technical staff. • No geographical/demographic installation constraints. • Low-cost energy carrier. **Weaknesses**: • Pollution: CO_2 and fine particulate matter. • Non-renewable energy carrier. • Fluctuating market prices. • Space required for storage. • Risk of soil pollution. **Threats**: • Policy to decarbonise energy production. • Energy dependence in a context of resource scarcity. • **Increasing awareness of the importance of air quality.** • **Rising fuel oil prices (in particular through the introduction of a carbon tax).** **Federal ban on the sale of oil-fired boilers from 2035.**

IX.5. Analysis of centralised heat distribution technology

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
District heating	237 GWh	**Technical potential: 16 712 GWh** • The method of calculation is as follows: The technical potential is estimated at 37% of the heating needs of the residential and service sectors, as presented in the study Heat Roadmap Belgium. This percentage does not include industry. 37% of substitutable heating needs in industry are therefore added.	1.4%	26.4% of HN 37.7% of SHN	**Strengths:** • Pooling of production. ○ Increases the energy efficiency of the system and reduces maintenance costs. ○ Makes use of multiple heat sources simultaneously or alternately. ○ Makes use of heat not used by one building by sharing it with others. ○ Allows for more professional maintenance of equipment through centralisation (better continuity of energy supply and improved energy and environmental performance). ○ The use of intermittent energy (for example solar power) makes it all the more attractive to manage heat in networks by pooling needs but also by centralising thermal energy storage capacities. • Local system to be adapted to each area according to its specific characteristics. • Centralisation of pollutants, making it easier to deal with them. • Complementarity of consumption profiles connected to the same network allows for a reduction in the total rated power to be installed and thus a reduction in the overall investment in heat generation. • Imposition of heat technology as a means of energy transition. The implementation of district heating is by its nature a means to accelerate the energy transition in the buildings sector as heat generation technology is imposed on a set of users connected to the networks.

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
					• Flexibility in the choice of heat generation technology in the long term. The centralisation of production allows the means of production to be updated/changed in line with technological developments, available resources and regional RES objectives. • Long lifespan of the investment. • Structural investment for a city, a co-owned building or a community association. • Possibility of public-private partnerships. • Greater independence from energy prices thanks to flexible means of production. **Weaknesses:** • Significant investments, in particular linked to costs of heat transmission facilities. The cost of heat paid by the consumer may create an obstacle to the development of these networks. • Thermal losses in the network. These losses may range from 5% to 20% for first-generation networks that are 50 years old. • A complex project requiring the involvement of many stakeholders and requiring the future needs of the site to be anticipated from the design stage. • Local system to be adapted to each area according to its specific characteristics. • Lack of expertise on the part of fitters and consultancy firms owing to a lack of training available in Wallonia and the low number of existing networks. • Very low awareness among the general public. • Lack of media visibility. • Depends on space for additional recipients on or alongside roads. • Competition with the gas network: space and final price of energy for the consumer. • Lack of information and transparency on procedures. **Opportunities:** • High energy density in urban areas. District heating has significant potential in urban areas with dense heat demand. • Waste heat recovery

	Current use of the resource	Technical potential	(1)	(2)	SWOT analysis
					• Increasing energy independence. Wallonia has many sources of energy that can be used to increase its energy independence (solid biomass, mining geothermal energy, deep geothermal energy, biogas, etc.) • Interest in areas with lower population density (rural) but with a cheap local resource. • Kyoto Fund: EUR 110 million made available in 2020 by the Walloon Government to finance transitional policies. **Threats:** • Extension of and competition from the natural gas network. • Cannot be developed without a political interest in promoting it.

IX.6. *Summary of technical analyses*

The table below sets out the key information from the technical analysis.

Technologies/resources	Current operation (GWh)	Technical potential (GWh)	Share of technical potential currently exploited	Share of technical potential in heating needs	Share of technical potential in substitutable heating needs
Production technologies					
Industrial waste heat	682	5 026	14%	8.0%	11.3%
Waste incineration	0	315	0%	0.5%	0.7%
Deep geothermal energy	16	3 226	0.5%	5.1%	7.3%
Solar thermal	114	4 486	3%	7.1%	10.1%
Gas cogen	2 799	8314	34%	13.2%	18.8%
Biomass cogen	3 421	6 422	53%	10.2%	14.5%
Heat pump	323	1 914	17%	3.0%	4.3%
Gas-condensing boiler	3 233	12 393	26%	19.6%	28.0%
Oil-condensing boiler	1 634	13 044	13%	20.6%	29.4%
Pellet boiler	271	10 289	3%	16.3%	23.2%
Wood chip boiler	44	1 819	2%	2.9%	4.1%
Distribution technology					
District heating	237	16 712	1.4%	26.4%	37.7%

Table 37: Summary of technical analyses

IX.7. Consumption profile matrix – technologies

Based on previous analyses, this section attempts to identify the most appropriate technologies for different consumption profiles which are representative of the heating needs in Wallonia. They are:

- An urban/peri-urban municipality (profile 1);
- 'Modest and healthy' blocks of flats designed on the basis of modernist reflections and theories (e.g. Etrimo/Amelinckx), principally built after the Second World War and in the seventies as social housing (profile 2);
- an industrial area (profile 3);
- A municipality, houses, housing, industries, etc. located near the borehole of a geothermal well (profile 4);
- an ecodistrict (profile 5).

To structure the analysis, each of the consumption profiles that are provided is associated with a base scenario and alternative scenarios. the base scenario describes the most likely technologies to meet the needs within each of the profiles considered. As referred to in Directive 2012/27/EU, the baseline scenario will serve as a reference point. The alternative scenarios are based on solutions that meet the same needs, but in a more effective way. Technologies that are not really technically relevant have not been considered in the construction of the alternative scenarios. Each of the scenarios will be subject to a cost-benefit analysis in Chapter 10.

Scenarios	Profile 1 – Urban or peri-urban municipality with high energy density	Profile 2 – Residential buildings	Profile 3 – Industrial site	Profile 4 – Municipality with high energy density located in an area where deep geothermal energy is available	Profile 5 – Ecodistrict
Baseline scenario	BS1 – Individual condensing boiler	BS2 – Decentralised condensing boiler per building	BS3 – Decentralised oil condensing boiler per building	BS4 – Decentralised gas/oil energy mix (individual boilers)	BS5 – Individual gas condensing boiler and installation of a gas distribution network
Alternative scenario 1:	AS1.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	AS2.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	AS3.1 – Industrial waste heat distributed by DH and central oil-fired back-up boiler	AS4.1 – Geothermal installations connected to DH and central gas-fired back-up boiler	AS5.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler
Alternative scenario 2:	AS1.2 – Solid biomass gasification cogeneration connected to DH and central gas-fired back-up boiler	AS2.2 – Solid biomass boiler connected to DH and central gas-fired back-up boiler	AS3.2 – Solid biomass cogeneration connected to DH and central oil-fired back-up boiler	/	AS5.2 – Solid biomass boiler connected to DH and central gas-fired back-up boiler
Alternative scenario 3:	AS1.3 – Waste heat distributed by DH and central gas-fired back-up boiler	AS2.3 – Waste heat distributed by DH and central gas-fired back-up boiler	AS3.3 – Centralised biogas cogeneration (obtained by biomethanation) with oil-fired back-up boiler	/	AS5.3 – Individual heat pumps and decentralised condensing gas boiler

Table 38: Matrix of scenarios and profiles considered

Chapter 10: Construction of scenarios and financial, economic and sensitivity analyses

X. Construction of scenarios and financial, economic and sensitivity analyses

X.1. *Reminder of Annex VIII*

Point 8 of Part III of Annex VIII to Directive 2012/27/EU sets out the content of comprehensive assessments of the potential for efficiency in heating and cooling.

The aim of this chapter is to give a cost-benefit analysis for each scenario of each profile and to analyse the sensitivity of the results to several variables. The details of the following points are on pages 3 to 5 of Annex VIII.

This analysis of the economic potential includes the following stages and considerations:

(a) Considerations
(b) Costs and benefits
(c) Relevant scenarios compared to the reference situation
(d) Limits and integrated approach
(e) Assumptions

X.2. *Introduction*

For the different profiles presented in the previous chapter, a descriptive analysis followed by a representativeness analysis precedes the economic analyses that have been carried out to estimate the discounted and annualised value of the net costs.

There is also an environmental analysis made for each profile studied. It only takes account of CO_2 emissions linked to fuel consumption (gas[90] and electricity).

Finally, as required by Directive 2012/27/EU, a sensitivity analysis was carried out considering the impact of a variation in investments and operational expenditure, fuel prices, CO_2 emissions and environmental impact. The technical and economic assumptions and the initial data are set out in the Annex to Chapter X.

Table 39 summarises the different scenarios studied for each profile.

[90] Note that to simplify things, a distinction was made between (1) electricity, (2) carbonaceous fuels, i.e. fuel oil and natural gas, and (3) decarbonised fuels (i.e. biomass). The emission factor used for carbonaceous fuels is that of gas, as the analysis mainly looks at alternative scenarios based on gas technologies in the case of carbonaceous fuels. This may lead to bias in some of the results of the analysis, which considers both fuel oil and gas technologies.

Profiles and scenarios	Characteristics
Profile 1 – Urban or peri-urban municipality with high energy density	
BS1 – Individual condensing boiler	The baseline scenario (BS1) envisages a situation where each building individually meets its own needs via condensing boilers. There is no district heating.
AS1.1 – Gas cogeneration connected to district heating and central gas-fired boiler (back-up)	Alternative scenario 1 (AS1.1) envisages a situation where 14% of the heating needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.
AS1.2 - Solid biomass cogeneration connected to district heating and central gas-fired boiler (back-up)	Alternative scenario 2 (AS1.2) envisages a situation where 32% of the heat needs are covered by cogeneration using solid biomass (by means of gasification) connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.
AS1.3 – Waste heat distributed by district heating and central gas-fired boiler (back-up)	Alternative scenario 3 (AS1.3) envisages a situation where 99% of the heat needs are covered by waste heat, via district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.
Profile 2 – Building stock	
BS2 - Decentralised condensing boiler for each building	The baseline scenario (BS2) envisages a situation where all of the heat needs are covered by decentralised condensing boilers for each building.
AS2.1 – Gas cogeneration connected to district heating and supplementary central gas-fired boiler (back-up)	Alternative scenario 1 (AS2.1) envisages a situation where 37% of the heat needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by collective gas heating.
AS2.2 – Solid biomass boiler connected to district heating and supplementary central gas-fired boiler (back-up)	Alternative scenario 2 (AS2.2) envisages a situation where 90% of the heat needs are covered by a communal boiler running on solid biomass connected to district heating. The remaining heating needs are covered by a centralised gas boiler.

AS2.3 – Waste heat distributed by district heating and central gas-fired boiler (back-up)	Alternative scenario 3 (AS2.3) envisages a situation where 73% of the heat needs are covered by waste heat. The remaining heating needs are covered by centralised gas heating.
Profile 3 – Industrial site	
BS3 – Decentralised oil condensing boiler for each building	The baseline scenario (BS3) envisages a situation where an industrial site meets its own needs via condensing boilers in each building. There is no district heating network. Furthermore, the baseline scenario (BS3) envisages a situation where an industrial site has an excess of heat (waste heat) that is unused, despite there being consumers nearby. These consumers have a condensing boiler in each of their buildings.
AS3.1 – Industrial waste heat distributed by district heating and central oil-fired back-up boiler	Alternative scenario 1 (AS3.1) envisages the distribution of excess industrial waste heat to nearby consumers. In this situation 93% of the heat needs are covered by industrial waste heat, via district heating. The remaining heating needs are covered by supplementary oil heating (serving also as a back-up) connected to district heating.
AS3.2 – Solid biomass cogeneration connected to district heating and central oil-fired boiler (back-up)	Alternative scenario 2 (AS3.2) envisages the existence of a solid biomass power plant, aimed mainly at producing renewable electricity. Heat is a by-product of this electricity production. Thus, in this situation 93% of the heat needs are covered by cogeneration fuelled by solid biomass (class B wood) connected to district heating. The remaining heating needs are covered by supplementary oil heating (serving also as a back-up) connected to district heating. Note that this scenario can be extended to any type of fuel (such as solid recovered fuel - SRF), as it is a co-incineration plant.
AS3.3 - Biogas cogeneration from a biomethanation unit, connected to a district heating network and central oil-fired boiler (back-up).	Alternative scenario 3 (AS3.3) envisages a situation where 53% of the heat needs are covered by centralised biogas cogeneration fuelled by biogas via a biomethanation unit. This is all connected to district heating. The remaining heating needs are covered by an oil boiler that is, likewise, centralised and connected to district heating.
Profile 4 - Municipality/housing/industry/residences with high energy density located in an area where deep geothermal energy can be exploited	
BS4 – Decentralised gas/fuel oil energy mix (individual boilers)	The baseline scenario (BS4) envisages a situation where each building individually meets its own needs via condensing boilers (gas or fuel oil). There is no district heating network.

AS4.1 – Geothermal installations connected to district heating and central gas boiler (back-up)	Alternative scenario 1 (AS4.1) envisages a situation where 87% of the heating needs are covered by a geothermal installation connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating. This coverage of 87% of the heating needs by deep geothermal energy is due to fact that a back-up is needed and a part is considered not to be provided by the loop (maintenance, for example).
Profile 5 – Ecodistrict (new builds)	
BS5 – Individual gas condensing boiler and installation of a gas distribution grid.	The baseline scenario (SB5) envisages a situation where each building individually meets its own needs via condensing boilers. There is no district heating network. However, this scenario envisages the establishment and cost of a network to be connected to the gas distribution grid.
AS5.1 – Gas cogeneration connected to district heating and central gas-fired back-up boiler	Alternative scenario 1 (AS5.1) envisages a situation where 38% of the heat needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.
AS5.2 – Solid biomass boiler room connected to district heating and central gas boiler (back-up)	Alternative scenario 2 (AS5.1) envisages a situation where 89% of the heat needs are covered by a biomass boiler room connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.
AS5.3 – Individual heat pumps and decentralised condensing gas boiler room	Alternative scenario 3 (AS5.3) envisages a situation where 37% of the heat needs are covered by heat pumps (in individual homes). The remaining heating needs (blocks of flats, service, etc.) are covered by an individual (decentralised) gas condensing boiler room per building.

Table 39: Summary of scenarios and profiles examined

X.3. Analysis of profile 1

X.3.1. Description of consumption profile 1

The table below presents key morphology and consumption data for profile 1. This profile corresponds to an urban or peri-urban municipality with a critical density, namely a linear energy density greater than 2 000 kWh/m[91]/year. The description focuses on the part of the town or city concerned. Indeed, not all housing and businesses (service) are connected to the district heating considered in the analysis.

Profile 1		
Characteristics	Municipality with a linear energy density greater than 2 000 kWh/m/year	
Practical example:	The town of Farciennes	
Description of the part of the town concerned.		
Thermal energy consumption	23 261 000 kWh	
Electrical energy consumption	2 394 000 kWh	
Sectors	Residential	Service
Characteristics of the building stock	670 houses, 7 small apartment blocks	5 schools, 1 swimming pool, 1 sports hall
Thermal energy consumption[92]	18 389 727 kWh	4 871 273 kWh
Electrical energy consumption[93]	1 892 653 kWh	501 347 kWh

Table 40: Description of profile 1

X.3.2. Representativeness of profile

The table below presents the range of representativeness of profile 1 based on the part of the building stock connected to a district heating network. Based on the available data on the 'Tibi' project in Farciennes, around 30% of the building stock is connected to district heating. This is the threshold necessary to ensure the profitability of the project. The upper range shows the representativeness of the profile if 100% of the building stock is connected. In other words, 9% of the heating needs of Wallonia's residential and service sectors are covered by this profile if 30% of the building stock of the 22 municipalities corresponding to profile 1 is connected to a district heating network. If 100% of the building stock is connected, 30% of the heating needs of the residential and service sectors are covered. The heating needs taken into account in this profile are mainly those of the residential and service sectors.

[91] Metre of excavation
[92] The breakdown between residential and service is based on the energy balance (79%/21%).
[93] The ratio of distribution of the thermal consumption needs is applied to electricity consumption.

Profile 1		
Areas similar to profile 1	22 Walloon municipalities with a linear energy density greater than 2 000 kWh	
Examples	Manage, Verviers, Boussu, Tubize, Seraing, Herstal, etc.	
Representativeness in terms of residents		
	Low range (30%)	High range (100%)
Number of inhabitants connected to the network	327 711 inhabitants	1 092 370 inhabitants
Representativeness in terms of heating needs		
	Low range (30%)	High range (100%)
Heating needs - residential	2 383 055 015 kWh	7 943 516 718 kWh
Heating needs - service	631 249 837 kWh	2 104 166 125 kWh
Heating needs – Total	3 014 304 853 kWh	10 047 682 843 kWh
WR (resid. + service) share of heating needs	9%	30%

Table 41: Representativeness of profile 1

To assess the representativeness of this profile as effectively as possible, it is also important to consider the position of gas in these municipalities which are dense enough to accommodate a district heating network. The same logic applies for both these types of infrastructure (heating and gas networks). These infrastructures require considerable investments and a certain density of population and energy needs in order to be economically viable. Consequently, the 22 municipalities corresponding to profile 1 are all covered by a gas distribution grid to certain extents varying from one municipality to another. Based on data showing the share of households connected to the gas network per municipality, it is possible to estimate the potential heating needs that could be covered by district heating if all the buildings that are not connected to the gas network were connected to a district heating network. By breaking down the heat needs of the residential and service sectors by inhabitant and by applying the share of households connected to a gas network to the population of each municipality, it seems that 3 504 GWh of heat needs are not covered by a gas network in these 22 municipalities and could therefore be potentially covered by a district heating network. This corresponds to 10.5% of Wallonia's heating needs for the residential and service sectors and corresponds to more than 380 000 inhabitants who could potentially be connected to district heating.

Municipalities	Population	Linear density (kWh/m/yr)	Heating needs Residential + Service (GWh)	Share of households connected to a gas distribution grid	Residential + Service heating needs not covered by gas (GWh)
Sources	Statbel (2019)[94]	PwC calculation based on data from the Iweps [*Institut wallon de l'évaluation, de la prospective et de la statistique*]	PwC calculation based on data from the 2016 energy balance	Iweps (2019)[95]	PwC calculation based on data in this table
Manage	23 308	6 413.93	214.4	76.70 %	50.0
Quaregnon	19 007	3 711.55	174.8	77.60 %	39.2
Verviers	55.207	3 486.21	507.8	35.10 %	329.6
Boussu	19 824	3 305.37	182.3	71.50 %	52.0
Comines-Warneton	18 024	3 091.54	165.8	77.20 %	37.8
Saint-Nicolas	24 263	3 034.13	223.2	64.20 %	79.9
Charleroi	202 267	2 702.45	1 860.5	62 %	707.0
Liège	197 327	2 675.52	1 815.0	66.10 %	615.3
Dison	15 248	2 589.15	140.3	66.10 %	47.5
Herstal	39 989	2 542.62	367.8	68.80 %	114.8
Seraing	64 259	2 524.17	591.1	70.40 %	175.0
Beyne-Heusay	11 929	2 384.44	109.7	64.80 %	38.6
Mons	95 613	2 347.94	879.4	69.80 %	265.6
Mouscron	58 474	2 343.16	537.8	82.30 %	95.2
La Louvière	80 757	2 287.37	742.8	71 %	215.4
Farciennes	11 316	2 270.85	104.1	43.10 %	59.2
Fléron	16 526	2 267.68	152.0	54.80 %	68.7
Tubize	26 233	2 112.41	241.3	53.70 %	111.7
Colfontaine	20 811	2 047.66	191.4	61.90 %	72.9
Jodoigne	14 123	2 037.04	129.9	19.20 %	105.0
Braine-l'Alleud	40 008	2 009.14	368.0	66.30 %	124.0
Châtelet	35 903	1 997.62	330.2	69.60 %	100.4
				Total	3 504.6

Table 42: Municipalities with a linear heat requirement greater than 2 000 kWh/m/year

[94] Statbel (2019): Population density by municipality 2019-2020
https://statbel.fgov.be/fr/themes/population/densite-de-la-population
[95] Iweps (2019): Share of households using the gas network
https://walstat.iweps.be/walstat-catalogue.php?niveau_agre=C&theme_id=9&indicateur_id=813000&sel_niveau_catalogue=T&ordre=2

X.3.3. Scenarios envisaged

.X.3.3.1. Description of the scenarios

With regard to the consumption profile described above, four scenarios were identified:

- **Baseline scenario (BS1)**: The baseline scenario (BS1) envisages a situation where each building individually meets its own needs via condensing boilers. There is no district heating network.

- **Alternative scenario 1 (AS1.1)**: Alternative scenario 1 (AS1.1) envisages a situation where 14% of the heating needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.

  Alternative scenario 2 (AS1.2): Alternative scenario 2 (AS1.2) envisages a situation where 32% of the heat needs are covered by cogeneration using solid biomass (by means of gasification) connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.

- **Alternative scenario 3 (AS1.3)**: Alternative scenario 3 (AS1.3) envisages a situation where 99% of the heat needs are covered by waste heat, via district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.

X.3.4. Presentation of technical and financial data

The table below consolidates the technical and financial data that were taken into account for the model supporting the analysis carried out. The main variables used are:

- the lifetime of that technology expressed in years
- the unit capital expenditure (investments) in EUR/kW or EUR/m for district heating
- the operational expenditure (OpEx) as a percentage of capital expenditure (CapEx) per year
- the other installation costs as a percentage of capital expenditure
- the seasonal thermal efficiency (%)
- the electricity yield (%)
- annual thermal production (kWh)
- the installed thermal power (kW)

	Baseline scenario (BS1)	Alternative scenario (AS 1.1)	Alternative scenario (AS 1.2)	Alternative scenario (AS 1.3)
General description of scenario	Decentralised condensing boiler for each building	Centralised gas cogeneration + back-up boiler / supplementary district heating	Centralised biomass gas cogeneration + back-up boiler / supplementary district heating network	District heating network with waste heat injection + back-up boiler / supplementary district heating network
Primary technology	***Condensing boiler***	***Gas cogeneration***	***Solid biomass cogeneration***	***Steam exchanger***
Lifespan	15 years	12 years	20 years	30 years
Unit CapEx (EUR/kWth)	281	758	4 200	199
Other installation costs (%CapEx)	n.a.	n.a.	n.a.	n.a.
OpEx (operation) (% CapEx/year)	4%	10%	7%	15%
Seasonal thermal yield on PCS (%)	90%	54%	50%	98%
Electricity yield (%)	n.a.	36%	30%	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	3
Annual thermal production (kWh/year)	23 261 000	3 250 000	7 380 000	22 950 000
Annual electric production (kWh/year)	n.a.	2 164 662	4 428 000	n.a.
Thermal power (kW)	16 748	650	984	2 700
Electric power (kW)	n.a.	433	590	n.a.
Secondary technology	***n.a.***	***Supplementary central gas heating***	***Supplementary central gas heating***	***Supplementary central gas heating***
Lifespan	n.a.	30 years	30 years	30 years
Unit CapEx (EUR/kW)	n.a.	177	177	177
OpEx (operation) (% CapEx/year)	n.a.	4%	4%	4%
Seasonal thermal yield on PCS (%)	n.a.	90%	90%	90%
Electricity yield (%)	n.a.	n.a.	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	n.a.	20 011 000	15 881 000	311 000
Thermal power (kW)	n.a.	8 000	8 000	8 000
Network	***n.a.***	***YES***	***YES***	***YES***
Lifespan (years)	n.a.	50 years	50 years	50 years
Length of network (m)	n.a.	7 015	7 015	7 015
Infrastructure CapEx (EUR/m)	n.a.	1 283	1 283	1 283
OpEx (operation) (%CapEx/year)	n.a.	1%	1%	1%
Distribution losses (%)	n.a.	10%	10%	10%

Table 43: Technical and financial data for profile 1

X.3.5. Economic analyses

Updated and annualised value of net costs

The alternative scenarios all present an updated and annualised net cost value lower than the baseline scenario, i.e. the scenario that envisages the installation of condensing boilers. Although the result is positive for each of the alternative technologies, this is clearly for different reasons:

- **Scenario AS1.1 (gas cogeneration)**: The advantage of this scenario is based on the production of co-generated electricity, i.e. a gain of EUR 31 800 on the resale of self-generated electricity plus an additional value of OpEx subsidies (green certificates) and annualised and updated CapEx subsidies of EUR 33 000. This scenario envisages a 20% decrease in capital expenditure to take account of investment aid (sustainable energy use aid for cogeneration and district heating networks).
- **Scenario AS1.2 (biomass cogeneration):** The advantage of this scenario is based on the production of co-generated electricity, i.e. a gain of EUR 65 000 on the resale of self-generated electricity, plus an additional value of OpEx subsidies (green certificates) and annualised and updated CapEx subsidies of EUR 535 000. This scenario envisages a 40% decrease in capital expenditure to take account of investment aid (sustainable energy use aid for cogeneration and district heating networks).

- **<u>Scenario AS1.3 (waste heat from incinerator):</u>** The advantage of this scenario is based on expenditure on fuel two to three times lower than in the other scenarios. This scenario envisages a 40% decrease in capital expenditure to take account of investment aid (sustainable energy use aid for investments aimed at improving production processes and district heating networks).

Scenario	BS1:	AS 1.1	AS 1.2	AS 1.3
Updated and annualised value of net costs (EUR/year)	2 339 032	1 897 924	1 845 856	1 554 861
Difference	0	441 10 8	493 175	784 171

Table 44 : Overall results for profile 1

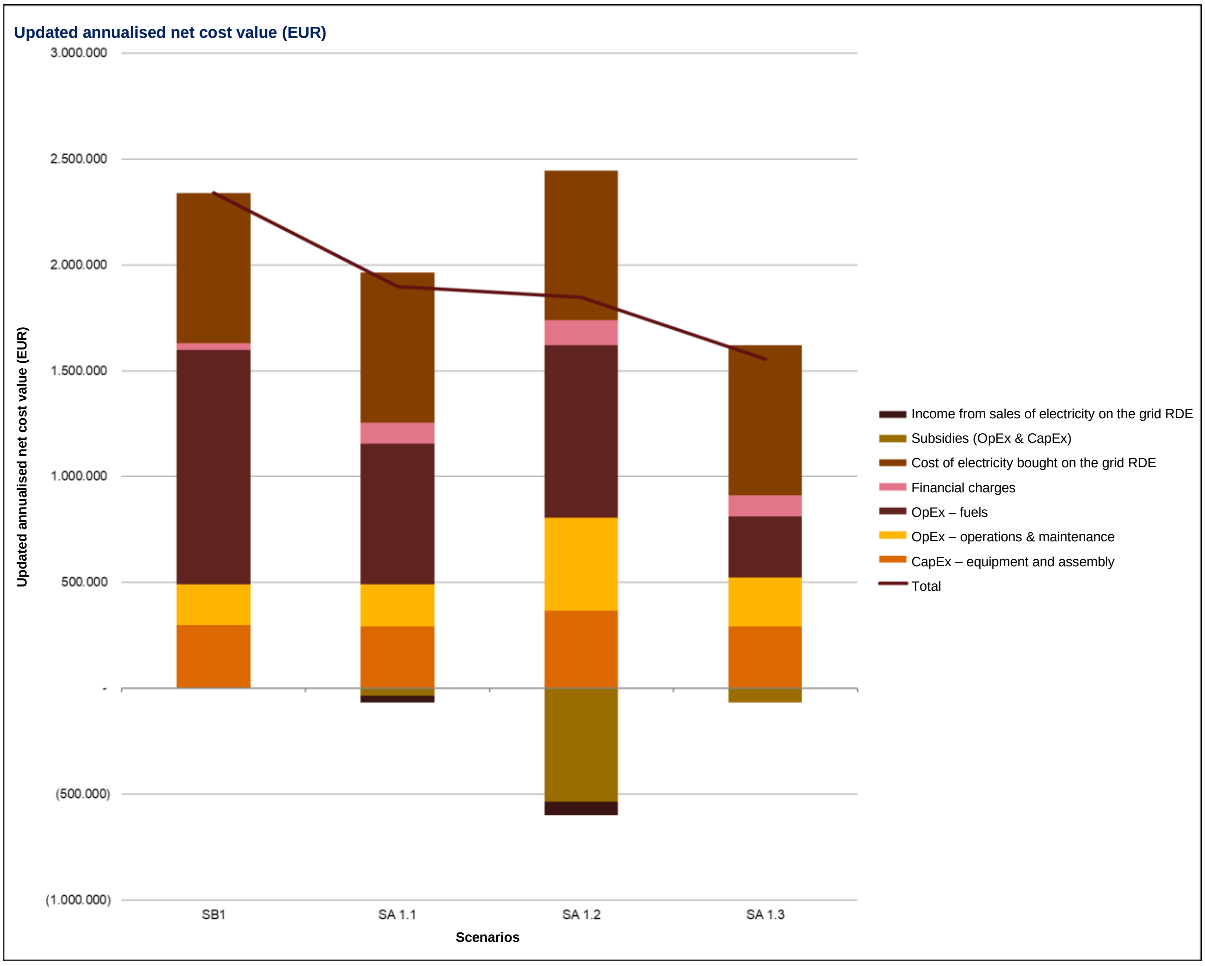


Figure 42: Updated and annualised net value of the four scenarios for profile 1 (EUR/year)

Comparison of annualised costs by cost item

An analysis of annualised costs by cost item makes it possible to identify the strengths and weaknesses of each of the scenarios:

- **CapEx - Equipment & assembly**: The capital expenditure for the different scenarios is more or less the same. Although cogeneration has much higher capital expenditure per kWh than the other scenarios, because it is centralised, its power can be significantly reduced, accordingly reducing the total costs of the capital expenditure.
- **OpEx – Operation & maintenance**: Compared to the other cost items, for scenarios BS1, AS1.1 and AS1.3, the costs linked to the operation and maintenance of the installations are relatively low. Alternative scenario AS2.1 is the scenario with the highest operational expenditure.
- **OpEx – Fuels**: The fuel costs cover the purchase of the fuels needed to cover the identified heat needs. Scenario AS1.3 benefits from the waste heat from an incinerator at a very low price. Cogeneration (AS1.1 and AS1.2) is highly fuel-intensive but benefits from a preferential price (equivalent to that of an industrial consumer) given the amount of fuel required. The baseline scenario (BS1) does not benefit from this favourable price. This explains the high value of operational expenditure for fuel for this scenario.
- **Financial charges:** The financial charges are lower in the baseline scenario as the technology used has a shorter life span. This means the amount of capital on which a financial charge is applied reduces more quickly.

- **Cost of the electricity purchased on the grid:** Based on the assumption that collective self-consumption does not exist, all the scenarios get 100% of their electricity on the distribution grid whether they benefit from electricity-generating technology (AS1.1 and AS1.2) or not (BS1 and AS1.3).
- **Revenue from the sale of electricity on the grid**: Given the amounts and coefficients of performance considered, it appears that biomass cogeneration generates more revenue than gas cogeneration. It is also important to stress that electricity resold on the grid is valued at EUR 0.025 per kWh (Belpex price). All co-generated electricity is resold to the grid on the assumption that collective self-consumption does not exist.

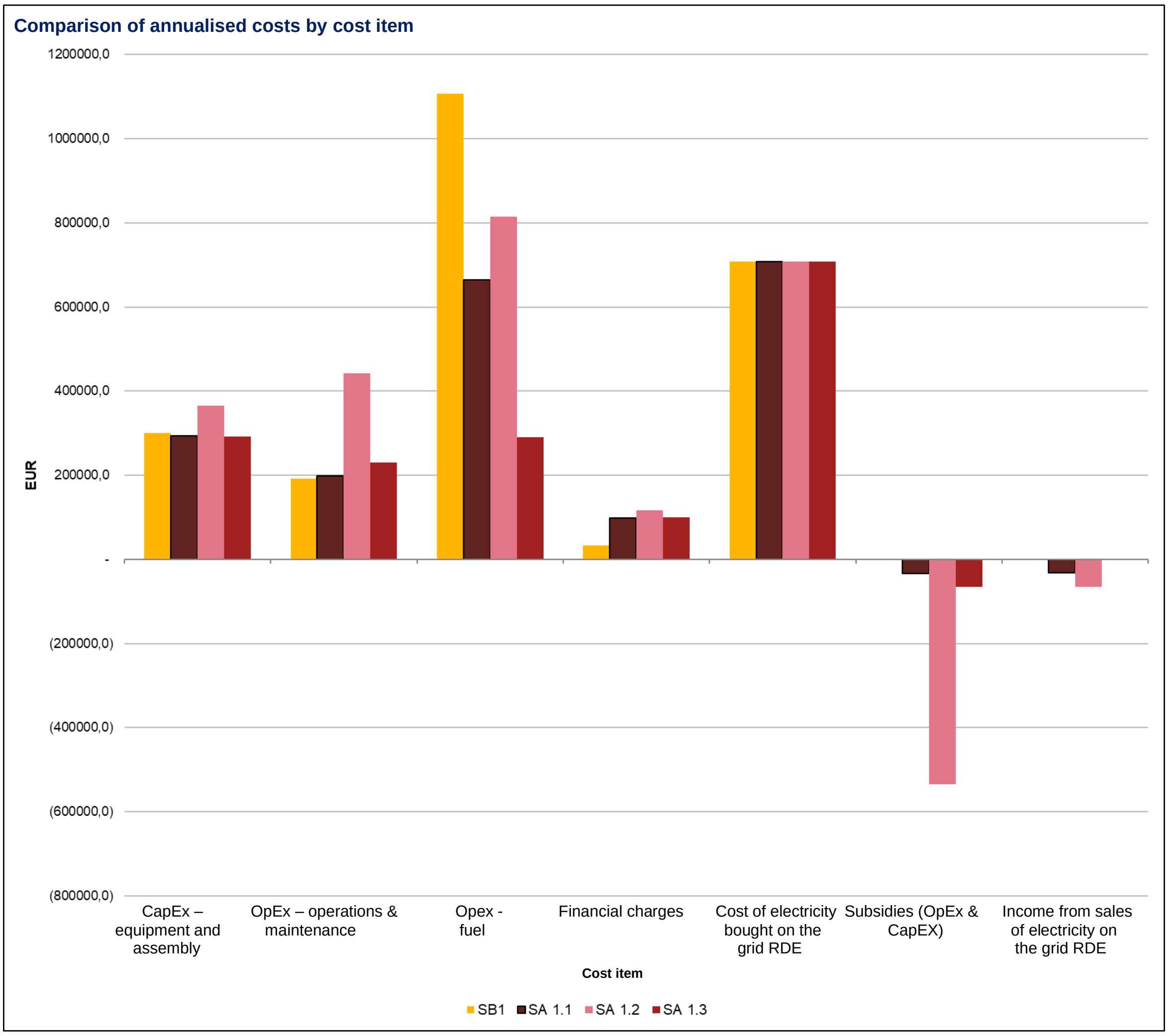


Figure 43: Comparison of annualised costs by cost item

Comparison of the cumulative net costs of the four scenarios (EUR)

The figure showing the cumulative net costs for the four scenarios envisaged should be put in perspective with the investments and the life spans of the technologies considered in each of these scenarios. This information makes it possible to understand the 'plateaus' shown in the figure. Although the baseline scenario has lower investments than the other scenarios, which allows it to be the most profitable in the short term, it appears that each alternative scenario considered is profitable in the longer term. We have to wait a period varying from 7 years for alternative scenarios AS1.1 and AS1.3 to 13 years for alternative scenarios AS1.2 before they have lower cumulative net costs than the baseline scenario. The gap between the alternative scenarios and the baseline scenario widens when the primary technology for the baseline scenario, which has a significant investment and a short lifespan, has to be replaced.

	Tech. investment Primary (EUR)	Primary tech. lifespan (years)	Supplementary tech. investment (EUR)	Supplementary tech. lifespan (years)
BS 2	4 706 166	15 years	n.a.	
AS 2.1	492 700	12 years	1 416 000	
AS 2.2	4 132 800	20 years		
AS 2.3	537 300	30 years	1 416 000	30 years

Table 45: Investments and lifespans of the Profile 1 technologies[96]

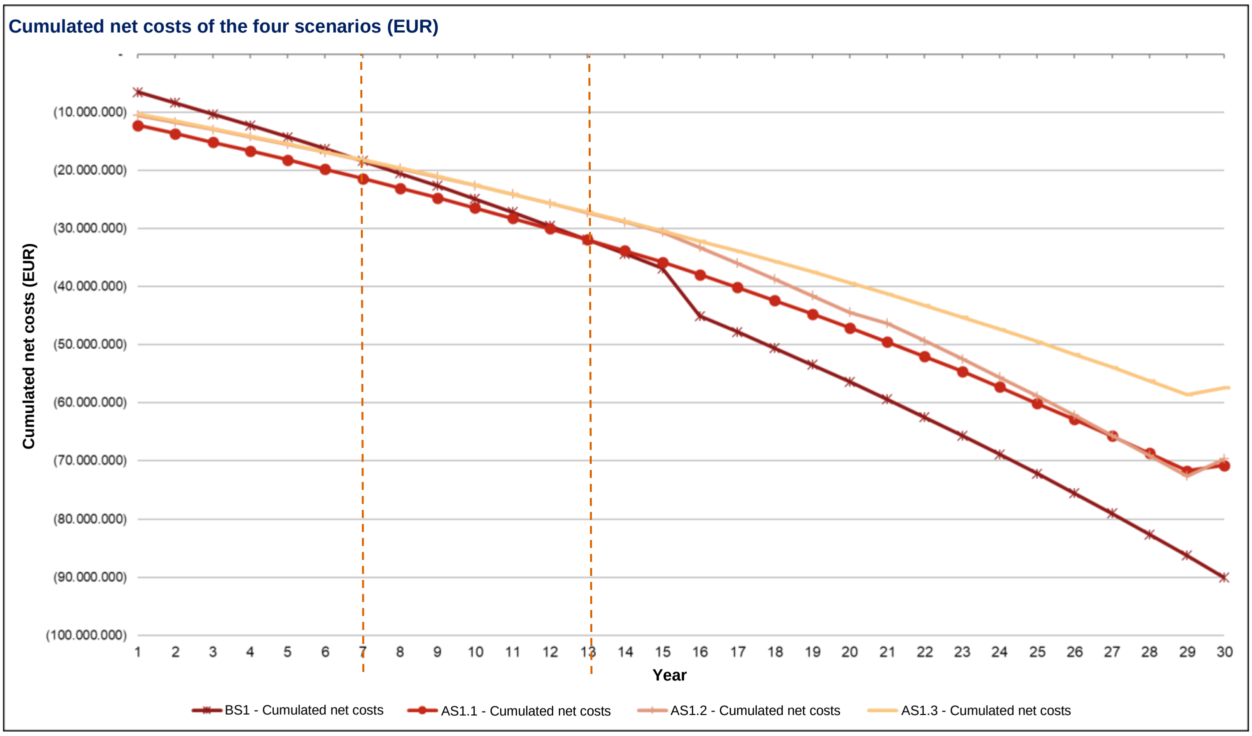


Figure 44: Cumulated net costs of the four scenarios of profile 1

X.3.6. *Sensitivity analysis*

Sensitivity analysis of variations in CapEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in the planned investments (capital expenditure). Regardless of the alternative scenario envisaged, it appears that a 20 % increase in capital expenditure should not compromise their advantage over the baseline technology (condensing boiler).

96 Added to the investments shown in this table are the investments relating to the development of the district heating network, i.e. an investment of EUR 9 million amortised over 50 years.

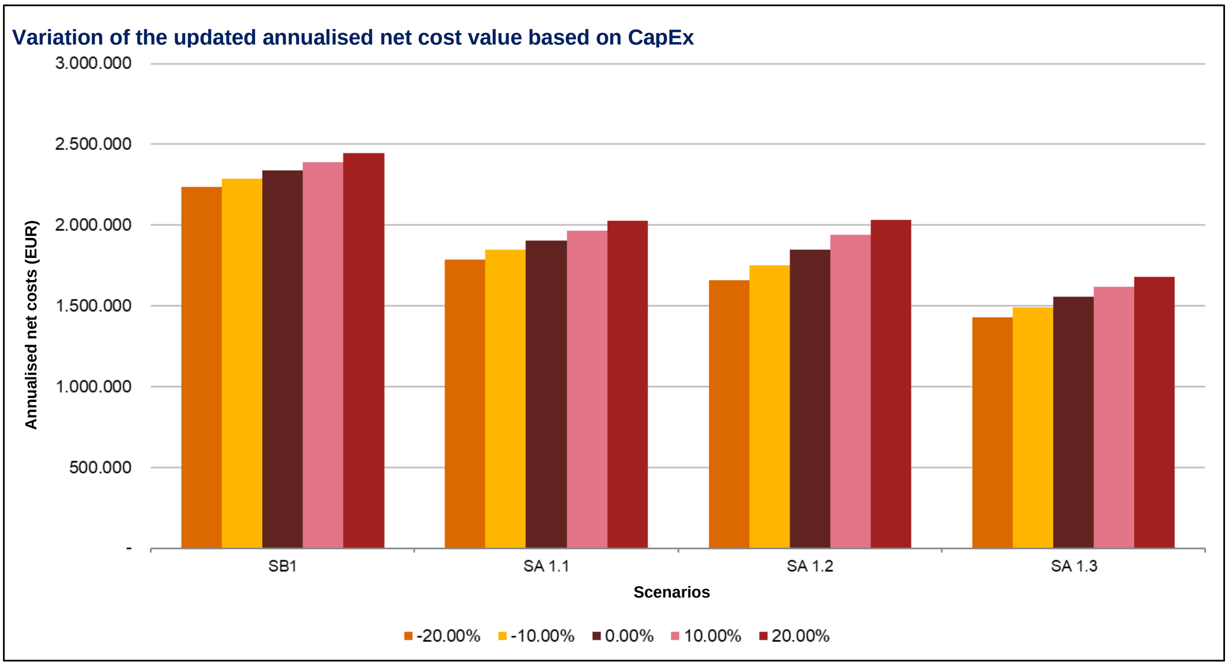


Figure 45: Variation of the updated and annualised net cost value based on the capital expenditure for profile 1

Sensitivity analysis of variations in OpEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in operational expenditure (excluding fuels and green certificates). The results of this sensitivity analysis reinforce the conclusions of the results presented above. Operating costs are not the highest cost items. It is thus probable that variations in these will only have a very slight impact on the results obtained.

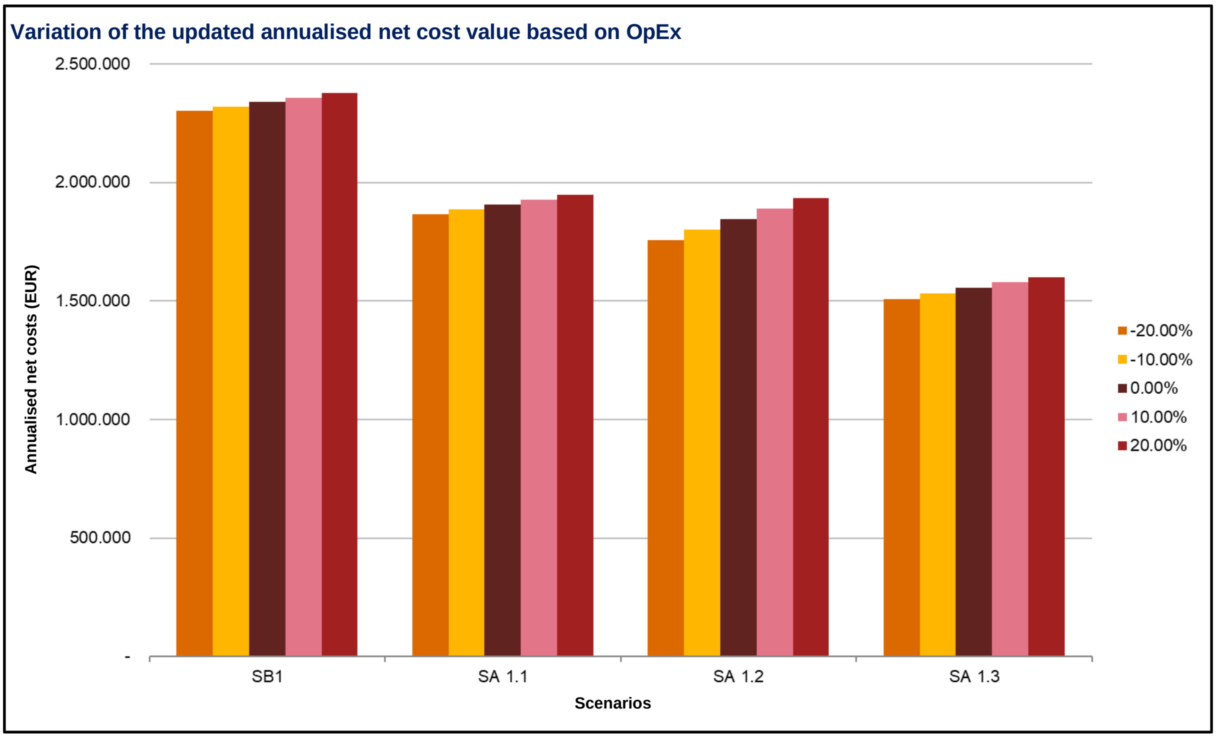


Figure 46: Evolution of the updated net costs based on the operational expenditure for profile 1

Introduction of a CO_2 cost

The graph below illustrates the differences between the alternative scenarios and the baseline scenario if consumers have to pay for the tonnes of CO_2 emitted by the production technologies considered. The analysis considers a price range of EUR 0 to EUR 20 per tonne of CO_2. This cost is on top of the updated and annualised net cost value for each scenario. The findings are:

- The difference between the **baseline scenario and alternative scenario AS1.1** does not increase significantly when prices per tonne of CO_2 increase. This is because the technologies considered in the AS1.1 scenario consume more gas than the technologies considered in the other scenarios.
- Conversely, scenarios AS1.2 and AS1.3 benefit from having the cost of CO_2 taken into account. The higher the cost per tonne of CO_2, the greater the difference.

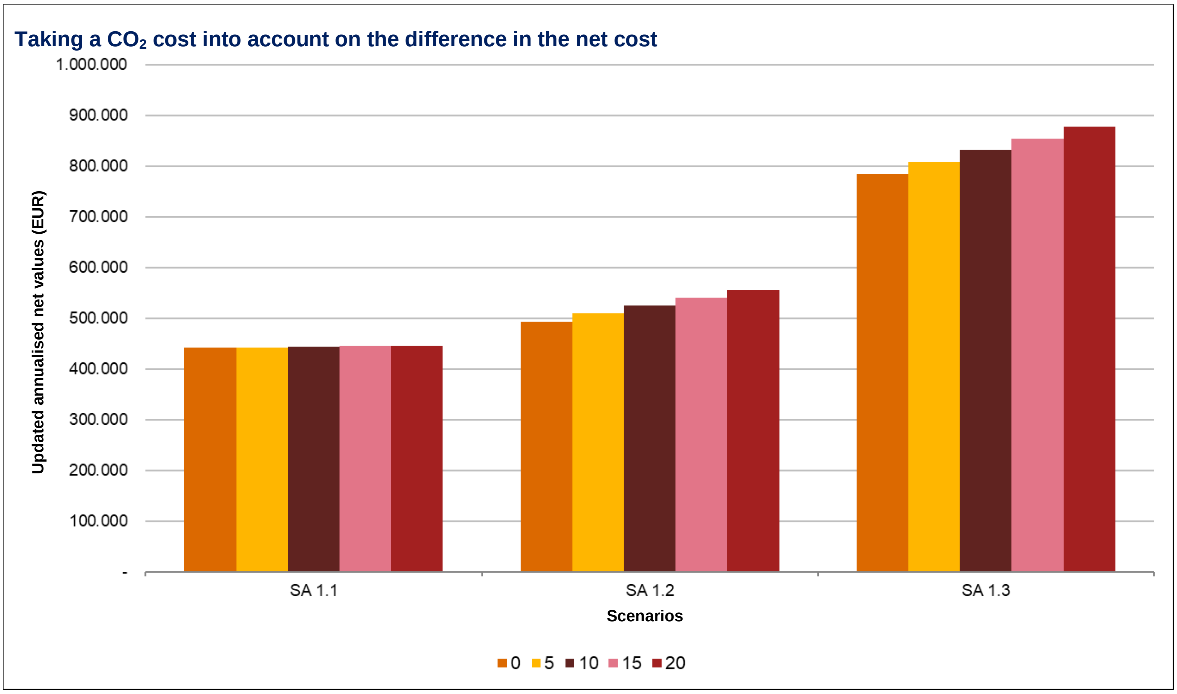


Figure 47: Taking a CO_2 cost into account for profile 1

Variation of the prices of gas and of electricity

Figure 48 illustrates the results of the scenarios analysed above if gas and electricity costs were higher or lower (range from -20% to + 20%). In order to make it easier to read this figure, an example (see green dotted rectangle) is developed. This rectangle represents the results of scenario AS1.1 (gas cogeneration) where the gas price is 20% higher than the price considered in the analysis (i.e. EUR 0.022/kWh + 20% or EUR 0.026/kWh) and the price of electricity varies from -20% to + 20% of the value considered in the analysis. All the scenarios are equally sensitive to changes in the price of electricity as shown by the similar slope of all the curves. As self-consumption is not considered, the electricity-generating scenarios are just as sensitive as the others. Furthermore, an increase in the price of fossil fuels leads to an increase in the updated and annualised net cost value (movement towards the top right). The lines of scenario AS1.3 are close. This reflects the fact that this scenario is very little dependent on gas prices. Almost all of the energy needed comes from waste heat.

Note also that this analysis makes it possible to assess the impact on the results of taking VAT into account. Depending on the fuels, there may be grounds for considering an increase of around 10% (VAT at 6%) or 20% (VAT at 21%).

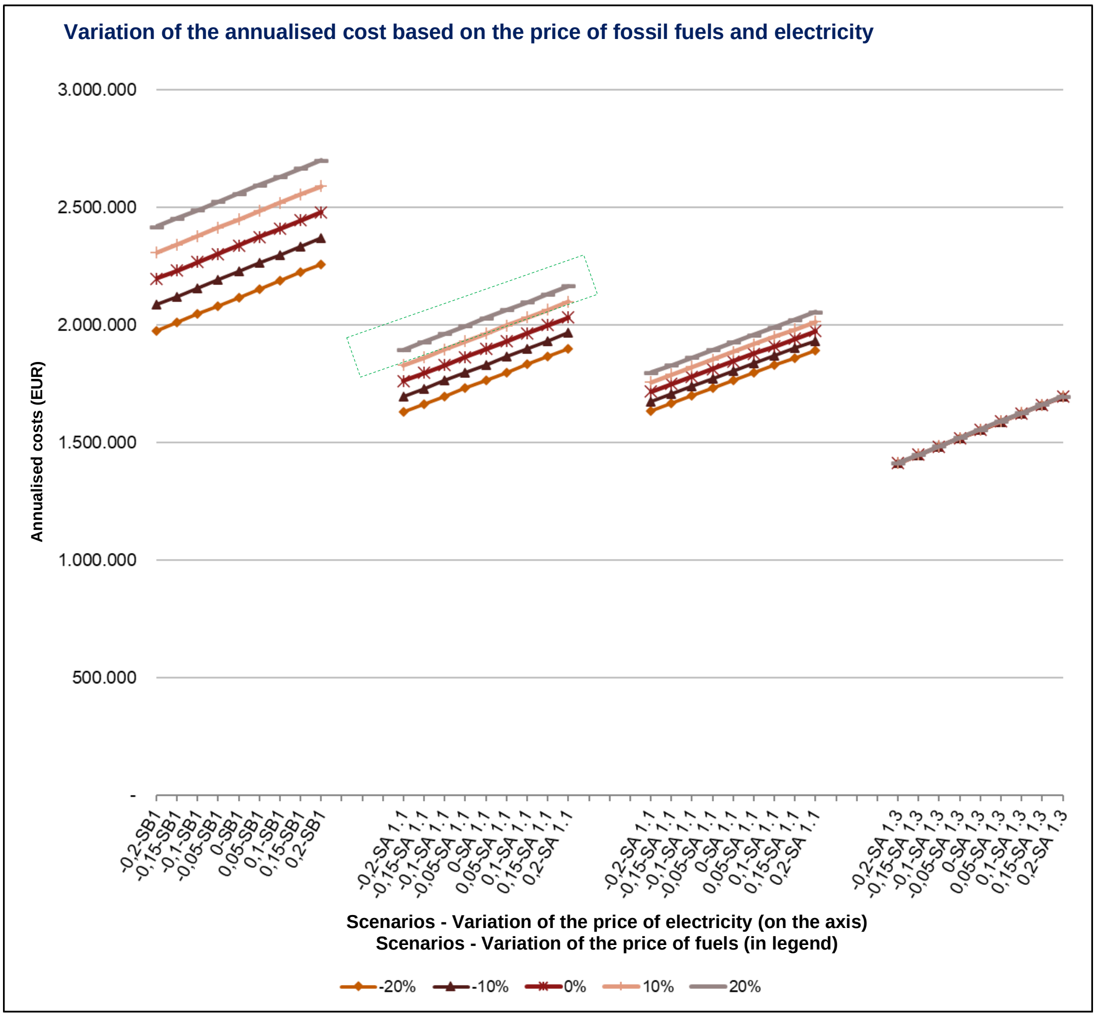


Figure 48: Variation of the gas and electricity prices for profile 1

Variation of the increase of the price of gas and of electricity

Figure 49 considers a variation in the increase in gas and electricity prices (initial hypotheses of +2%/year and +4%/year, respectively). In order to make it easier to read this figure, an example (see green dotted rectangle) is developed. This example illustrates the situation in AS1.1 (gas cogeneration) where the gas price rises at a rate of 8% higher than that considered, i.e. an annual increase of 10%. The points on the right illustrate the results of the analysis in cases where the increase in the electricity price is between 0% and 8% higher than the initial value considered, i.e. an annual increase between 4% (0-AS1.1) and 12% (0.08-AS1.1). It appears that updated and annualised net cost values of all scenarios increase when inflation on electricity prices increases. It also appears that alternative scenario AS1.3 is relatively insensitive to fuel price inflation as it partly relies on waste heat.

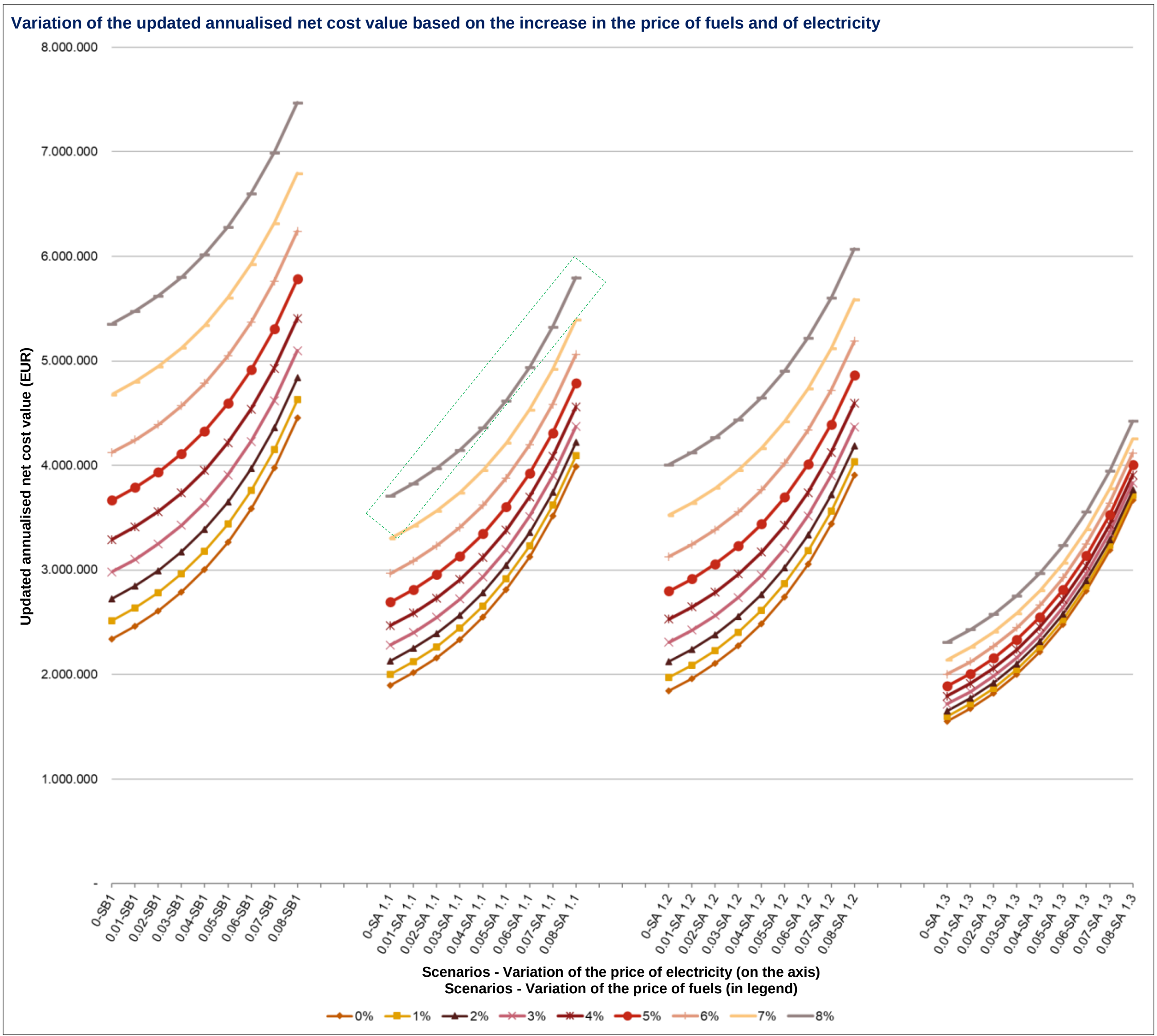


Figure 49: Evolution of the updated and annualised net cost value depending on the increase in the price of fuels and electricity for profile 1

Sensitivity analysis on collective self-consumption

The following figure shows the updated and annualised net cost value for each scenario in two situations: (1) without collective self-consumption and (2) with collective self-consumption of 100 % of self-generated electricity. Only the two scenarios involving cogeneration are concerned, but this result highlights how energy communities could be a potential asset. The main gain in self-consumption is at the level of the 'Electricity purchases' item, which becomes zero when the output exceeds needs. In this situation, scenarios AS1.1 and AS1.2 where cogeneration is used become the most attractive scenarios.

Figure 50: Analysis for collective self-consumption

.X.3.6.1. *Environmental review*

The baseline scenario shows a total annual CO_2 production of almost 6 400 tonnes. Alternative scenarios AS1.1, AS1.2. and AS1.3 show lower annual emissions of 6 100 tonnes, 4 000 tonnes and 1 270 tonnes of CO_2 respectively. This is consistent with the environmental nature of the way energy is consumed to produce heat. It is important to stress that cogeneration also generates green electricity. In alternative scenarios AS1.1 and AS1.2., the electricity produced through cogeneration allows the prevention of emissions of over 870 tonnes and 1 800 tonnes of CO_2, respectively.

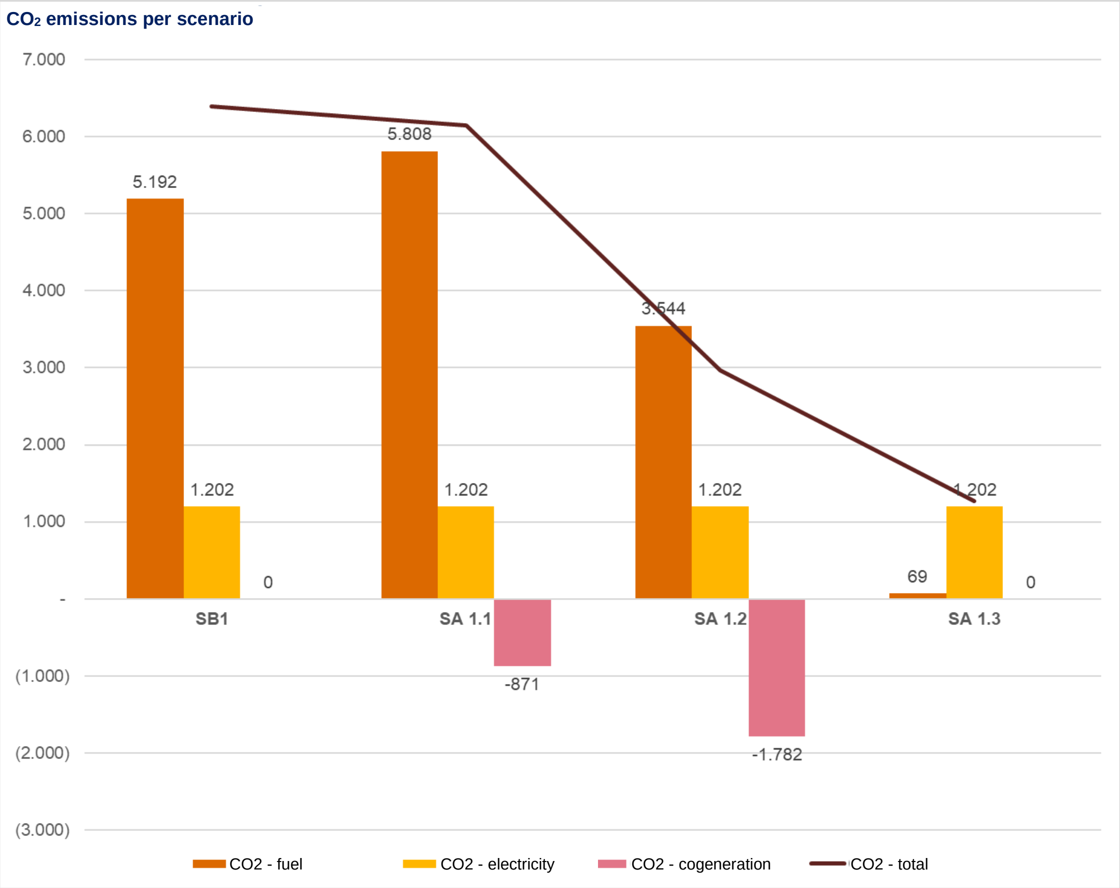


Figure 51: CO_2 emissions per scenario for profile 1

Figure 52 shows the impact of each investment on CO_2 emissions compared to the baseline scenario. The following approach was used to identify the grams of CO_2 saved per euro invested. For each scenario, the difference in CO_2 emissions from the baseline scenario is divided by its updated and annualised net cost value. Scenario AS1.3 appears to be the most effective investment in terms of reducing CO_2 emissions. Each euro invested could reduce CO_2 emissions by more than 3 000 g compared to the baseline scenario.

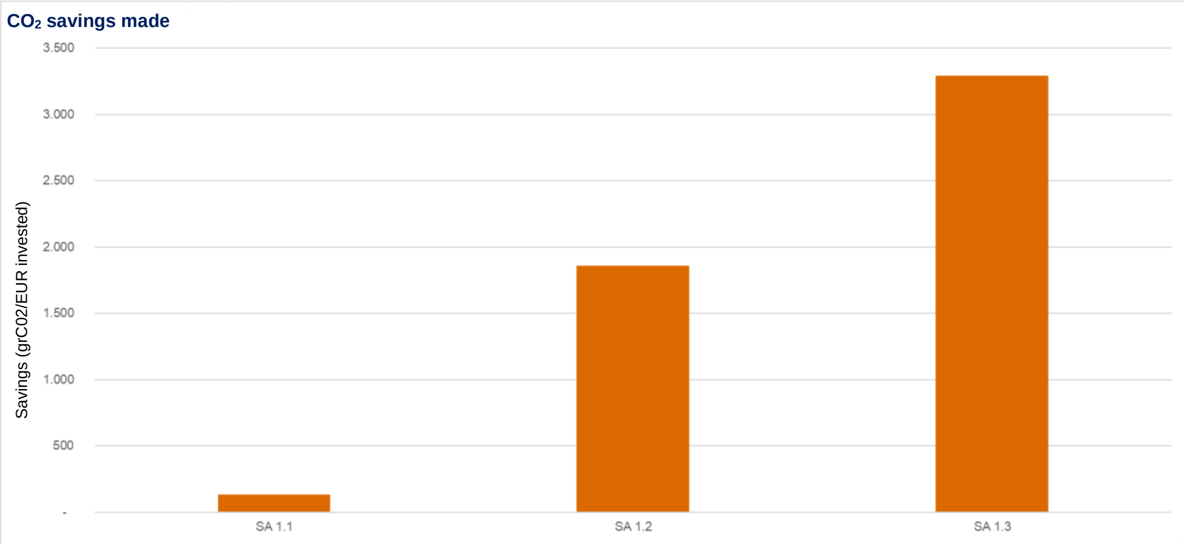


Figure 52: Impact of the investments on CO_2 emissions

X.3.7. *Conclusions*

The economic and sensitivity analyses carried out above make it possible to identify several points:

1. All the alternative solutions studied that include district heating show more efficient discounted net costs than a decentralised and fossil solution. However, a long-term vision is needed to observe this advantage. However, without support for the production of 'green' heat, this vision cannot be reconciled with the short-term profitability requirements of a private project developer;
2. The recovery of waste heat is a competitive solution with the greatest positive impact on our carbon footprint;
3. Cogeneration gas remains more efficient from an economic point of view thanks to the flexibility of the technology in terms of power modulation and its lower cost. However, its impact in terms of CO_2 emissions is limited due to the use of fossil fuel.
4. In the long term, gas and biomass cogeneration (gasification) have the same profitability, but the CO_2 impact of the technology makes biomass the preferred technology.
5. From a CO_2 balance point of view, the first resource to be recovered is the waste heat, because this makes it possible to reduce CO_2 emissions more than fivefold compared to the baseline scenario. If this resource is not available, the use of biomass is the best alternative. Gas cogeneration remains an alternative that is suitable for the urban environment when the transport of biomass is not possible. In addition, cogeneration makes it possible to reduce CO_2 emissions through the production of 'green' electricity. This has a positive impact on the CO_2 balance;
6. The increase in carbon-based fuel prices improves the competitive positioning of technologies that use biomass or waste heat. This increase is also an indication of the importance of using primary technology as much as possible because it is often more profitable than secondary technology;
7. Self-consumption of the electricity produced, in the form of an energy community, significantly increases the attractiveness of scenarios that use cogeneration.

X.4. Analysis of profile 2

X.4.1. Description of consumption profile 2

The table below presents key morphology and consumption data for profile 2. This profile corresponds to apartment blocks such as the Etrimo complex in Saint-Exupéry.

Profile 2	
Characteristics	Building stock (collective housing)
Characteristics of the building stock	3 buildings, ranging from 12 to 16 floors, 8 blocks, 450 apartments
Practical example:	Etrimo complex in Saint-Éxupéry
Thermal energy consumption	5 757 440 kWh
Electrical energy consumption	140 384 kWh

Table 46: Description of consumption profile 2

X.4.2. Representativeness of profile 2

Profile 2	
Areas similar to profile 2	Around 4 650 residential buildings, ranging from 8 to 13 floors with 3 or 4 façades[97] in Wallonia
Examples	Etrimo buildings in Charleroi
Representativeness in terms of residents	
400 000 – 450 000 residents	
Representativeness in terms of heating needs	
Between 11% and 12% of the heating needs of the residential sector (this type of building dates back to the 1950s and 1960s, so they are relatively poorly insulated)	

Table 47: Representativeness of profile 2

X.4.3. Scenarios envisaged

.X.4.3.1. Description of the scenarios

With regard to the consumption profile described above, four scenarios were identified and analysed:

- **Baseline scenario (BS2)**: The baseline scenario (BS2) envisages a situation where all of the heat needs are covered by decentralised condensing boilers for each building.
- **Alternative scenario 1 (AS2.1)**: Alternative scenario 1 (AS2.1) envisages a situation where 37%[98] of heating needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by collective gas heating.

[97] Data provided by the map expert
[98] Based on a specific residential profile calculated in line with the rules defined by BRUGEL, the Brussels regulator.

- **Alternative scenario 2 (AS2.2)**: Alternative scenario 2 (AS2.2) envisages a situation where 90% of the heat needs are covered by a communal boiler running on solid biomass connected to district heating. The remaining heating needs are covered by a centralised oil boiler.

- **Alternative scenario 3 (AS2.3)**: Alternative scenario 3 (AS2.3) envisages a situation where 73% of the heat needs are covered by waste heat. The remaining heating needs are covered by centralised gas heating.

X.4.4. *Presentation of technical and financial data*

The following table consolidates the technical and financial data that were taken into account for the model supporting the analysis carried out. The variables used are identical to those taken into account in the financial and economic analyses of the other profiles.

	Baseline scenario (BS 2)	Alternative scenario (AS 2.1)	Alternative scenario (AS 2.2)	Alternative scenario (AS 2.3)
General description of scenario	Residential: decentralised gas-fired condensing boilers	Centralised gas cogeneration with centralised gas back-up and district heating	Solid biomass boiler with centralised gas back-up and district heating	District heating network with waste heat injection plus supplementary centralised gas/district heating
Primary technology	***Condensing boiler***	***Gas cogeneration***	***Communal solid biomass boiler***	***Installation for heat injection***
Lifespan	15 years	10 years	25 years	35 years
Unit CapEx (EUR/kWth)	167	650	695	199
Other installation costs (%CapEx)	n.a.	n.a.	n.a.	n.a.
OpEx (operation) (% CapEx/year)	6%	15%	10%	10%
Seasonal thermal yield on PCS (%)	90%	54%	84%	98%
Electricity yield (%)	n.a.	36%	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	5 757 440	2 134 859	5 200 000	4 200 000
Annual electric production (kWh/year)	n.a.	1 421 816	n.a.	n.a.
Thermal power (kW)	4 145	390	1 000	1 500
Electric power (kW)	n.a.	260	n.a.	n.a.
Secondary technology	*n.a.*	***Supplementary centralised gas heating***	***Supplementary centralised gas heating***	***Supplementary centralised gas heating***
Lifespan	n.a.	30 years	30 years	30 years
Unit CapEx (EUR/kW)	n.a.	177	177	177
OpEx (operation) (% CapEx/year)	n.a.	4%	4%	4%
Seasonal thermal yield on PCS (%)	n.a.	90%	90%	90%
Electricity yield (%)	n.a.	n.a.	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	n.a.	3 622 581	557 440	1 557 440
Thermal power (kW)	n.a.	3 000	3 000	3 000
Network	*n.a.*	***YES***	***YES***	***YES***
Lifespan (years)	n.a.	50 years	50 years	50 years
Length of network (m)	n.a.	200	200	200
Infrastructure CapEx (EUR/m)	n.a.	1 100	1 100	1 100
OpEx (operation) (%CapEx/year)	n.a.	1%	1%	1%
Distribution losses (%)	n.a.	3%	3%	3%

Table 48: Technical and financial data for profile 2

X.4.5. *Economic analyses*

Updated and annualised value of net costs

The alternative scenarios all present an updated and annualised net cost value lower than the baseline scenario, i.e. the scenario that envisages the installation of condensing boilers. Although the result is positive for each of the alternative technologies, this is clearly for different reasons:

- **Scenario AS2.1 (gas cogeneration)**: The advantage of this scenario is mainly based on existing support for the production of green electricity for 15 years, resulting in a very low total energy bill. The scenario considers a situation where the price of gas is lower because cogeneration involves the purchase of a significant amount of fuel centrally. Consumers also benefit from the sale of self-generated electricity. This scenario envisages a 20 % decrease in capital expenditure to take account of investment aid (sustainable energy use aid for cogeneration and district heating networks).
- **Scenario AS2.2 (solid biomass boiler):** The advantage of this scenario is mainly based on fuel expenditure (EUR 0.027/kWh) lower than in the baseline scenario. This scenario envisages a 40% decrease in capital expenditure to take account of investment aid (sustainable energy use aid for solid

biomass boilers and district heating networks). The lack of support for green energy production puts this scenario at a disadvantage.

- **<u>Scenario AS2.3 (waste heat):</u>** The advantage of this scenario is based on expenditure on fuel two to four times lower than in the other scenarios. This scenario envisages a 40% decrease in capital expenditure to take account of investment aid (sustainable energy use aid for investments aimed at improving production processes and district heating networks).

Scenario	BS 2	AS 2.1	AS 2.2	AS 2.3
Updated and annualised value of net costs (EUR/year)	406 336	285 264	341 914	220 459
Difference	0	121 072	64 422	185 877

Table 49: Overall results for profile 2

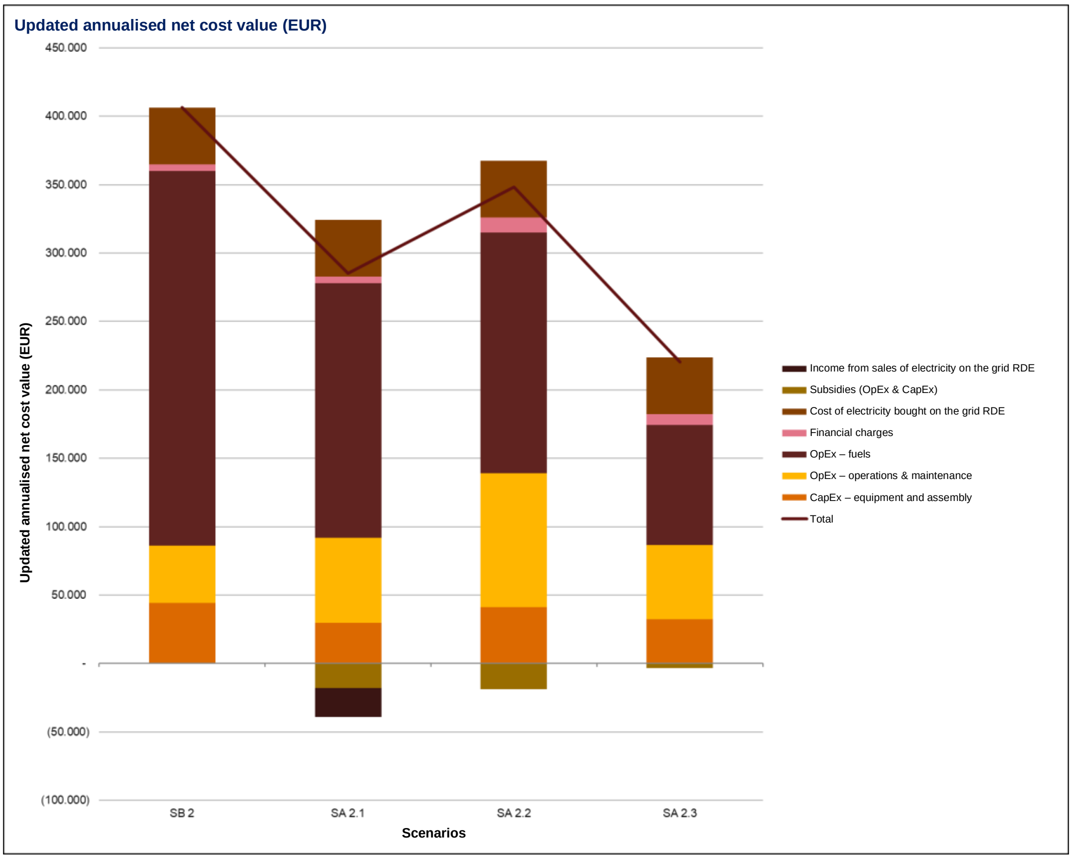


Figure 53: Updated and annualised net value for the four scenarios for profile 2 (EUR/year)

Comparison of annualised costs by cost item

An analysis of annualised costs by cost item makes it possible to identify the strengths and weaknesses of each of the scenarios:

- **CapEx - Equipment & assembly**: Alternative scenario AS2.1 shows the lowest capital expenditure. Unlike the other profiles analysed in this study, the capital expenditure for alternative technologies is not affected by a significant investment in the district heating network. This is due to the geographical proximity of the buildings studied. The district heating network envisaged is just 200 metres.
- **OpEx – Operation & maintenance** : In the baseline scenario, the costs associated with the operation and maintenance of the installations are relatively low. This component is less weighty in the total updated and annualised net value than the capital expenditure. In the alternative scenarios, the operational expenditure is higher than the respective capital expenditure.
- **OpEx – Fuels**: The operational expenditure for fuel covers the purchase of the fuels needed to cover the identified heat needs. Scenario AS2.3 benefits from the waste heat from an incinerator at a very low price. Gas cogeneration (AS2.1) is highly fuel-intensive, but benefits from a preferential price (equivalent to that of an industrial consumer) given the amount of fuel required. The baseline scenario (BS2) does not benefit from this advantageous price. This explains the high value of operational expenditure for fuel. Scenario AS2.2 has the disadvantage of the relatively high price of fuel oil.
- **Financial charges:** The financial charges are lower in the baseline scenario as the technology used has a shorter life span. This means the amount of capital on which a financial charge is applied reduces more quickly.
- **Cost of the electricity purchased on the grid:** Based on the assumption that collective self-consumption does not exist, all scenarios get 100% of their electricity on the grid, whether they benefit from electricity-generating technology (AS2.1) or not (BS2, AS2.2 and AS2.3).
- **Revenue from the sale of electricity on the grid**: By selling electricity generated on the grid, scenario AS2.1 produces a revenue of EUR 21 000.

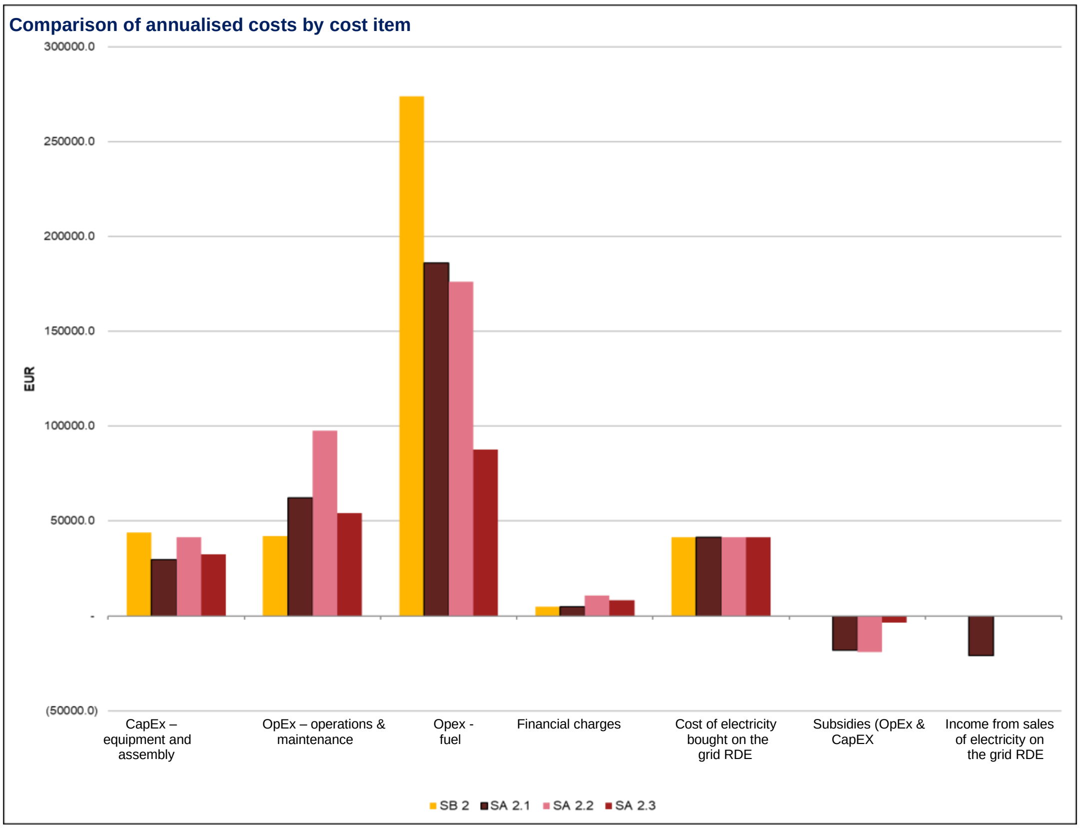


Figure 54: Comparison of annualised costs by cost item for profile 2

Comparison of the cumulative net costs of the four scenarios (EUR)

The figure showing the cumulative net costs for the four scenarios envisaged should be put in perspective with the investments and the life spans of the technologies considered in each of these scenarios. This information makes it possible to understand the 'plateaus' shown in the figure. Although the baseline scenario has lower investments than the other scenarios, which allows it to be the most profitable in the short term, it appears that each alternative scenario considered is profitable in the longer term. We have to wait a period of 2 years for alternative scenarios AS2.1 and AS2.3 to have lower cumulative net costs than the baseline scenario. As of the 15th year, alternative scenario AS2.2 becomes more attractive than the baseline scenario. The gap between alternative scenarios widens as the initial fuel cost in scenarios AS2.1 and AS2.3 is lower than in scenario AS2.2.

	Tech. investment Primary (EUR)	Primary tech. lifespan (years)	Supplementary tech. investment (EUR)	Supplementary tech. lifespan (years)
BS 2	690 756	15 years	n.a.	
AS 2.1	253 500	11 years	531 000	
AS 2.2	727 531	25 years	531 000	
AS 2.3	298 500	35 years	531 000	30 years

Table 50: Investments and lifespans of the profile 2 technologies[99]

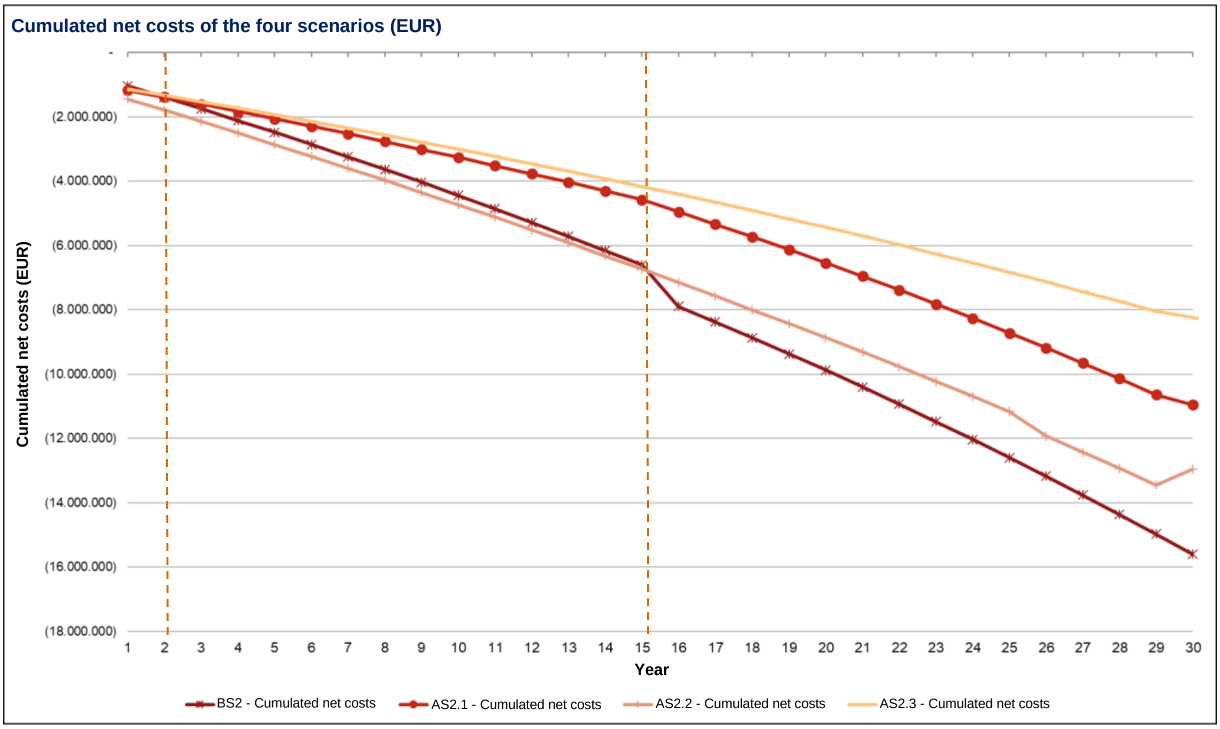


Figure 55: Cumulated net costs of the four scenarios of profile 2

[99] Added to the investments show in this table are the investments relating to the development of the district heating network, i.e. an investment of EUR 220 000 amortised over 50 years.

X.4.6. *Sensitivity analysis*

Sensitivity analysis of variations in CapEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in the planned investments (capital expenditure). Regardless of the alternative scenario envisaged, it appears that a 20 % increase in capital expenditure should not compromise their advantage over the baseline technology (condensing boiler). Note that the initial analyses take account of the subsidies currently awarded for the various technologies (investment subsidies such as sustainable energy use aid).

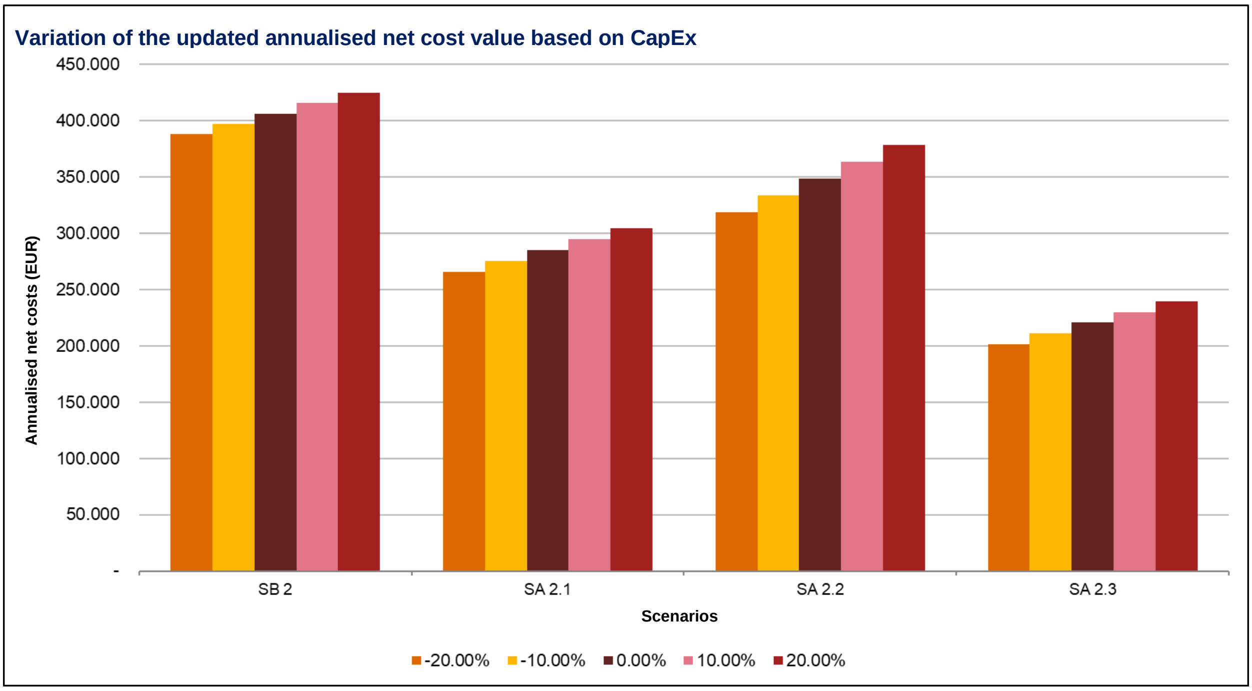


Figure 56: Variation of the updated and annualised net cost value based on the capital expenditure for profile 2

Sensitivity analysis of variations in OpEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in operational expenditure (excluding fuels and green certificates). The results of this sensitivity analysis reinforce the conclusions of the results presented above. Operating costs are not the highest cost items. It is thus probable that variations in these will only have a very slight impact on the results obtained.

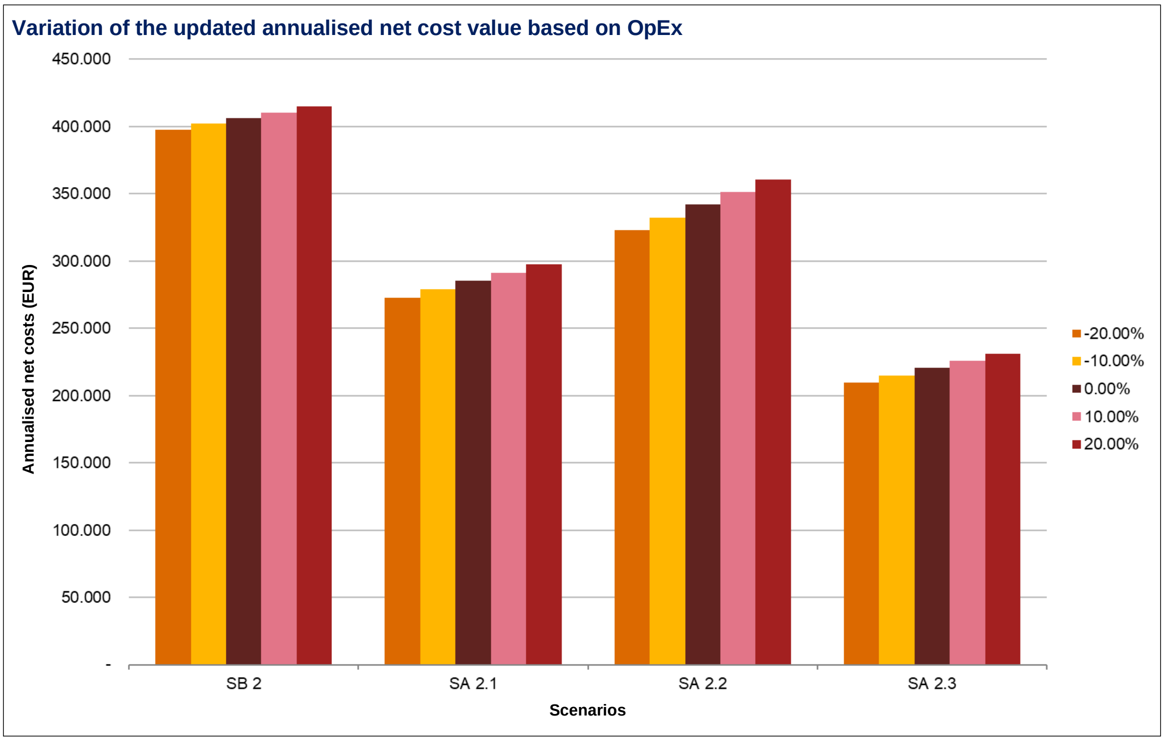


Figure 57: Evolution of the updated net costs based on the operational expenditure for profile 2

Introduction of a CO_2 cost

The graph below illustrates the differences between the alternative scenarios and the baseline scenario if consumers have to pay for the tonnes of CO_2 emitted by the production technologies considered. The analysis considers a price range of EUR 0 to EUR 20 per tonne of CO_2. This cost is on top of the updated and annualised net cost value for each scenario. The findings are:

- The difference between the **baseline scenario and alternative scenario AS1.1** does not increase significantly when prices per tonne of CO_2 increase. This is because the technologies considered in the AS1.1 scenario consume more gas than the technologies considered in the other scenarios.
- Conversely, scenarios **AS1.2 and AS1.3** benefit from having the cost of CO_2 taken into account. The higher the cost per tonne of CO_2, the greater the difference.

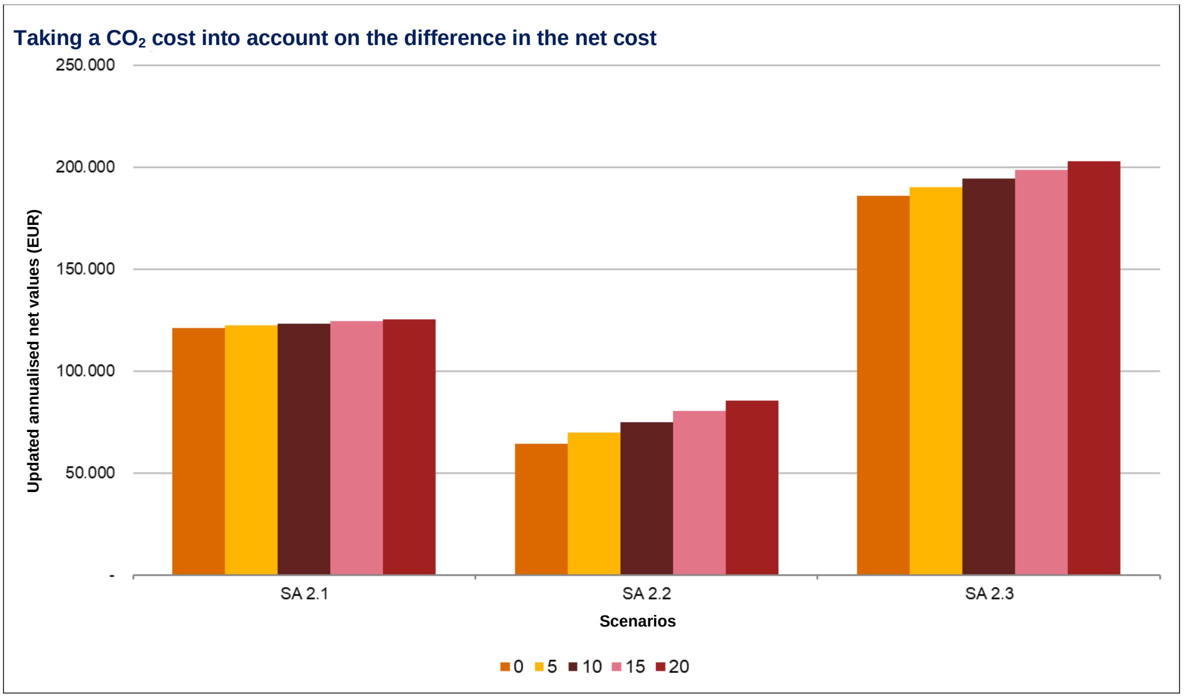


Figure 58: Taking a cost of CO_2 into account for profile 2 - Difference in updated and annualised net value from the baseline scenario

Variation of the prices of gas and of electricity

This analysis makes it possible to assess the impact on the results of taking VAT into account. Depending on the fuels, there may be grounds for considering an increase of around 10% (VAT at 6%) or 20% (VAT at 21%). Given the difference between each scenario, it appears that the inclusion of VAT would not have had an impact on the 'ranking' of the updated and annualised net values of the technologies, even though the AS2.1 scenario is close to the values of AS2.2 scenario, and there is a decrease in the gas price for BS2. The scenarios considered are not very sensitive to a change in electricity prices, as the slope of the lines shows.

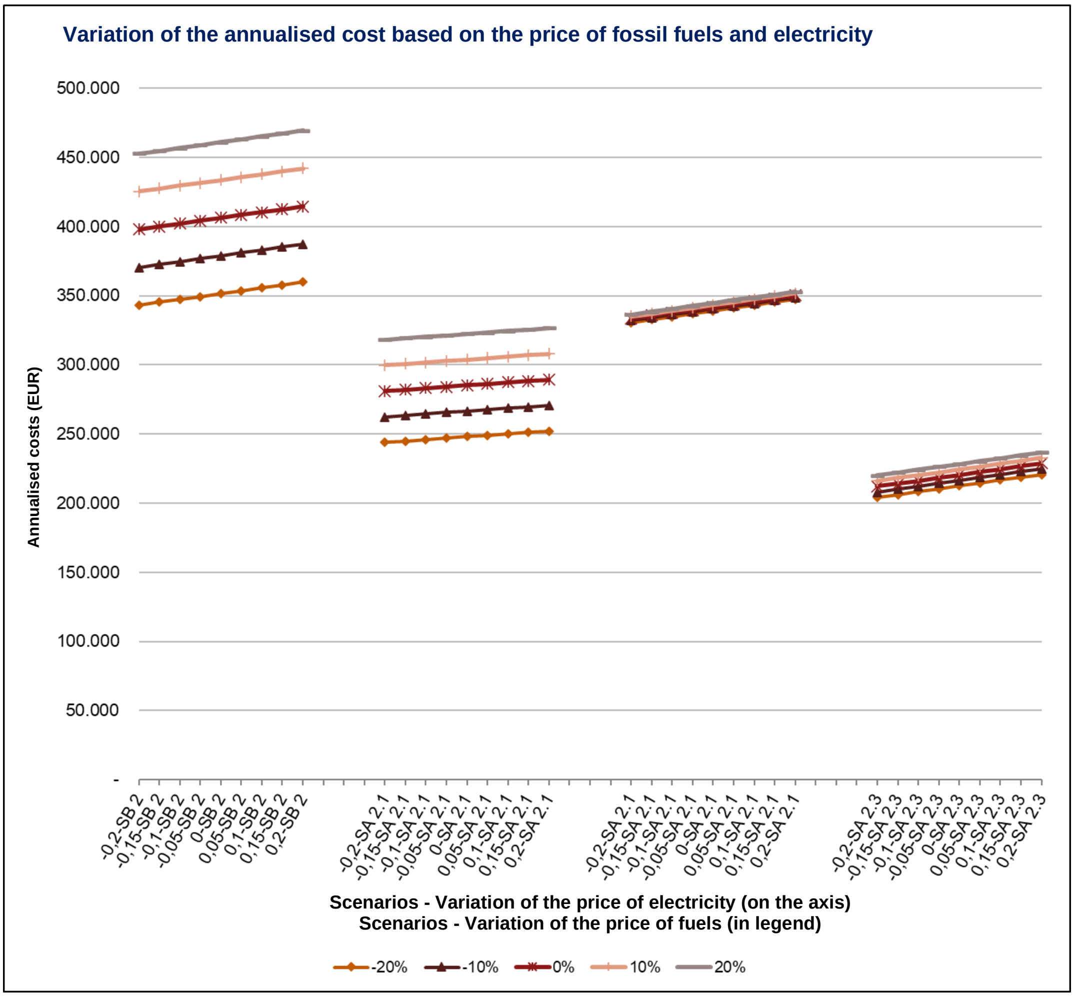


Figure 59: Variation of the gas and electricity prices for profile 2

Variation of the increase of the price of gas and of electricity

It appears that updated and annualised net cost values for scenarios BS2, AS2.2 and AS2.3 increase when inflation on electricity prices increases.

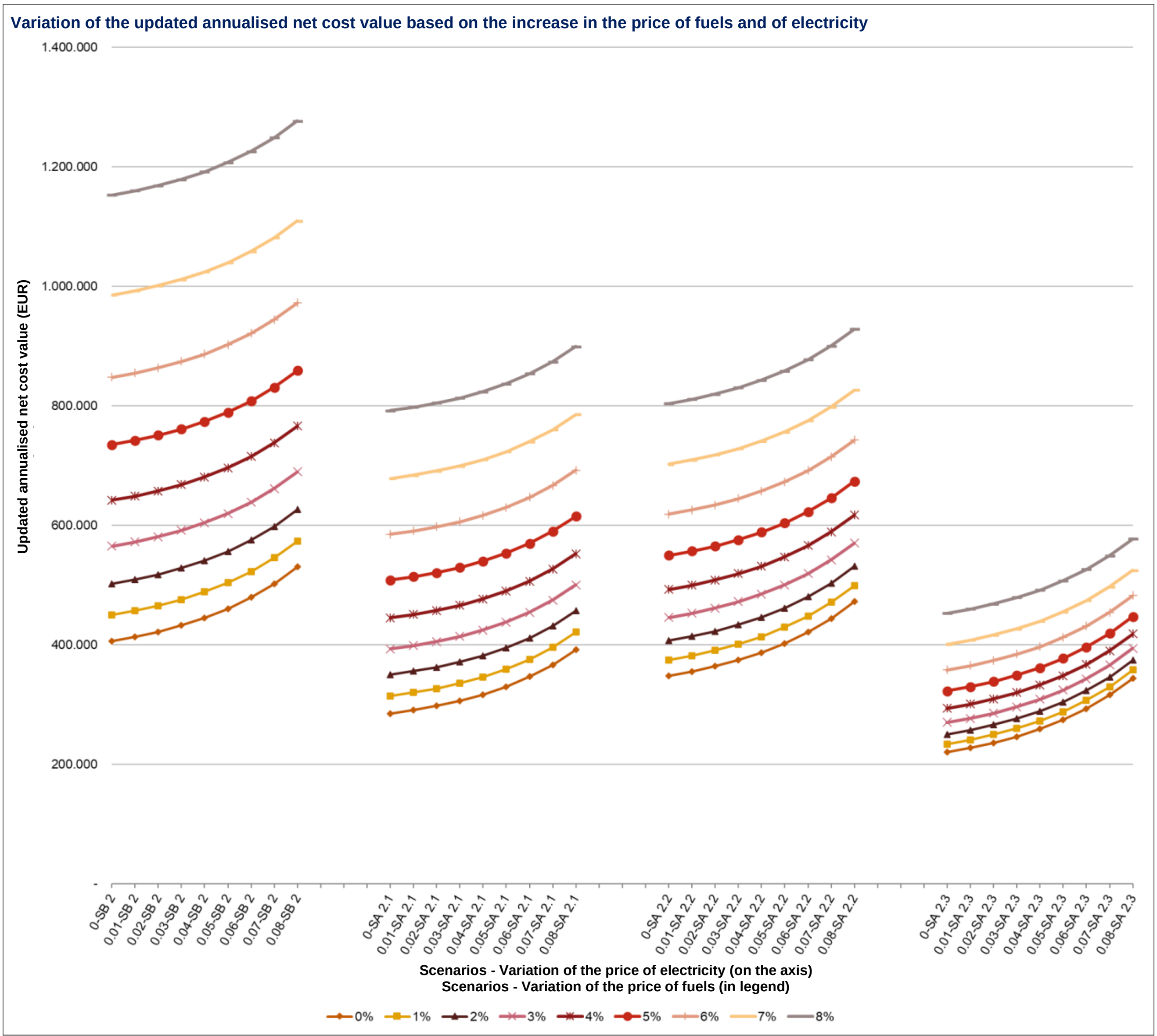


Figure 60: Variation in the updated and annualised net value depending on the inflation in the price of gas and electricity for profile 2

Sensitivity analysis on collective self-consumption

The following figure shows the updated and annualised net cost value for each scenario in two situations: (1) without collective self-consumption and (2) with collective self-consumption of 100 % of self-generated electricity. Only the scenarios involving cogeneration is concerned, but this result highlights how energy communities could be a potential asset. The main gain in self-consumption is at the level of the 'Electricity purchases' item, which becomes zero when the output exceeds needs. However, fuel-related costs make it less attractive than scenario AS2.3.

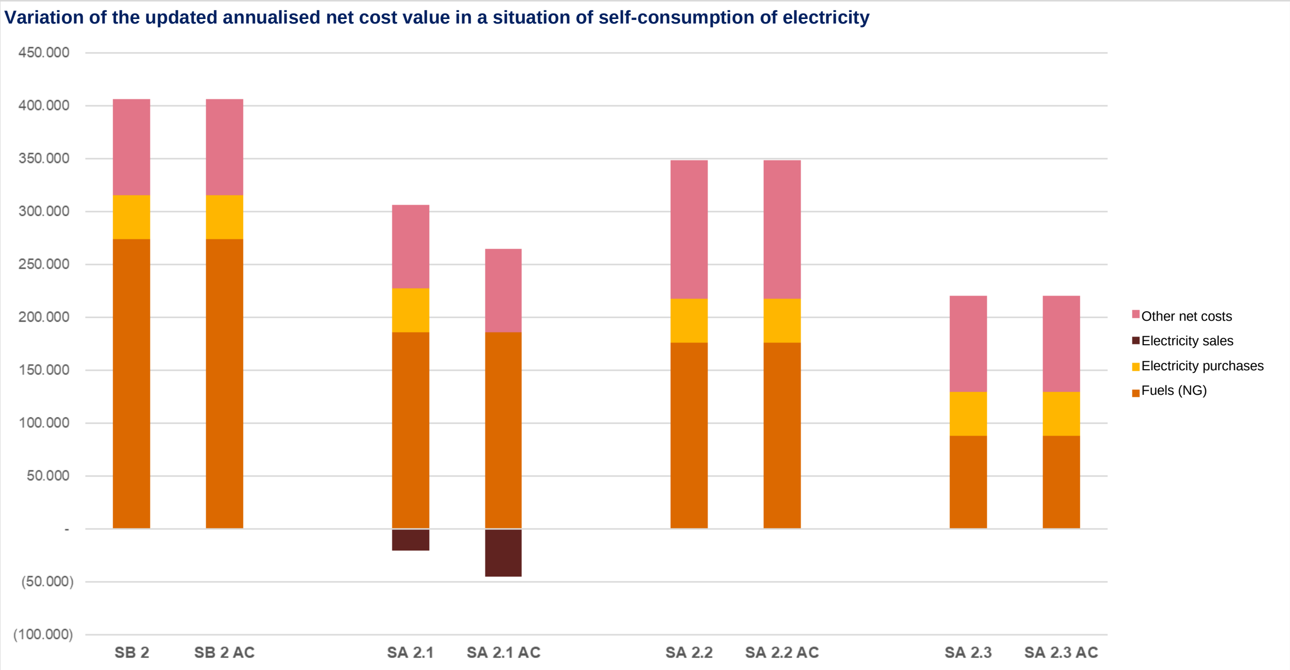


Figure 61: Analysis for collective self-consumption

.X.4.6.1. *Environmental review*

The baseline scenario shows an annual CO_2 production of 1 350 tonnes. Alternative scenarios AS2.1, AS2.2 and AS2.3 show lower annual emissions of 1 100 tonnes, 190 tonnes and 420 tonnes of CO_2 respectively. This is consistent, given the renewable nature of the energy used to produce heat in these scenarios. It is important to stress that cogeneration also generates green electricity. In alternative scenario AS2.1, the electricity produced through cogeneration allows the prevention of over 570 tonnes of CO_2 emissions.

Figure 62: CO_2 emissions per scenario for profile 2 in tonnes of CO_2

Figure 62 shows the impact of each investment on CO_2 emissions compared to the baseline scenario. The following approach was used to identify the grams of CO_2 saved per euro invested. For each scenario, the difference in CO_2 emissions from the baseline scenario is divided by its updated and annualised net cost value. Scenario AS2.3 appears to be the most effective investment in terms of reducing CO_2 emissions. Each euro invested could reduce CO_2 emissions by 4.000 gr compared to the baseline scenario.

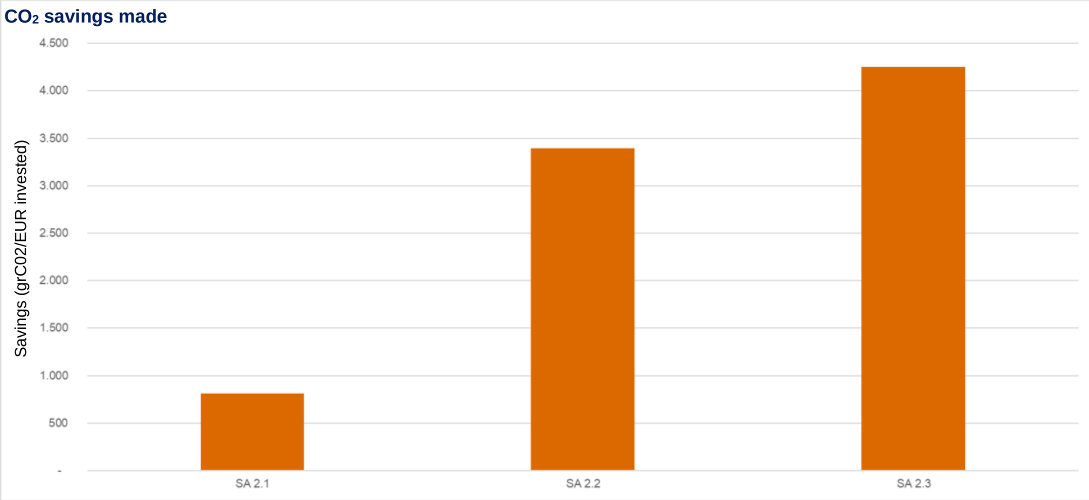


Figure 63: CO_2 savings made with the alternative scenarios

X.4.7. Conclusions

The economic and sensitivity analyses carried out above make it possible to identify several points:

1. All the alternative solutions studied show discounted net costs lower than those of the baseline scenario in the current context (in the very short term for scenarios integrating cogeneration and waste heat recovery and in the medium term for the scenario integrating a biomass boiler);
2. The recovery of waste heat is a competitive solution but it does not offer the greatest impact on our carbon footprint. ;
3. The cogeneration gas remains more efficient than biomass from an economic point of view thanks to its lower operating costs and the sale of electricity. This is mainly because the fuel is not 'standardised' biomass and may thus require more maintenance and monitoring. A better-organised biomass sector could partially reduce this problem;
4. The increase in the prices of' 'carbonaceous' fuels improves the competitive positioning of the alternative technologies under consideration. This increase also shows the importance of using primary technology as much as possible because it is often more profitable than secondary technology, especially for technologies operating on biomass or waste heat. ;
5. The centralisation of the heating technology makes it possible to reduce the price of fuel and make the solution more attractive than a decentralised solution. ;
6. Self-consumption of the electricity produced, in the form of an energy community, significantly increases the attractiveness of scenarios that use cogeneration.
7. The 'gas cogeneration' scenario makes it possible to slightly reduce the CO_2 produced compared to the baseline scenario because of the use of fossil energy, which emits CO_2. Alternative scenarios 2 and 3 make it possible to significantly reduce CO_2emissions. We note the advantage of using RES fuel or waste heat which does not produce CO_2. ;
8. Support for green heat would equalise the cogeneration and biomass scenarios.

X.5. Analysis of profile 3

X.5.1. Description of consumption profile 3

The table below presents key morphology and consumption data for profile 3. This profile corresponds to an industrial site.

Profile 3	
Characteristics	Industrial site
Thermal energy consumption	15 000 000 kWh
Electrical energy consumption	1 543 785 kWh

Table 51: Description of consumption profile 3

X.5.2. Representativeness of profile

Alternative scenario 1 (AS3.1) is based on the use of industrial waste heat. Therefore, the estimation of representativeness should be based on the available industrial waste heat with a technical potential of 5 026 GWh[100] in Wallonia. This represents more than 43% of the substitutable heat needs of the Walloon industrial sector (11 639 GWh in 2016)[101]. The length of the district heating network envisaged in the alternative scenarios is over 4 000 metres. This would make it possible to distribute heat within an industrial estate. As the majority of industrial sites in Wallonia are located in a limited geographical area (Sambre-et-Meuse valley) and within industrial estates, this makes this profile even more representative.

X.5.3. Scenarios envisaged

.X.5.3.1. Description of the scenarios

With regard to the consumption profile described above, four scenarios were identified:

- **Baseline scenario (BS3)**: The baseline scenario (BS3) envisages a situation where an industrial site meets its own needs via oil condensing boilers in each building. There is no district heating network.

- **Alternative scenario 1 (AS3.1)**: Alternative scenario 1 (AS3.1) envisages a situation where 93 % of the heat needs are covered by industrial waste heat, via district heating. The remaining heating needs are covered by supplementary oil heating (serving also as a back-up) connected to district heating.

- **Alternative scenario 2 (AS3.2)**: Alternative scenario 2 (AS3.2) envisages a situation where 93% of heating needs are covered by cogeneration using solid biomass (using Class B wood) connected to district heating. The remaining heating needs are covered by supplementary oil heating (serving also as a back-up) connected to district heating.

- **Alternative scenario 3 (AS3.3):** Alternative scenario 3 (AS3.3) envisages a situation where 53% of the heat needs are covered by centralised biogas cogeneration fuelled by biogas via a biomethanation unit. This is all connected to district heating. The remaining heating needs are covered by an oil boiler that is, likewise, centralised and connected to district heating.

[100] See Chapter 9
[101] See Chapter 1

X.5.4. *Presentation of technical and financial data*

The table below consolidates the technical and financial data that were taken into account for the model supporting the analysis carried out. The main variables used are:

- The lifetime of that technology expressed in years
- the unit capital expenditure (investments) in EUR/kW or EUR/m for district heating
- the operational expenditure (OpEx) as a percentage of capital expenditure (CapEx) per year
- the other installation costs as a percentage of capital expenditure
- the seasonal thermal efficiency (%)
- the electricity yield (%)
- annual thermal production (kWh)
- the installed thermal power (kW)

	Baseline scenario (BS3)	Alternative scenario (AS 3.1)	Alternative scenario (AS 3.2)	Alternative scenario (AS 3.3)
General description of scenario	Decentralised oil-fired condensing boiler for each building	Industrial waste heat and supplementary oil boiler	Biomass plant and supplementary oil boiler	Centralised biogas cogeneration and supplementary oil boiler
Primary technology	***Condensing boiler***	***Steam exchanger***	***Solid biomass cogeneration***	***Biogas cogeneration***
Lifespan	15 years	30 years	15 years	8 years
Unit CapEx (EUR/kWth)	323	199	2 500	4 330
Other installation costs (%CapEx)	n.a.	n.a.	n.a.	n.a.
OpEx (operation) (% CapEx/year)	6%	8%	9%	10%
Seasonal thermal yield on PCS (%)	85%	98%	50%	54%
Electricity yield (%)	n.a.	n.a.	15%	0%
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	15 000 000	14 000 000	14 000 000	8 000 000
Annual electric production (kWh/year)	n.a.	n.a.	4 200 000	10 800 000
Thermal power (kW)	5 400	4 000	2 000	2 000
Electric power (kW)	n.a.	n.a.	600	1 350
Secondary technology	***n.a.***	***Supplementary central oil boiler***	***Supplementary central oil boiler***	***Supplementary central oil boiler***
Lifespan	n.a.	30 years	30 years	30 years
Unit CapEx (EUR/kW)	n.a.	177	177	177
OpEx (operation) (% CapEx/year)	n.a.	4%	4%	4%
Seasonal thermal yield on PCS (%)	n.a.	90%	90%	90%
Electricity yield (%)	n.a.	n.a.	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	n.a.	1 000 000	1 000 000	7 000 000
Thermal power (kW)	n.a.	5 000	5 000	5 000
Network	***n.a.***	***YES***	***YES***	***YES***
Lifespan (years)	n.a.	50 years	50 years	50 years
Length of network (m)	n.a.	4 384	4 384	4 384
Infrastructure CapEx (EUR/m)	n.a.	1 283	1 283	1 283
OpEx (operation) (%CapEx/year)	n.a.	1%	1%	1%
Distribution losses (%)	n.a.	10%	10%	10%

Table 52: Technical and financial data for profile 3

X.5.5. *Economic analysis*

Updated and annualised value of net costs

Alternative scenario AS3.1 presents an updated and annualised net cost value lower than the baseline scenario, i.e. the scenario that envisages the installation of condensing boilers. This is not the case for scenario AS3.2. The main reasons for these results are as follows:

- **Scenario AS3.1 (waste heat):** The advantage of this scenario is based on fuel-related expenditure around two times lower than in the other scenarios.
- **Scenario AS3.2 (biomass cogeneration):** The disadvantage of this scenario is that the capital expenditure and operational expenditure are much higher than in the other scenarios.
- **Scenario AS3.3 (gas cogeneration):** The disadvantage of this scenario is that setting up the biomethanation and cogeneration, plus the maintenance, are much costlier than the other scenarios.

Scenario	BS3:	AS 3.1	AS 3.2	AS 3.3
Updated and annualised value of net costs (EUR/year)	1 022 484	852 693	1 186 506	1 448 774
Difference	0	169 791	-164.021	-426.290

Table 53: Overall results for profile 3

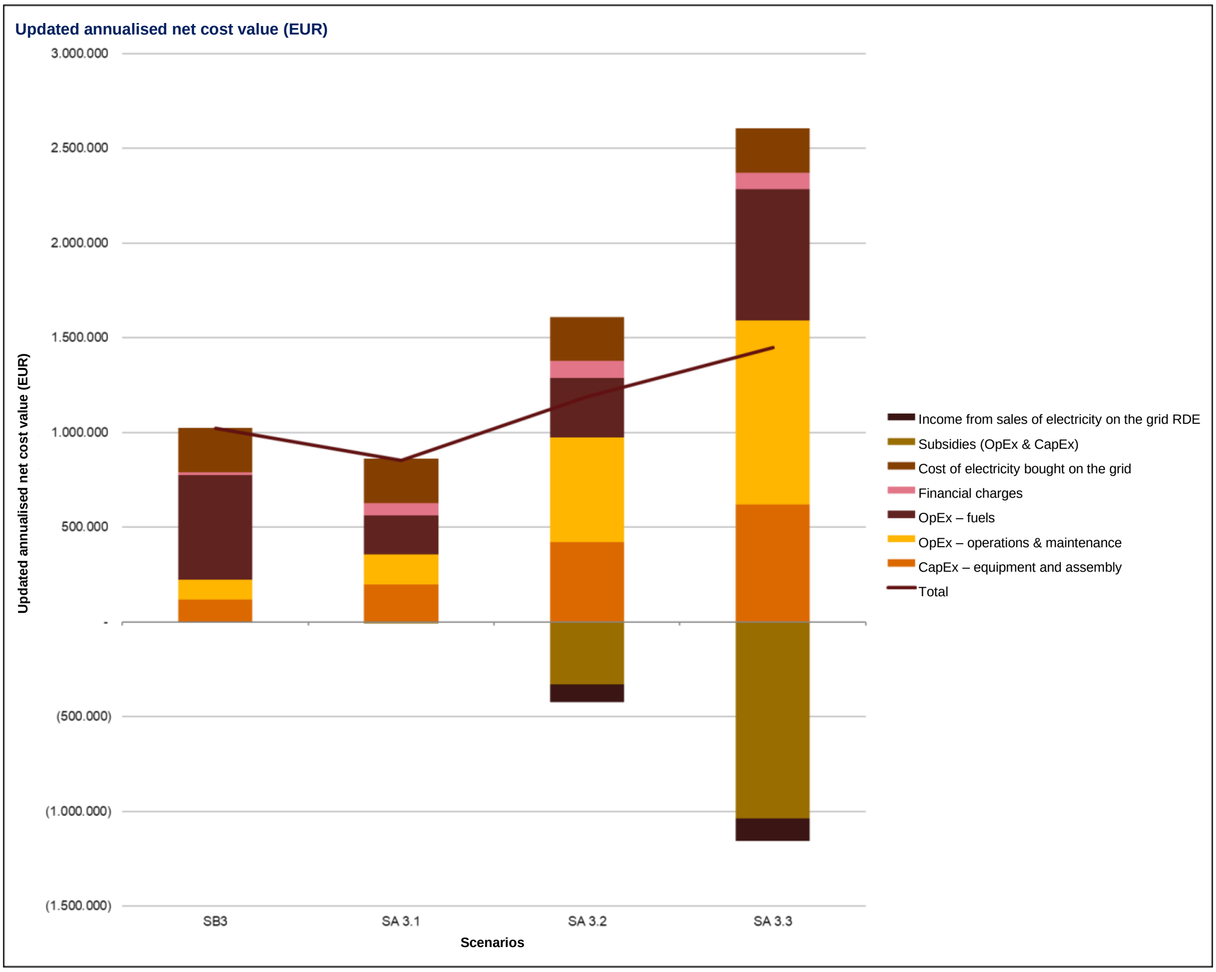


Figure 64: Updated and annualised net value for the three scenarios for profile 3 (EUR/year)

Comparison of annualised costs by cost item

An analysis of annualised costs by cost item makes it possible to identify the strengths and weaknesses of each of the scenarios:

- **CapEx - Equipment & assembly**: The main disadvantage of biomass and biogas cogeneration (AS3.2 and AS3.3) is the high level of capital expenditure needed. Conversely, relatively little capital expenditure is needed for baseline scenario BS3 and alternative scenario AS3.1.
- **OpEx – Operation & maintenance** : Compared to the other cost items, the costs associated with the operation and maintenance of the installations are relatively low for scenarios BS3 and AS3.1. For scenarios AS3.2 and AS3.3, the costs are much higher (almost four times higher than for scenarios BS3 and AS3.1 for scenario AS3.2 and over six times higher for scenario AS3.3).
- **OpEx – Fuels**: The operational expenditure for fuel covers the purchase of the fuels needed to meet the identified heat needs. Scenario AS3.1 benefits from industrial waste heat at a very low price. Gas cogeneration (AS3.2) is highly fuel-intensive, but benefits from a preferential price (equivalent to that of an industrial consumer) given the amount of fuel required. The second cogeneration also consumes a lot of fuel but at a much higher price (almost twice as expensive as AS3.2), which explains why the fuel costs are almost twice as high in this scenario.
- **Financial charges:** The financial charges are lower in the baseline scenario as the technology used has a shorter life span. This means the amount of capital on which a financial charge is applied reduces more quickly.
- **Cost of the electricity purchased on the grid:** Based on the assumption that collective self-consumption does not exist, all the scenarios get 100% of their electricity on the distribution grid whether they benefit from electricity-generating technology (AS3.2 and AS3.3) or not (BS3 and AS3.1).
- **Revenue from the sale of electricity on the grid**: Only scenarios AS3.2 and AS3.3 produce electricity and can thus valorise it by selling it on the grid. Note that electricity resold on the grid is valued at EUR 0.040 per kWh.

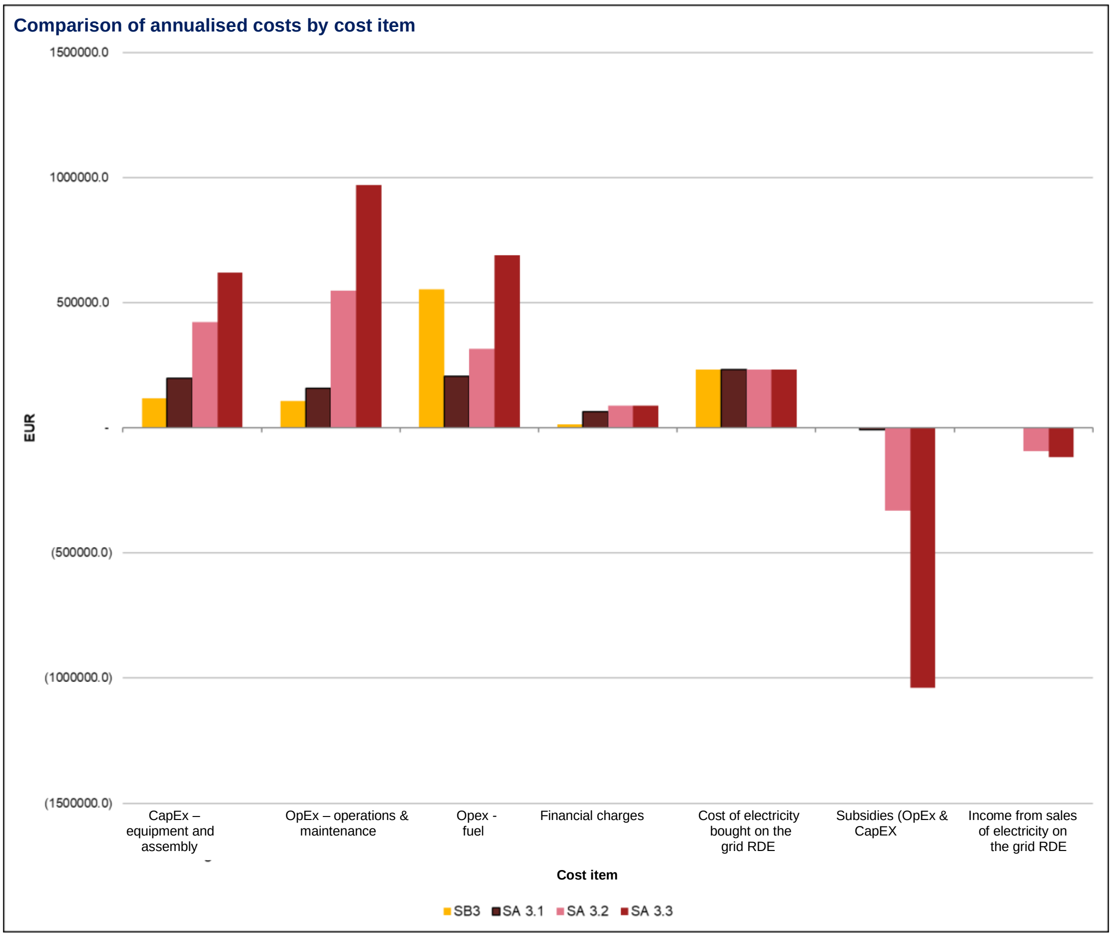


Figure 65: Comparison of annualised costs by cost item for profile 3

Comparison of the cumulative net costs of the three scenarios (EUR)

The figure showing the cumulative net costs for the three scenarios envisaged should be put in perspective with the investments and the life spans of the technologies considered in each of these scenarios. This information makes it possible to understand the ‘plateaus’ shown in the figure. Although the baseline scenario has lower investments than the other scenarios, which allows it to be the most profitable in the short term, it appears that alternative scenario AS3.1 is profitable in the longer term. This alternative scenario takes 16 years to have lower cumulative net costs than the baseline scenario. From year 15 onwards, there is an increase in the net prices of the baseline scenario, because all the boilers have to be replaced. On the other hand, scenarios AS3.2 and AS3.3 will never become more attractive than the baseline scenario, firstly because of their high capital expenditure, and secondly, because they are no longer subsidised from year 15 on.

	Primary tech. investment (EUR)	Primary tech. lifespan (years)	Supplementary tech. investment (EUR)	Supplementary tech. lifespan (years)
BS3:	1 745 010	15 years	0	n.a.
AS 3.1	796 000	30 years	885 000	30 years
AS 3.2	5 000 000	15 years	885 000	30 years
AS 3.3	8 660 000	8 years	885 000	30 years

Table 54: Investments and lifespans of the profile 3 technologies

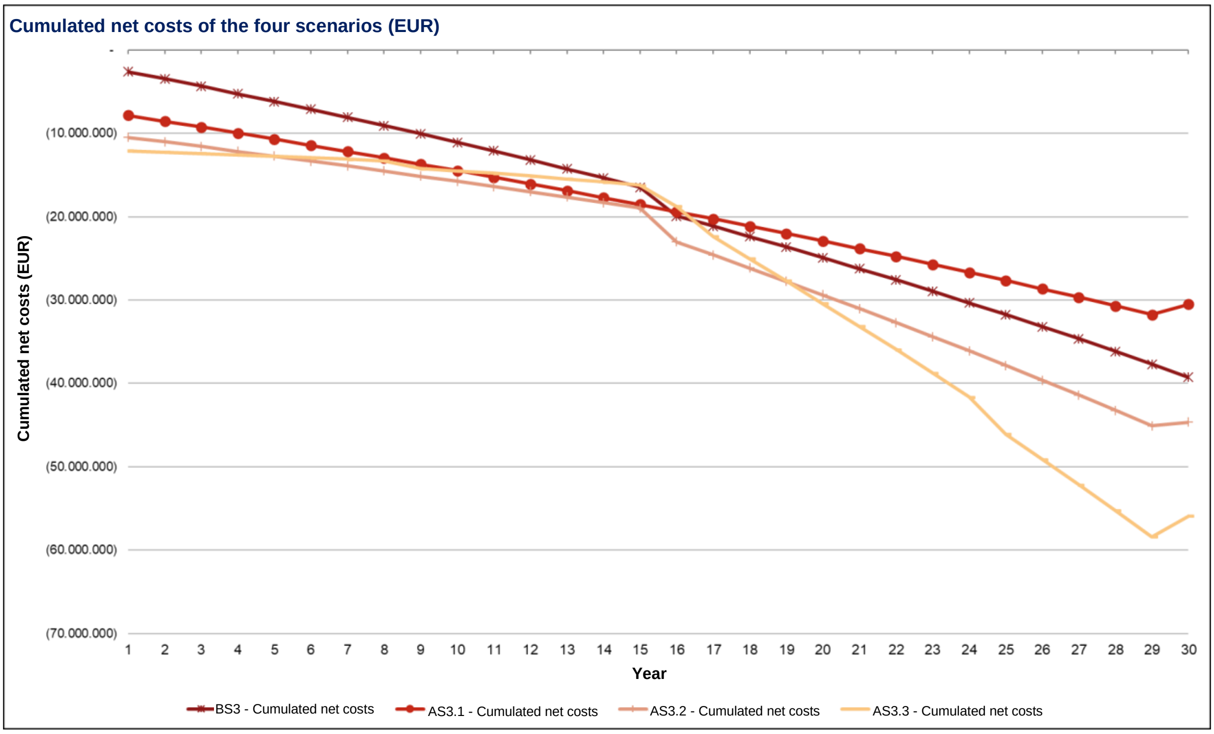


Figure 66: Cumulated net costs of the three scenarios of profile 3

X.5.6. Sensitivity analysis of the CapEx variations

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in the planned investments (capital expenditure). It appears that the baseline scenario and alternative scenario AS3.1 do not vary significantly in terms of capital expenditure, since the basic investment is smaller. The updated and annualised net value of the alternative scenarios AS3.2 and AS3.3 vary greatly depending on the increase or decrease of capital expenditure. A 20 % reduction in capital expenditure in scenario AS3.2 makes it competitive with scenarios BS3 and AS3.1. Despite a sharp decrease in the updated and annualised net value in the AS3.3 scenario, it remains more expensive than the rest.

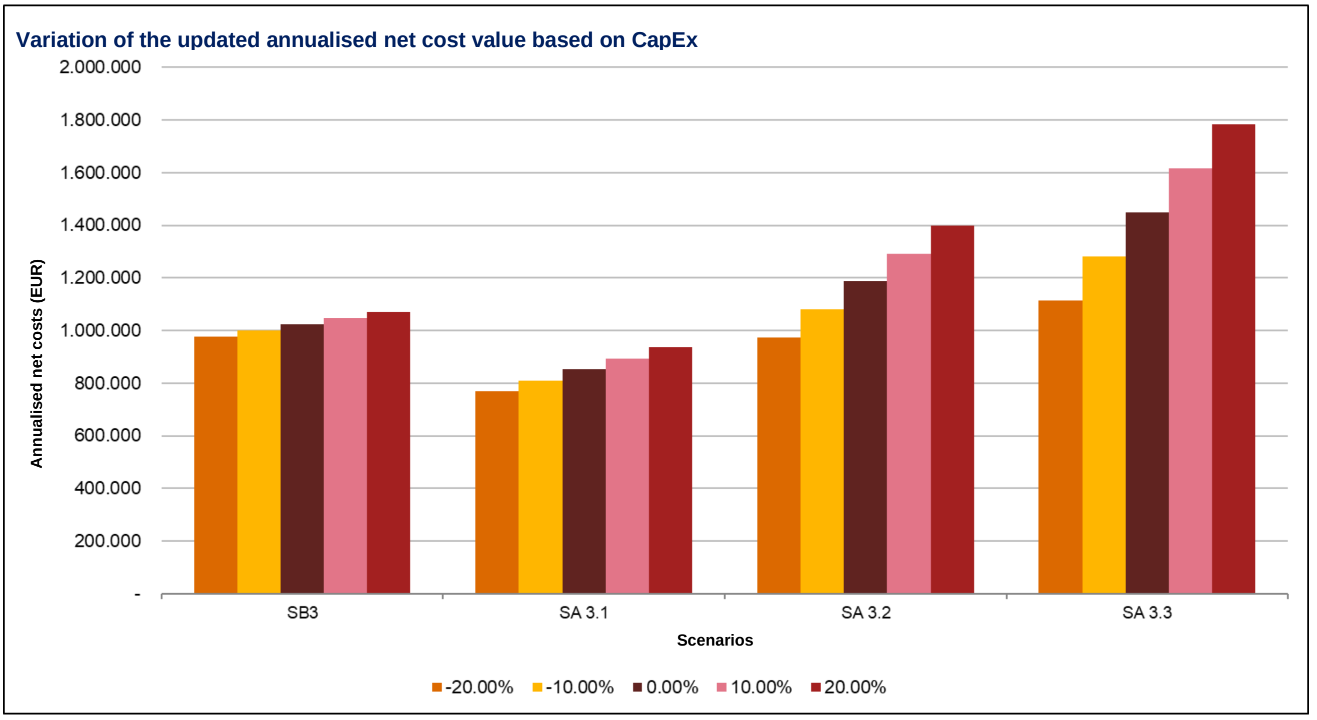


Figure 67: Variation of the updated and annualised net cost value based on the capital expenditure for profile 3

Sensitivity analysis of variations in OpEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in operational expenditure (excluding fuels). The results of this sensitivity analysis reinforce the conclusions of the results presented above. Operating costs are not the highest cost items. It is thus probable that variations in these will only have a very slight impact on the results obtained. As operational expenditure is a percentage of capital expenditure, this makes the variation very similar to the previous figure.

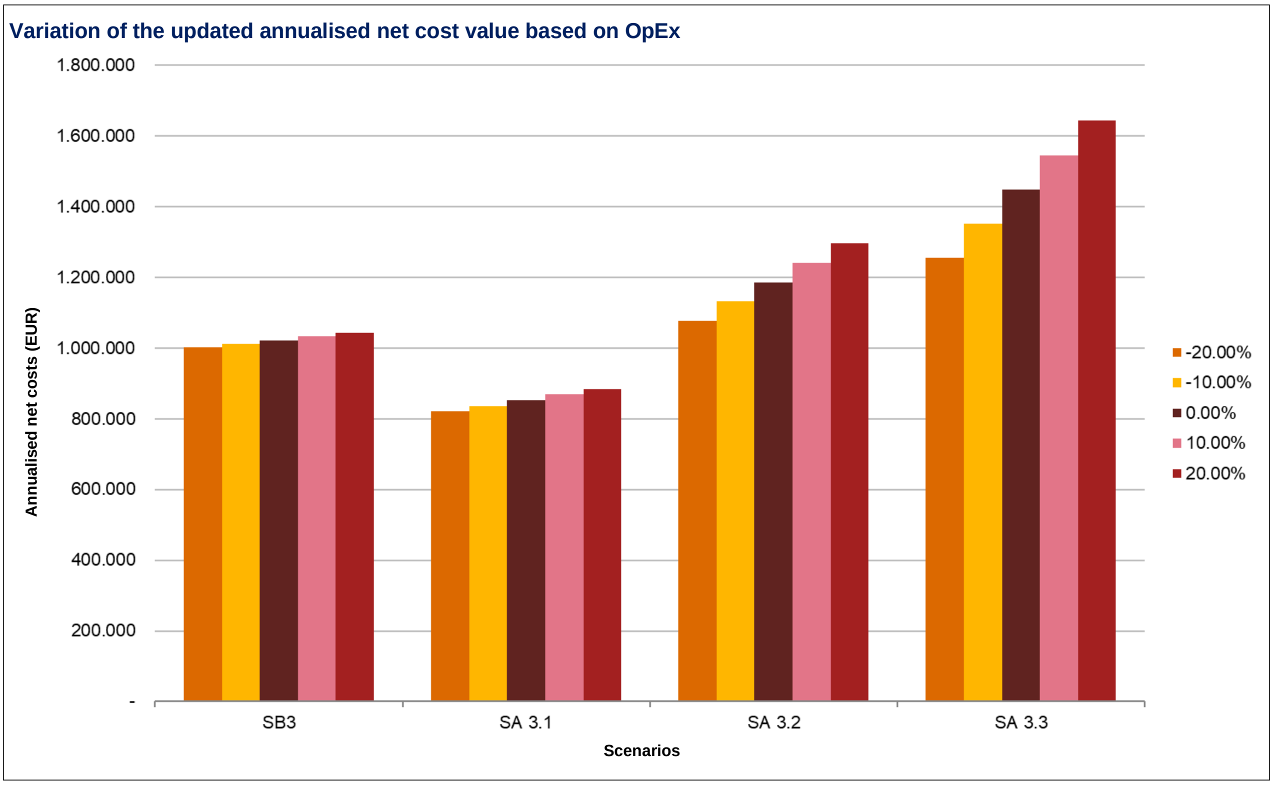


Figure 68: Development of the updated and annualised net cost values based on the operational expenditure for profile 3

Introduction of a CO_2 cost

The graph below illustrates the differences between the alternative scenarios and the baseline scenario if consumers have to pay for the tonnes of CO_2 emitted by the production technologies considered. The analysis considers a price range of EUR 0 to EUR 20 per tonne of CO_2. The findings are:

- The difference between the **baseline scenario and alternative scenario AS3.1** increases when the price per tonne of CO_2 increases. This is because the technology considered in the alternative scenario consumes less fossil fuel than the technology considered in the baseline scenario.
- For scenarios AS3.2 and AS3.3, introducing a cost for CO_2 makes it possible to reduce the updated and annualised net value. The technology used (biomethanation) uses fuels that make it possible to produce green gas, which is considered as a non-emitter of CO_2. However, it is noted that the introduction of a cost for CO_2 does not make it possible to close the gap with the baseline scenario and scenario AS3.1, confirming that they are not attractive under the conditions established here.

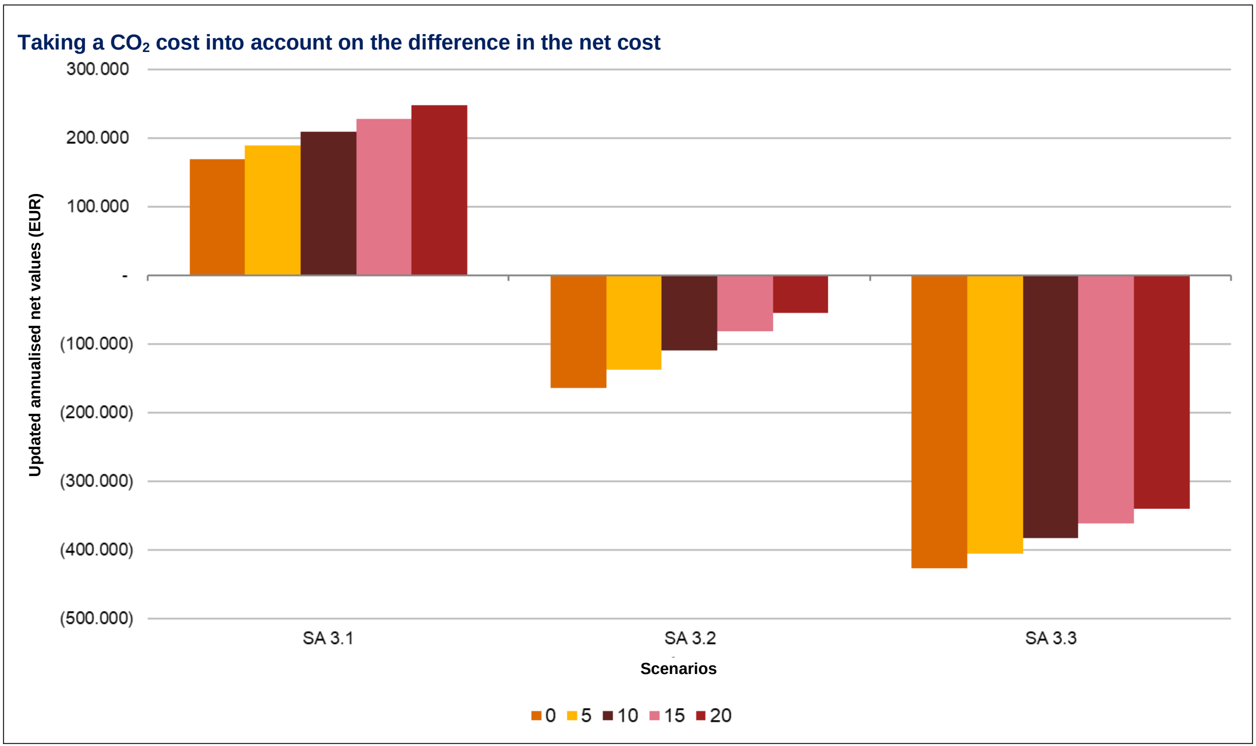


Figure 69: Taking a CO_2 cost into account for profile 3

Variation of the prices of gas and of electricity

The following figure illustrates the results of the scenarios analysed above if gas and electricity costs were higher or lower (range from -20% to + 20%). On the basis of this analysis, it appears that regardless of the variation in gas and electricity prices, no scenario changes its position (profitable or not) compared to the others in terms of annualised costs. An increase in the price of electricity would have the same impact on the different scenarios (parallel lines). However, an increase in fuel prices leads to an increase (upper rightward shift) of the updated and annualised net value, especially in scenarios BS3 and AS3.3, which consume more fossil energy than the other two scenarios. In scenario AS3.3, 47% of the heat needs are covered by a supplementary oil boiler, while 93% of the heat needs in scenarios AS3.1 and AS3.2 are covered by green technologies (waste heat and biomass plant).

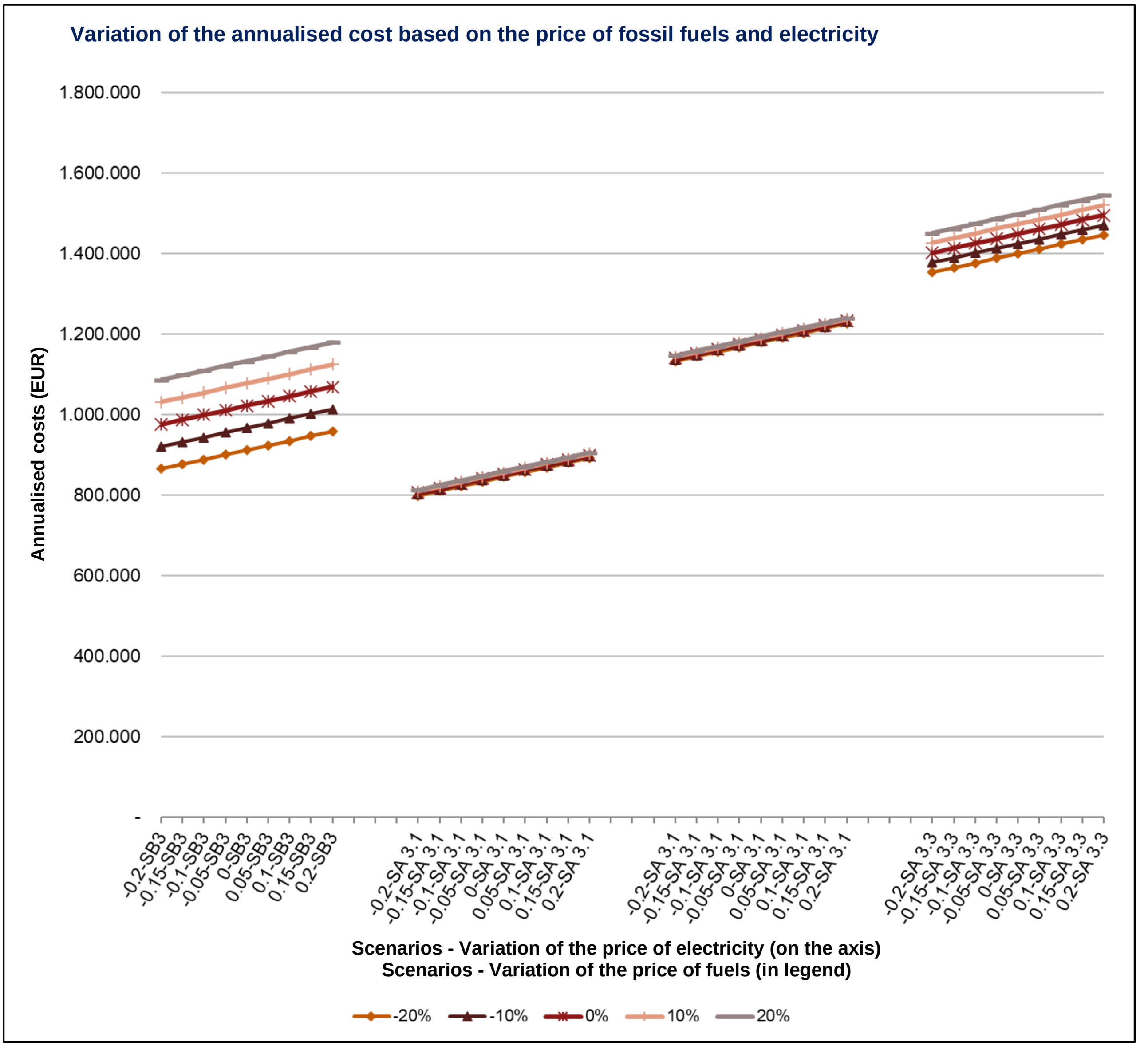


Figure 70: Variation of the gas and electricity prices for profile 3

Variation of the increase of the price of gas and of electricity

The following figure considers a variation in the increase in gas and electricity prices (initial assumptions of +2% per year and +4% per year, respectively). Based on this analysis, it seems that in a situation where electricity costs increase sharply and fuel costs remain stable or increase slightly (maximum 6%), the AS3.2 scenario potentially presents discounted net costs lower than those of the other scenarios, since the technology in the AS3.2 scenario produces electricity, which gives it a double advantage in a self-consumption situation: there is no expenditure on electricity and the surplus generated is a source of income.

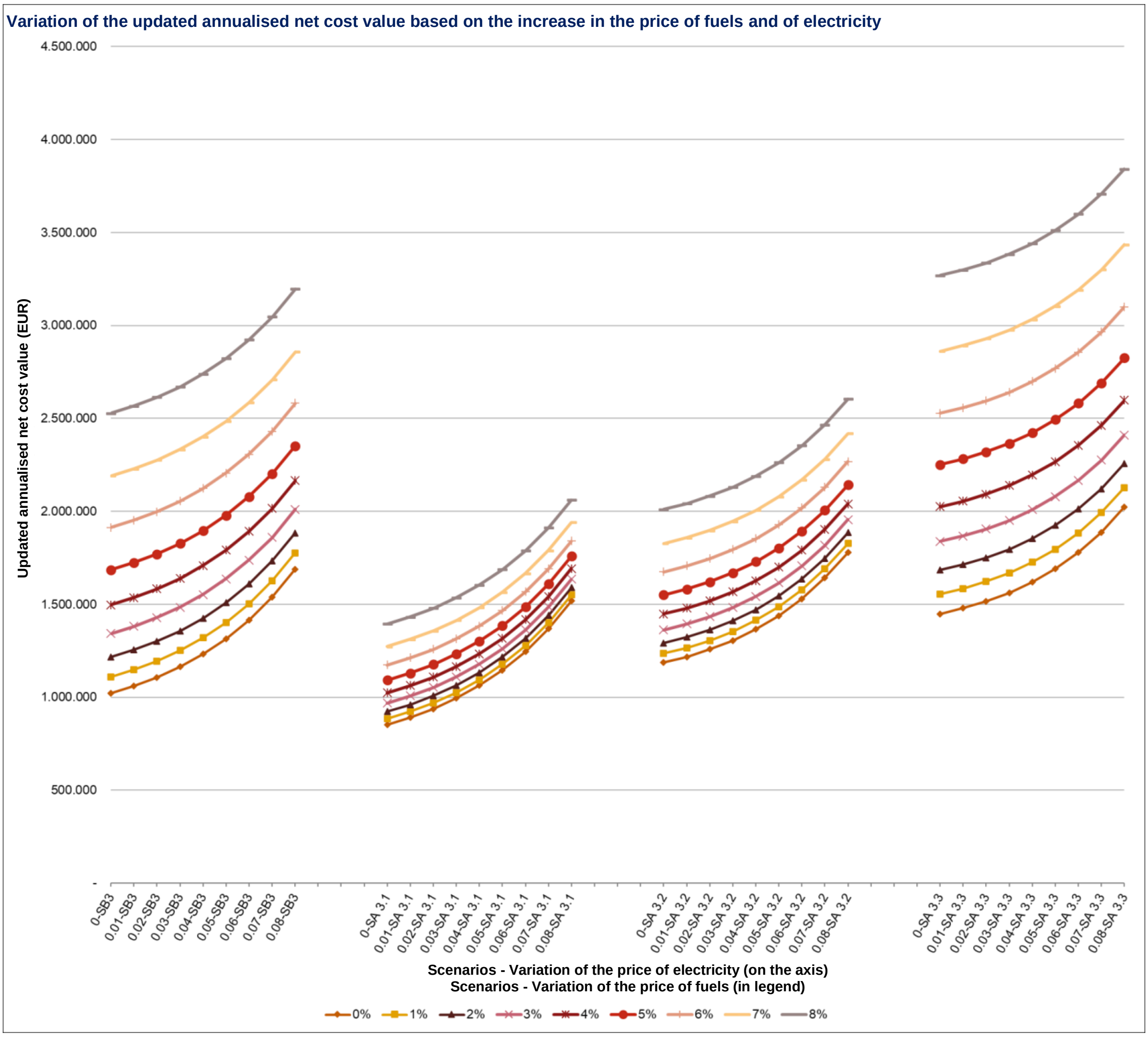


Figure 71: Evolution of the updated and annualised net cost value depending on the increase in the price of fuels and electricity for profile 3

.X.5.6.1. Environmental review

The baseline scenario shows an annual CO_2 production of over 5 400 tonnes. Alternative scenarios AS3.1 and AS3.3 show lower annual emissions of 1 100 tonnes and 700 tonnes of CO_2 respectively. This is consistent with the environmental nature of the way energy is consumed to produce heat. In addition, scenario AS3.2 makes it possible to reduce CO_2 emissions through the production of green electricity and using an RES fuel. Its impact is -600 tonnes of CO_2 per year. Note that the cogeneration in scenarios AS3.2 and AS3.3 generates green electricity, which further reduces their emissions relative to the amount of energy generated by 1 690 and 2 150 tonnes of CO_2. Furthermore, scenario AS3.3 does not cover 100 % of the heat demand of the profile, so a supplementary fossil fuel is still needed.

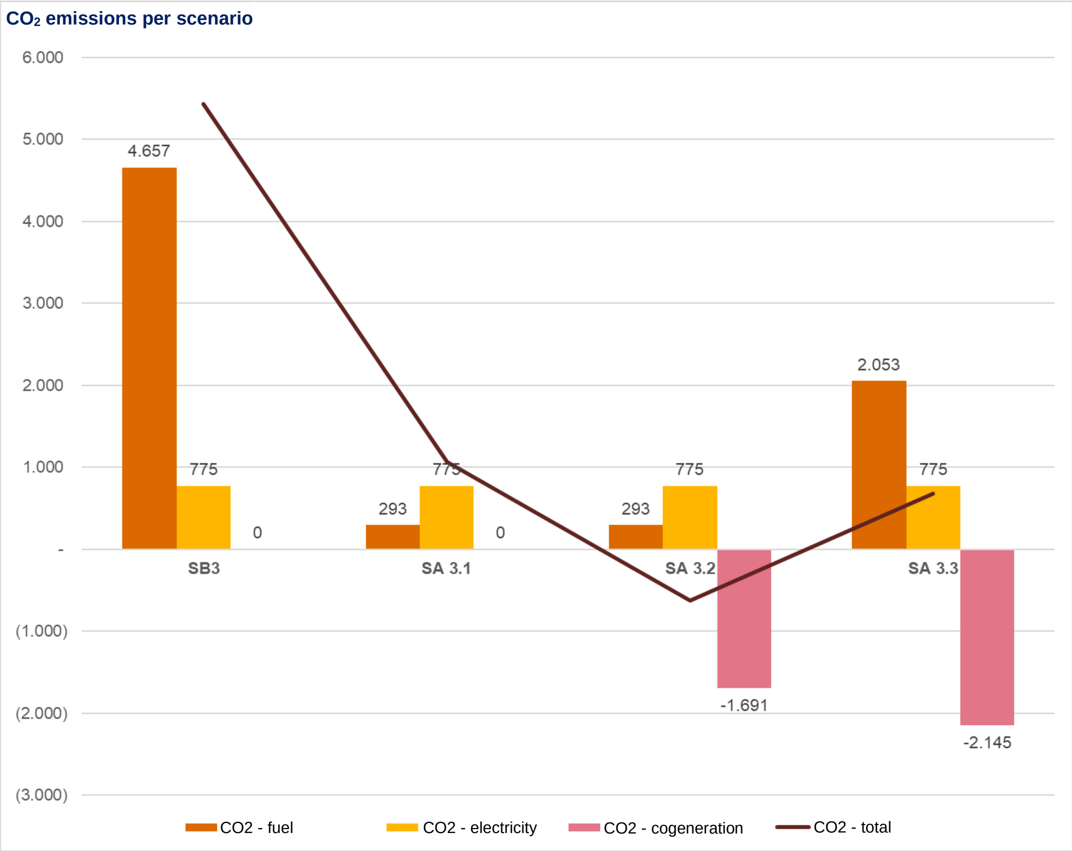


Figure 72: CO_2 emissions per scenario for profile 3

Figure 73 shows the impact of each investment on CO_2 emissions compared to the baseline scenario. The following approach was used to identify the grams of CO_2 saved per euro invested. For each scenario, the difference in CO_2 emissions from the baseline scenario is divided by its updated and annualised net cost value. AS3.2 appears to be the most effective investment in terms of reducing CO_2 emissions. Each euro invested could reduce CO_2 emissions by almost 7 000 g compared to the baseline scenario.

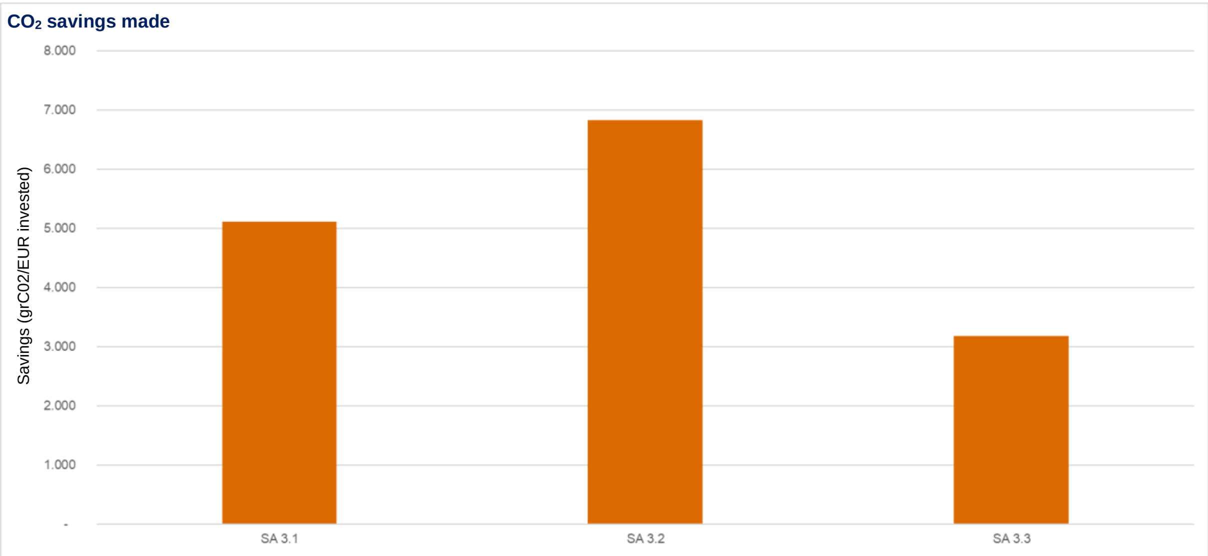


Figure 73: CO_2 savings with the alternative scenarios for profile 3

X.5.7. *Conclusions*

The economic and sensitivity analyses carried out above make it possible to identify several points:

1. The scenario ‘waste heat’ (AS3.1) shows discounted net costs that are lower than those of the base scenario. Due to a significant CapEx and OpEx charge for the installation and maintenance of a biomethanation plant of sufficient critical size, scenario AS3.3 shows discounted net costs higher than the baseline scenario. Similarly, scenario AS3.2 does not have lower net costs than the baseline scenario. ;
2. In a situation where electricity costs increase sharply and fuel costs remain stable or increase slightly (maximum 6%), the scenario ‘biomass cogeneration’ (AS 3.2) potentially presents discounted net costs lower than those of the base scenario and those of the alternative ‘biomethanation’ scenario (AS 3.1) thanks to cogeneration which makes it possible to produce electricity. ;
3. The AS3.3 ‘biomethanation’ scenario has higher discounted net costs than all the other scenarios. In addition, it benefits from a lot of subsidies but these do not allow it to be competitive compared to other technologies, especially in a context of low fossil fuel prices. Only maintaining the support mechanism for the production of renewable electricity throughout the life of the project can guarantee sufficient profitability.
4. The significant increase in the prices of carbon-based fuels improves the competitive positioning of technologies that use renewable energy such as waste heat or biomass;
5. The implementation of a CO_2 cost makes it possible to improve the positioning of technologies that use renewable energies such as waste heat or biomass. However, for biomass (solid & biogas), this is not enough to reach a financial break-even point without green certificates.
6. The biomethanation solution has the lowest CO_2 gain per euro invested. However, the analysis does not take into account the ‘external’ profits in terms of circular economy, soil quality and hence reduction in the use of fertilisers, etc.

X.6. *Analysis of profile 4*

X.6.1. *Description of consumption profile 4*

The table below presents key morphology and consumption data for profile 4. This profile concerns a municipality with a critical energy density in a geographically suitable area (i.e. an area where deep geothermal energy can be exploited). The heating needs taken into account in this profile are mainly those of the residential and service sectors.

Profile 4	
Characteristics	Urban or peri-urban municipality
Practical example:	Verviers
Thermal energy consumption	23 261 000 kWh
Electrical energy consumption	1 543 785 kWh

X.6.2. *Representativeness of profile*

Based on the study on the potential of deep geothermal energy in Wallonia (Analysis of the use of geothermal heat via district heating networks in Wallonia)[102], it appears that 18 municipalities are relevant for the development of geothermal projects. These municipalities have been identified on the basis of geographical proximity to sites that can be exploited and the density of their energy needs. To best assess the representativeness of this profile, an approach similar to profile 1 is used, with consideration given to the position occupied by gas in these municipalities. These 18 municipalities are all covered by a gas distribution grid. Based on data showing the share of households connected to the gas network per municipality, it is possible to estimate the potential heating needs that could be covered by district heating if all the buildings that are not connected to the gas network were connected to a district heating network. By reducing the heat needs of the residential and service sectors per inhabitant and by applying the share of households connected to a gas network to the population of each municipality, it seems that 3 281 GWh of heat needs are not covered by a gas network in these 18 municipalities and could therefore potentially be covered by a district heating network. This corresponds to 10 % of Wallonia's heating needs for the residential and service sectors and corresponds to more than 355 000 inhabitants who could potentially be connected to a district heating network.

[102] Le potentiel de la géothermie profonde en Wallonie : Analyse de l'utilisation de la chaleur géothermique via des réseaux de chaleur en Wallonie' (PwC, 2019) [The potential for deep geothermal energy in Wallonia: Analysis of the use of geothermal heat via district heating networks in Wallonia.]

Municipalities	Population	Heating needs Residential + Service (GWh)	Share of households connected to a gas distribution grid	Residential + Service heating needs not covered by gas (GWh)
Orphan	Statbel (2019)[103]	Calculation PwC based on data from the 2016 energy balance	Iweps (2019)[104]	PwC calculation based on data in this table
Jemeppe-sur-Sambre	19 190	176.5	4.5 %	168.6
Saint-Georges-sur-Meuse	6 803	62.6	16.2 %	52.4
Saint-Ghislain	23 311	214.4	39.4 %	129.9
Manage	23 308	214.4	76.7 %	50.0
Visé	17 812	163.8	56.1 %	71.9
Verviers	55 207	507.8	35.10 %	329.6
Mons	95 613	879.4	69.80 %	265.6
Châtelet	35 903	330.2	69.6 %	100.4
Wanze	13 738	126.4	35.2 %	81.9
Charleroi	202 267	1 860.5	62 %	707.0
Quaregnon	19 007	174.8	77.6 %	39.2
Boussu	19 824	182.3	71.5 %	52.0
Liège	197 327	1 815.0	66.1 %	615.3
La Louvière	80 757	742.8	71 %	215.4
Seraing	64 259	591.1	70.4 %	175.0
Engis	6 138	56.5	41.9 %	32.8
Herstal	39 989	367.8	68.8 %	114.8
Saint-Nicolas	24 263	223.2	64.20 %	79.9
			Total	3 281.5

X.6.3. Scenarios envisaged

.X.6.3.1. Description of the scenarios

With regard to the consumption profile described above, four scenarios were identified:

- **Baseline scenario (BS4)**: The baseline scenario (BS4) envisages a situation where each building individually meets its own needs via condensing boilers (gas or fuel oil). There is no district heating network.
- **Alternative scenario 1 (SA4.1)**: Alternative scenario 1 (AS4.1) envisages a situation where 85 % of the heating needs are covered by a geothermal installation connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating. This coverage of 85% of the heating needs by deep geothermal energy is due to fact that a back-up is needed and a part is considered not to be provided by the loop (maintenance, for example).

[103] Statbel (2019): Population density by municipality 2019-2020 https://statbel.fgov.be/fr/themes/population/densite-de-la-population
[104] Iweps (2019): Part des ménages utilisant le réseau de gaz [Share of households using the gas network] https://walstat.iweps.be/walstat-catalogue.php?niveau_agre=C&theme_id=9&indicateur_id=813000&sel_niveau_catalogue=T&ordre=2

X.6.4. *Presentation of technical and financial data*

The table below consolidates the technical and financial data that were taken into account for the model supporting the analysis carried out. The main variables used are:

- The lifetime of that technology expressed in years
- the unit capital expenditure (investments) in EUR/kW or EUR/m for district heating
- the operational expenditure (OpEx) as a percentage of capital expenditure (CapEx) per year
- the other installation costs as a percentage of capital expenditure
- the seasonal thermal efficiency (%)
- annual thermal production (kWh)
- the installed thermal power (kW)

	Baseline scenario (BS4)	**Alternative scenario (AS4.1):**
General description of scenario	Decentralised gas/oil energy mix	Geothermal with supplementary gas
Primary technology	***Oil-fired condensing boiler***	***Geothermal installation***
Lifespan	15 years	50 years
Unit CapEx (EUR/kWth)	323	3 014
Other installation costs (%CapEx)	n.a.	n.a.
OpEx (operation) (% CapEx/year)	3%	1%
Seasonal thermal yield on PCS (%)	88%	100%
Electricity yield (%)	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.
Annual thermal production (kWh/year)	14 654 430	20 125 000
Annual electric production (kWh/year)	n.a.	n.a.
Thermal power (kW)	13 957	7 000
Electric power (kW)	n.a.	n.a.
Secondary technology	***Gas-fired condensing boiler***	***Supplementary central gas boiler***
Lifespan	15 years	15 years
Unit CapEx (EUR/kW)	281	177
OpEx (operation) (% CapEx/year)	4%	4%
Seasonal thermal yield on PCS (%)	90%	90%
Electricity yield (%)	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.
Annual thermal production (kWh/year)	8 606 570	3 136 000
Thermal power (kW)	8 907	8 000
Network	*n.a.*	***YES***
Lifespan (years)	n.a.	50 years
Length of network (m)	n.a.	4 384
Infrastructure CapEx (EUR/m)	n.a.	1 283
OpEx (operation) (%CapEx/year)	n.a.	1%
Distribution losses (%)	n.a.	10%

Table 55: Technical and financial data for profile 4

X.6.5. *Economic analysis*

Updated and annualised value of net costs

Alternative scenario AS4.1 presents an updated and annualised net cost value lower than the baseline scenario. The main reasons for this result are as follows:

- **<u>Scenario AS4.1 (deep geothermal with gas back-up):</u>** The advantage of this scenario is based on operational expenditure on fuel over 7 times lower than in the baseline scenario. This is justified by the fact that the share of heat produced by deep geothermal energy (87%) consumes a very cheap fuel, namely waste heat (geothermal).

Scenario	BS4:	AS4.1:
Updated and annualised value of net costs (EUR/year)	2 534 503	1 923 108
Difference	0	611 396

Table 56: Overall results for profile 4

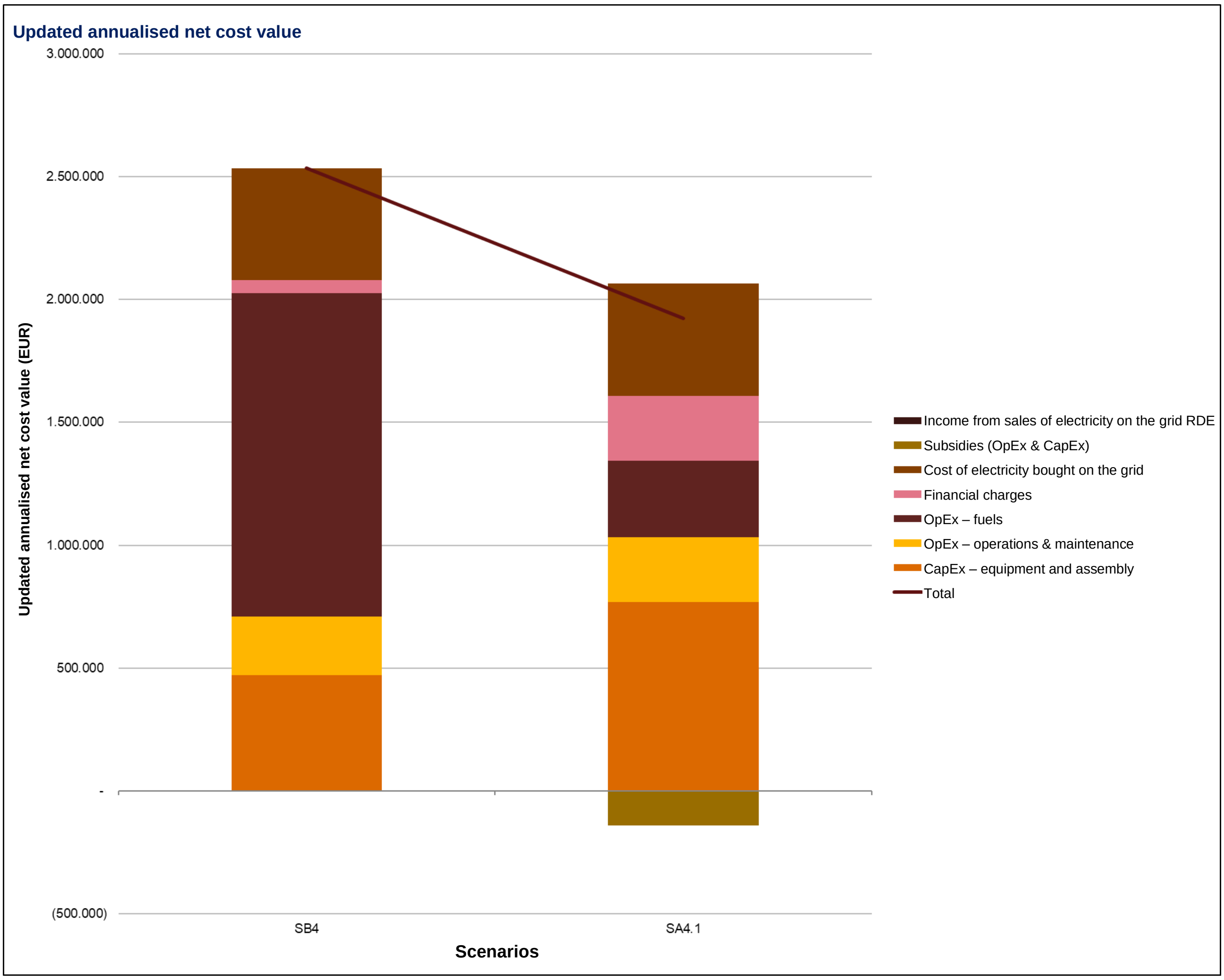


Figure 74: Updated and annualised net value of the two scenarios from Profile 4 (EUR/year)

Comparison of annualised costs by cost item

An analysis of annualised costs by cost item makes it possible to identify the strengths and weaknesses of each of the scenarios:

- **CapEx - Equipment & assembly**: The main disadvantage of geothermal energy is the high capital expenditure (linked to drilling) needed compared to the baseline scenario.
- **OpEx – Operation & maintenance** : Compared to the baseline scenario, the costs associated with the operation and maintenance of the installations are slightly higher for geothermal energy.
- **OpEx – Fuels**: The fuel costs cover the purchase of the fuels needed to cover the identified heat needs. This cost is significantly lower in the case of the alternative scenario (AS4.1) envisaging geothermal energy. It is mainly this parameter that makes scenario AS4.1 the most attractive.
- **Financial charges:** The financial charges are lower in the baseline scenario as the technology used has (1) a shorter life span and (2) much less capital expenditure.
- **Cost of the electricity purchased on the grid:** Scenarios BS4 and AS4.1 do not have the benefit of a power-generating technology and consider electricity consumption fully covered by the grid.

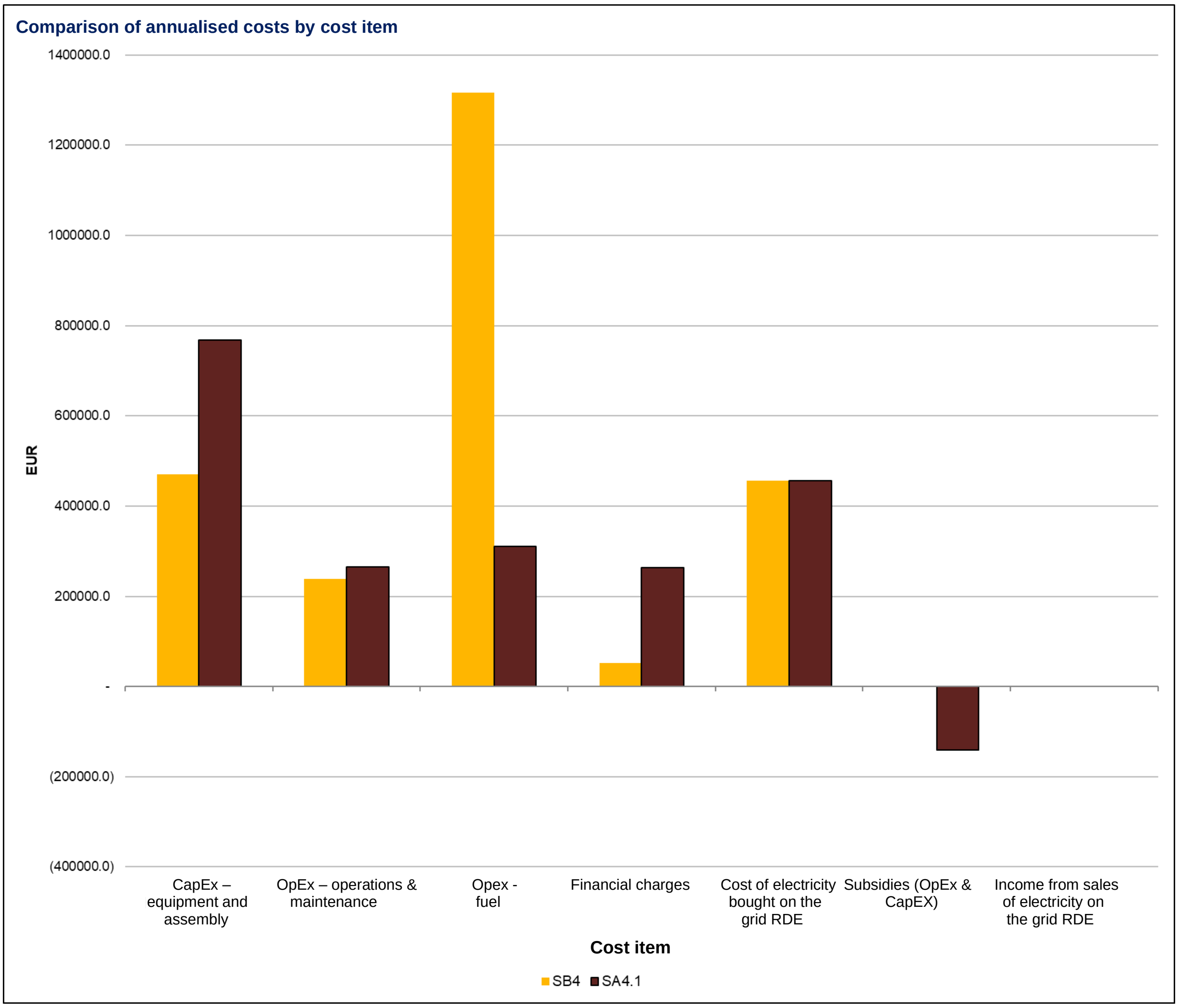


Figure 75: Comparison of annualised costs by cost item for profile 4

Comparison of the cumulative net costs of the four scenarios (EUR)

The figure showing the cumulative net costs for the two scenarios envisaged should be put in perspective with the investments and the life spans of the technologies considered in each of these scenarios. This information makes it possible to understand the 'plateaus' shown in the figure. By analysing the evolution of costs over a period of 30 years, the alternative scenario becomes more attractive as of the 16th year. This is mainly due to the short life span of the technology in the baseline scenario.

	Primary tech. investment (EUR)	Primary tech. lifespan (years)	Supplementary tech. investment (EUR)	Supplementary tech. lifespan (years)
BS4	4 510 075	15 years	2 502 922	15 years
AS4.1	21 098 000	50 years	1 416 000	15 years

Table 57: Investments and lifespans of the profile 4 technologies

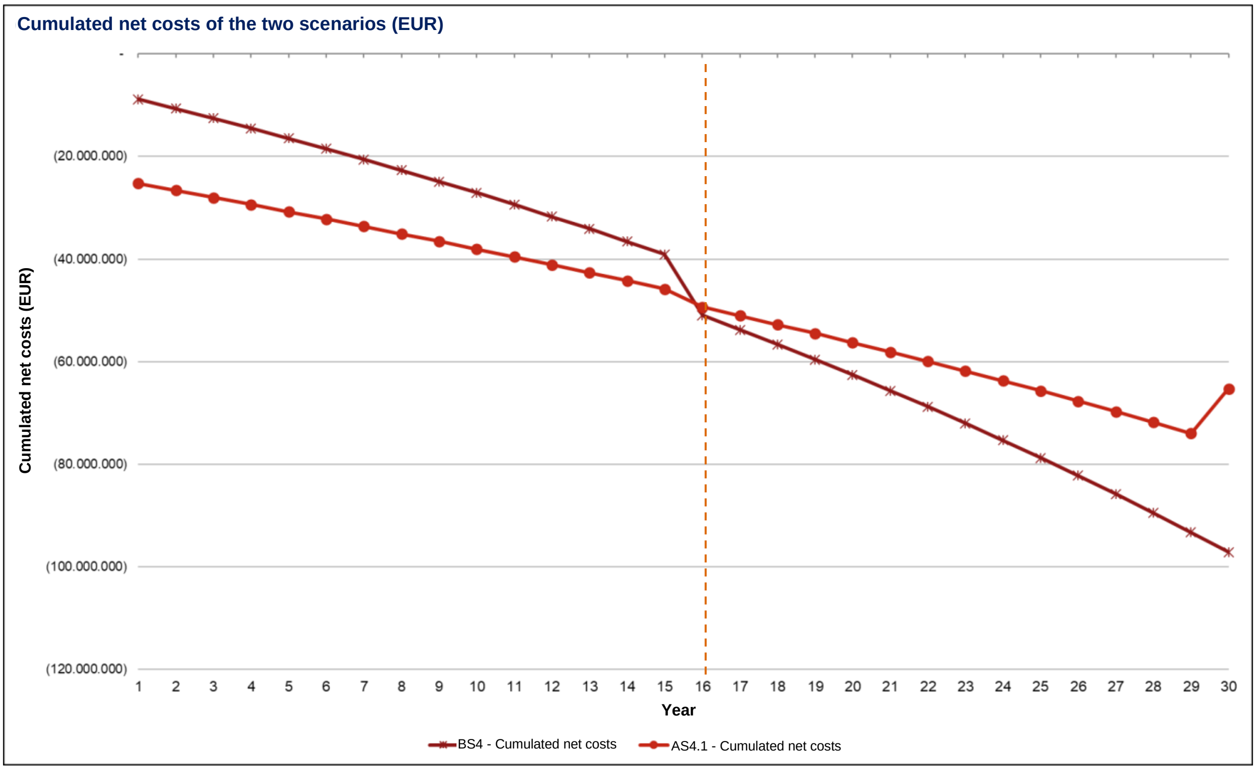


Figure 76: Cumulated net costs of the two scenarios of profile 4

X.6.6. Sensitivity analysis

Sensitivity analysis of variations in CapEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in the planned investments (capital expenditure). Given that the capital expenditure represents a significant part of the costs of the alternative scenario, a high increase in those costs at the same time as a decrease in the capital expenditure in the baseline scenario could make its position less attractive.

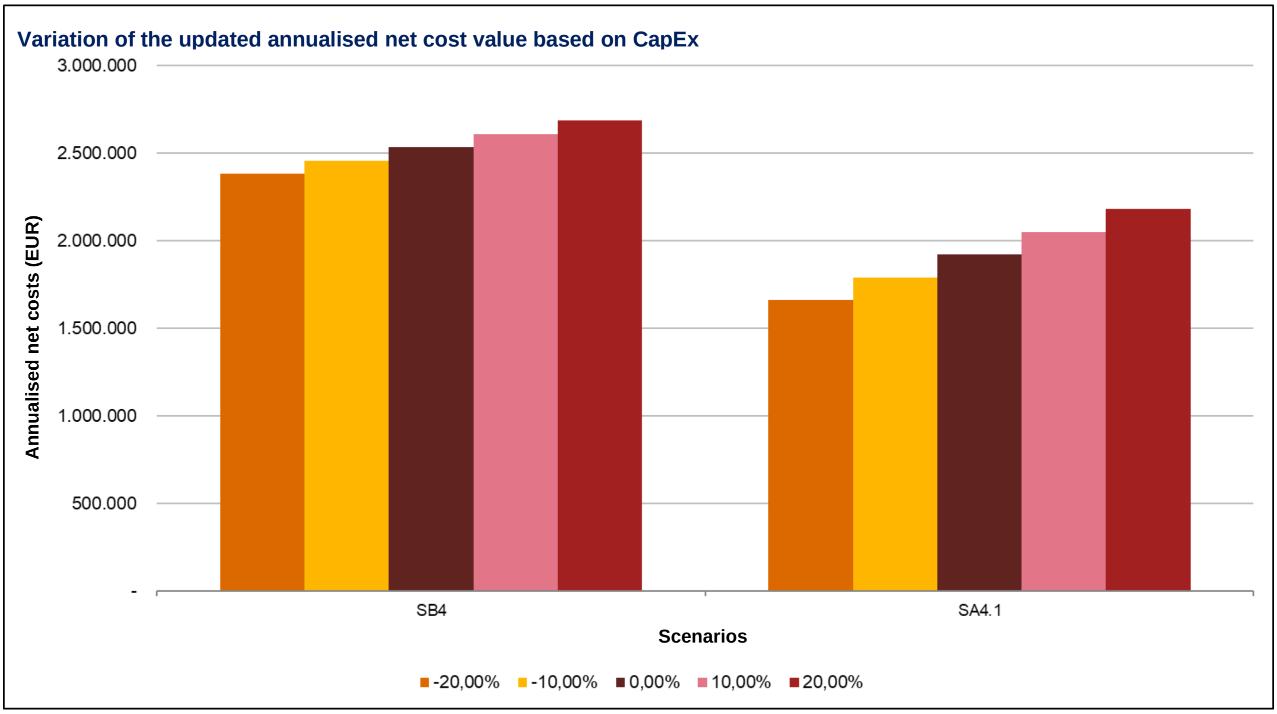


Figure 77: Variation of the updated and annualised net cost value based on the capital expenditure for profile 4

Sensitivity analysis of variations in OpEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in operational expenditure (excluding fuels). The results of this sensitivity analysis reinforce the conclusions of the results presented above. Operating costs are not the highest cost items. It is thus probable that variations in these will only have a very slight impact on the results obtained. The greater impact of a variation in operational expenditure for the alternative scenario AS4.1 is because operational expenditure is calculated as a percentage of capital expenditure. Thus, it contributes to the high level of capital expenditure in this scenario.

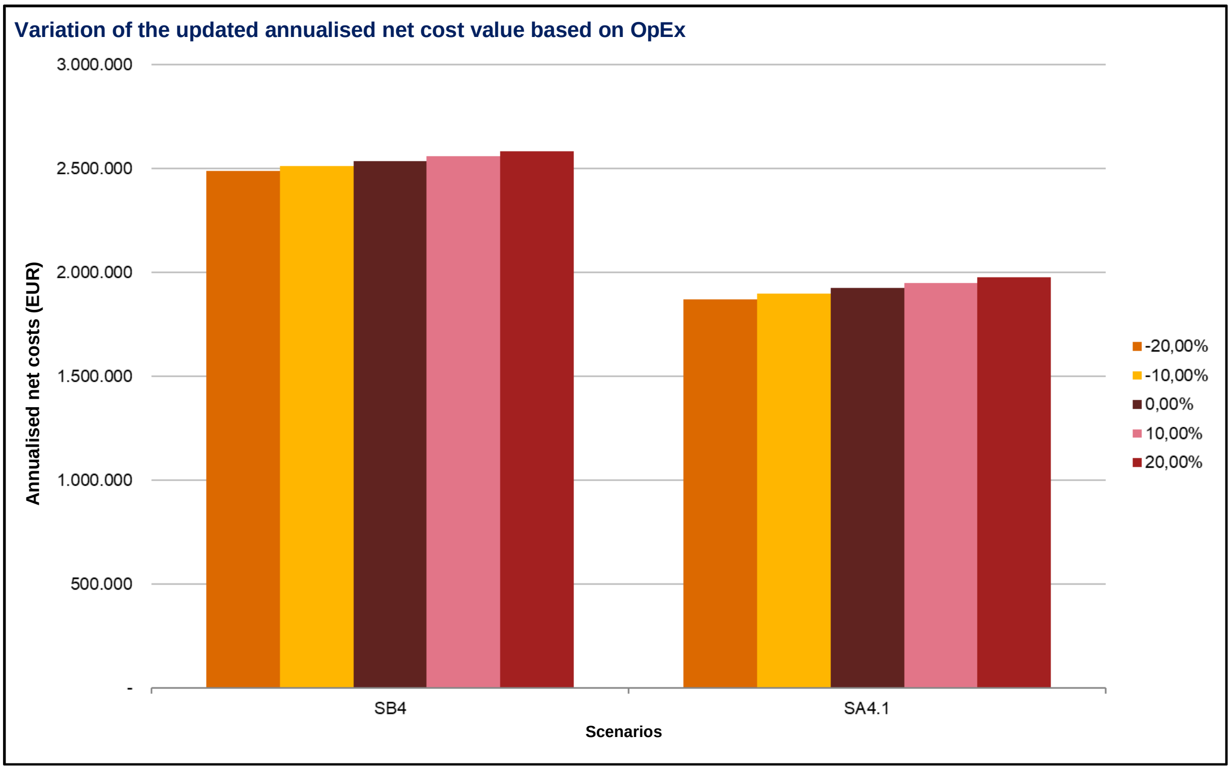


Figure 78: Variation of the updated and annualised net cost value based on the operational expenditure for profile 4

Introduction of a CO_2 cost

The graph below illustrates the differences between the alternative scenario and the baseline scenario if consumers have to pay for the tonnes of CO_2 emitted by the production technologies considered. The analysis considers a price range of EUR 0 to EUR 20 per tonne of CO_2. The findings are:

- The difference between the **baseline scenario and the alternative scenario** increases when prices per tonne of CO_2 increase. This is because the technologies considered in the BS4 scenario consume fuels that emit CO_2, while the technologies considered in the other scenario use waste heat. It therefore appears that imposing a price per tonne of CO_2 would enhance the competitiveness of deep geothermal energy compared to fossil-fuel-based technologies.

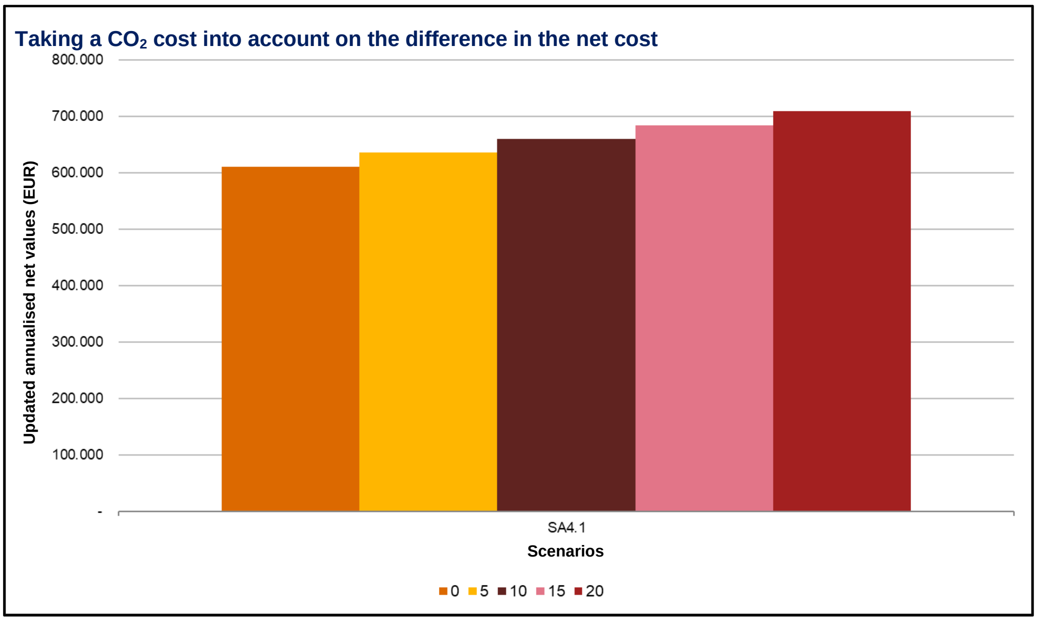


Figure 79: Taking a CO_2 cost into account for profile 4

Variation of the prices of gas and of electricity

The following figure illustrates the results of the scenarios analysed above if gas and electricity costs were higher or lower (range from -20% to + 20%). On the basis of this analysis, it appears that regardless of the variation in gas and electricity prices in this range, no scenario changes its position (profitable or not) compared to the other in terms of annualised costs. It also appears that the geothermal solution is not very sensitive to changes in fuel prices. The two scenarios are equally sensitive to changes in the price of electricity, since neither of the scenarios generates electricity and the self-consumption hypothesis is not analysed.

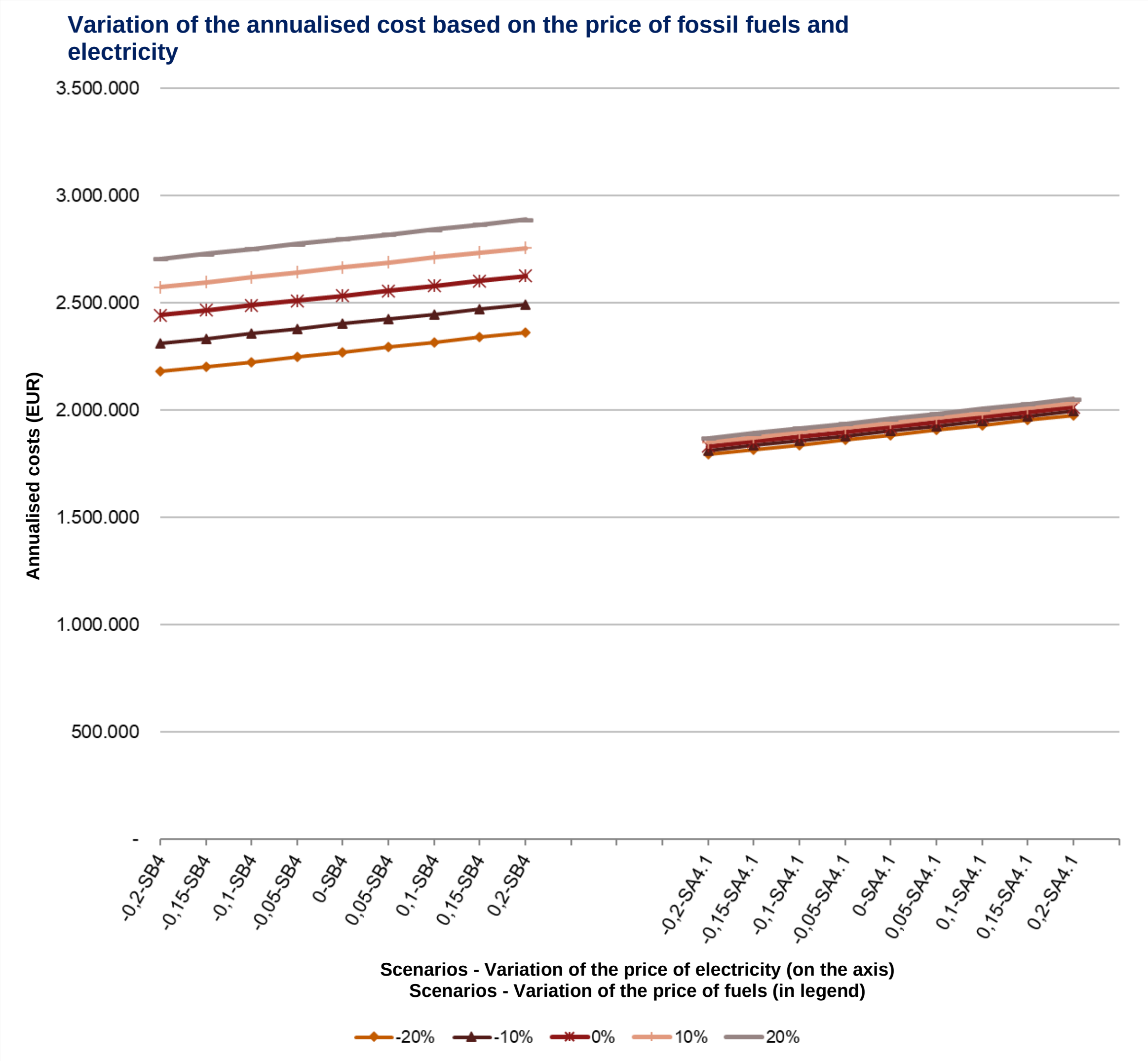


Figure 80: Variation of the gas and electricity prices for profile 4

Variation of the increase of the price of gas and of electricity

The following figure considers a variation in the increase in gas and electricity prices (initial assumptions of +2% per year and +4% per year, respectively). On the basis of this analysis, it appears that regardless of the variation in gas and electricity prices, no scenario changes its position (profitable or not) compared to the others in terms of their updated and annualised net value. The sensitivity of each scenario to electricity prices is similar as they have the same needs for electricity from a source external to their technologies (these technology mixes do not produce electricity). The difference in sensitivity to fuel prices is again highlighted.

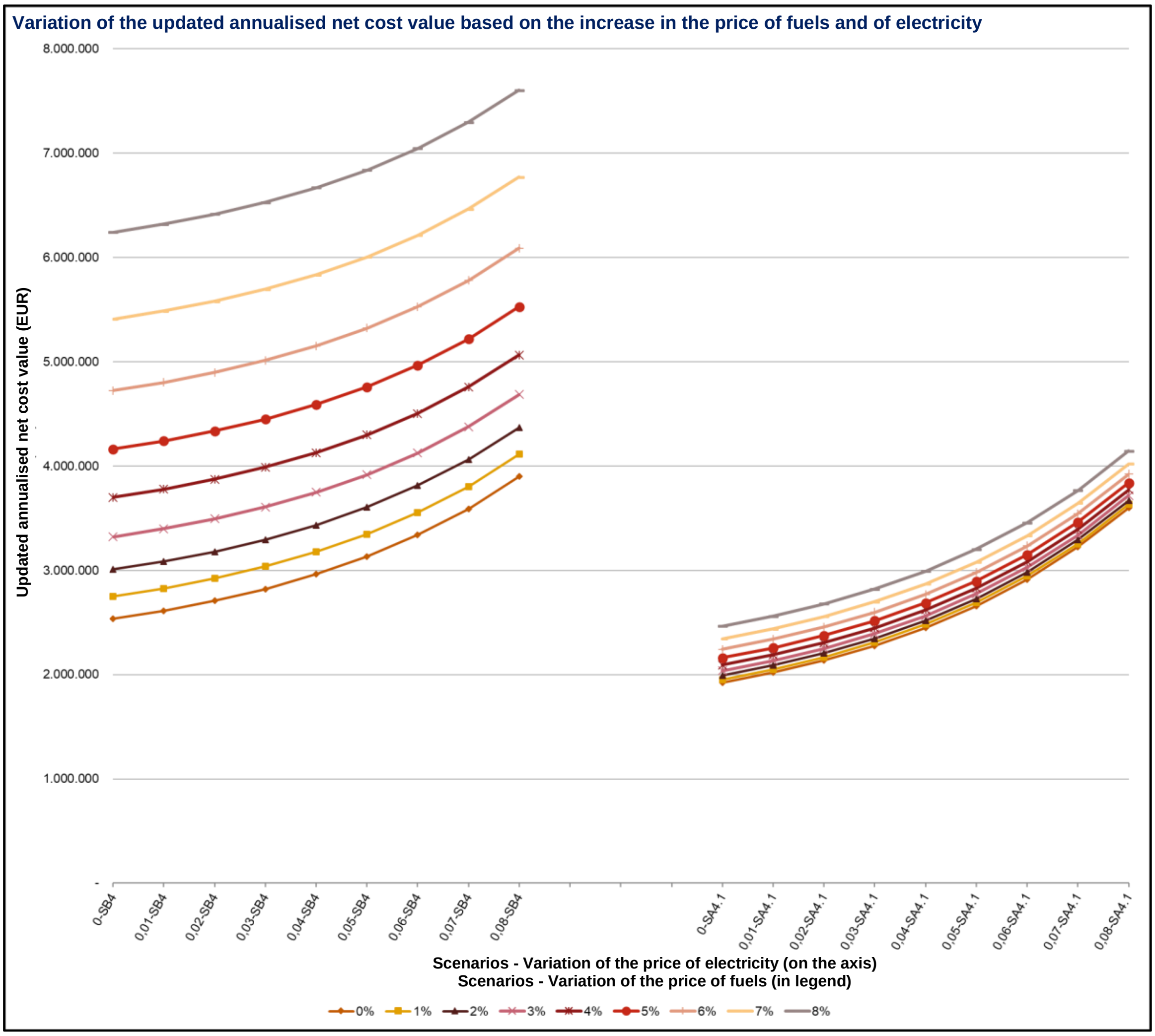


Figure 81: Evolution of the updated and annualised net cost value depending on the increase in the price of fuels and electricity for profile 4

.X.6.6.1. *Environmental review*

The baseline scenario shows an annual CO_2 production of over 7 000 tonnes. Alternative scenario AS4.1 has much lower annual emissions, almost 775 tonnes attributed only to electricity needs and emissions of 920 tonnes for heat production related to the supplementary gas required. This result is consistent since alternative (geothermal) technology does not emit CO_2 during its operation, although it does consume electricity. This also explains why introducing a charge for CO_2 makes the alternative scenario more competitive compared to the baseline scenario.

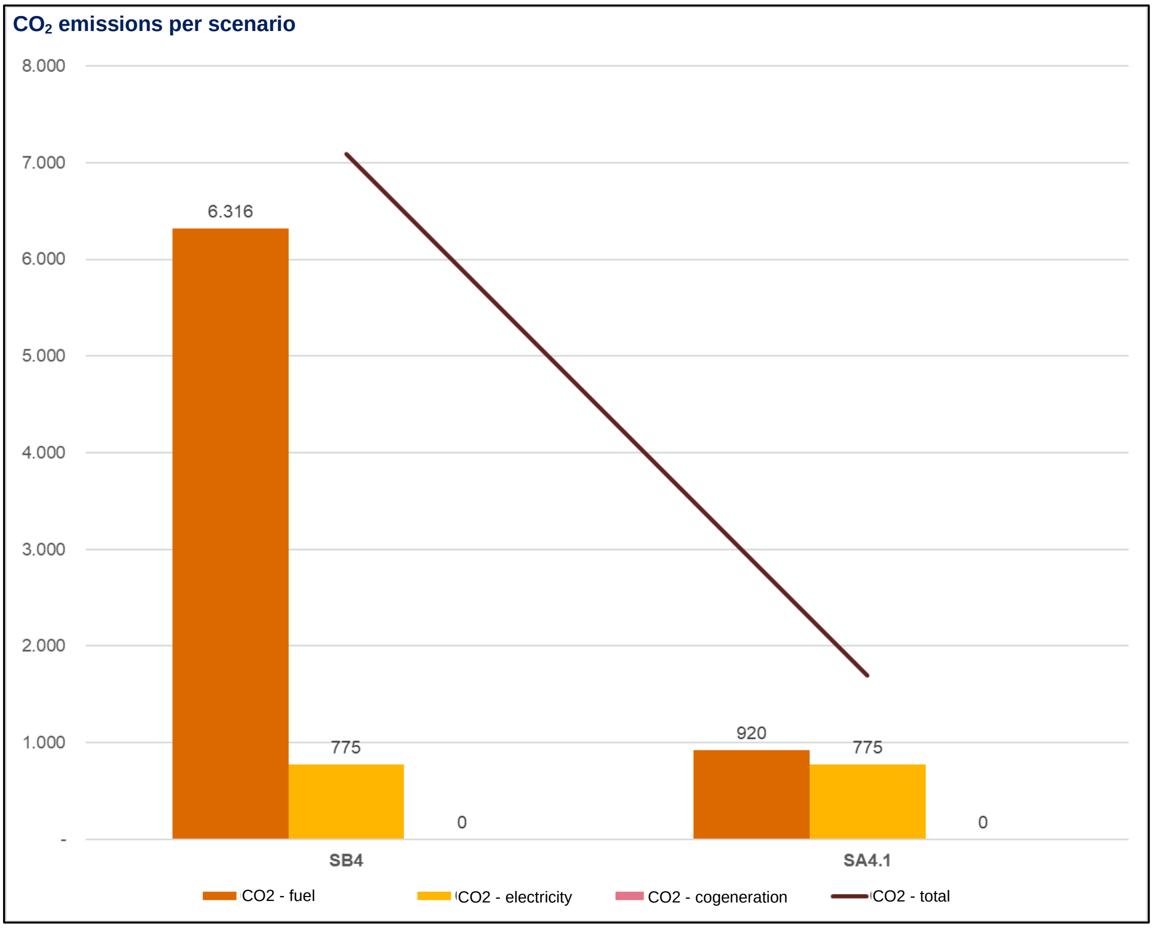


Figure 82: CO_2 emissions per scenario for profile 4

Figure 83 shows the impact of the alternative scenario's investments on CO_2 emissions compared to the baseline scenario. The following approach was used to identify the grams of CO_2 saved per euro invested. For each scenario, the difference in CO_2 emissions from the baseline scenario is divided by its updated and annualised net cost value. It appears that scenario AS4.1 would make it possible to reduce CO_2 emissions by 2 800 g for each euro invested compared to the baseline scenario.

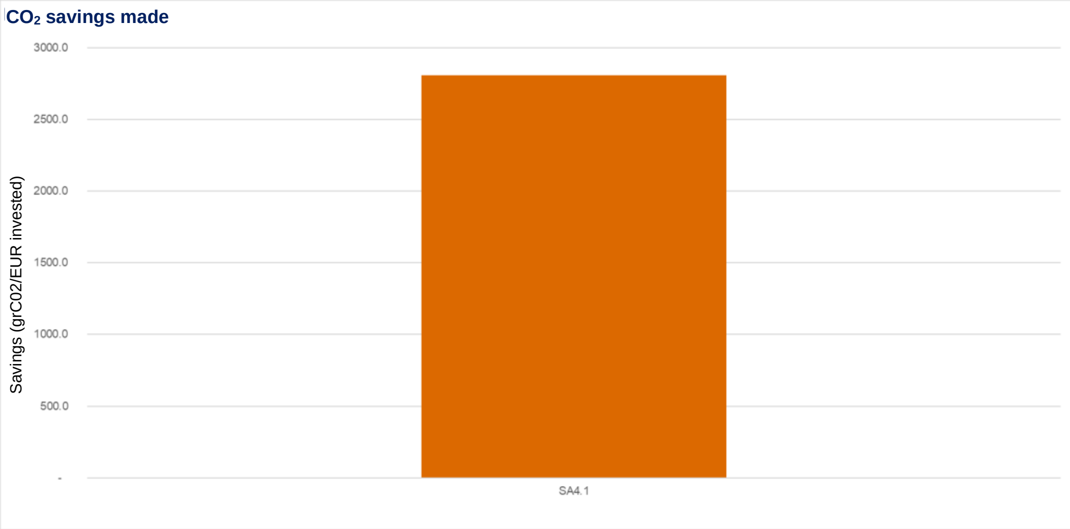


Figure 83: CO_2 saving achieved through investments in scenario AS4.1

X.6.7. *Conclusions*

The economic and sensitivity analyses carried out on profile 4 make it possible to identify several points:

1. Whatever changes in fuel and electricity prices are considered, the alternative scenario (geothermal) is still more attractive than the baseline scenario from a long-term economic point of view.
2. The minor role of fuels in the cost structure of the alternative scenario makes it very inelastic to the change in fuel prices. Moreover, an increase in the price of fuel makes the alternative scenario more and more profitable compared to the base scenario. ;
3. The implementation of a 'CO_2' cost makes it possible to improve the competitive positioning of geothermal installations. ;
4. The alternative scenario has a better carbon footprint with CO_2 emissions over four times lower.

Remark: Despite all of these indicators which mitigate in favour of the deep geothermal scenario, it is useful to remember that deep geothermal energy only becomes more profitable than the baseline scenario after 16 years. This crucial detail demonstrates the financial risk incurred with this project in view of the initial investment required.

In view of the results referred to above, it is therefore important to establish a legal basis for a regional geothermal guarantee system for deep geothermal projects, to cover the geological risk with regard to the geothermal energy resource.

Given the high investment costs, the risk of not accessing the expected geothermal resource and the lack of an insurance policy covering this 'natural' risk, such a guarantee system is considered necessary to create an investment climate that favours the production of renewable heat from deep geothermal energy.

X.7. Analysis of profile 5

X.7.1. Description of consumption profile 5

The table below presents key morphology and consumption data for profile 5. This profile corresponds to a mixed ecodistrict. A number of ecodistricts are emerging or being planned in Wallonia Developers active in this sector are manifestly interested in district heating networks. When developing a new neighbourhood, the cost of extending a district heating network or gas mains is essentially the same. Therefore, a more in-depth analysis of this consumption profile within this study seems fitting.

Profile 5		
Characteristics	Construction of an ecodistrict with (1) a sufficient size and (2) varying consumption profiles.	
Practical example:	The 'Bella Vita' ecodistrict in Waterloo.	
Description		
Thermal energy consumption	4 217 000 kWh	
Electrical energy consumption	2 210 300 kWh	
Sectors	**Residential**	**Service**
Characteristics of the building stock	87 houses and 182 apartments	A crèche, an assisted living facility, a nursing home, a healthcare centre
Thermal energy consumption[105]	3 331 443 kWh	885 570 kWh
Electrical energy consumption[106]	1 746 137 kWh	464 163 kWh

Table 58: Description of profile 5

X.7.2. Representativeness of profile

Based on the definition of ecodistrict proposed by the CPDT[107]: "A part of an urban area designed with pedestrians in mind that maximises the use of its own environmental, social and economic resources in order to minimise its environmental impact and that acts as a lever to initiate the eco-transition of the surrounding areas", ecodistricts apparently position themselves as a future solution to environmental challenges. Based on projections from the Federal Planning Bureau, a 13.9% increase in the number of dwellings in Wallonia is expected between 2016 and 2050, corresponding to more than 200 000 new dwellings. With increasing pressure on the land for the construction of new housing, there is a real rethinking of the detached house model at political level. The ecodistrict is also a response to the demographic question.

At present there is no register of ecodistricts in Wallonia. This is due to the lack of an accepted labelling. Nevertheless, qualitative research suggests that the number of projects that describe themselves as an ecodistrict is growing. Examples include:

- The Île aux Oiseaux district in Mons
- The ecodistrict of Sart-Tilman
- Jambe Gameda
- The ecodistrict at Fontaine Domalus in Boncelles
- The I-dyle project in Genappe
- The ecodistrict in Coronmeuse

[105] The distribution ratio between residential and service is based on the energy balance (79%/21%).
[106] The distribution ratio of the thermal consumption needs is applied to electricity consumption.
[107] CPDT, **Ecoquartiers : faut-il labéliser … ?**, les cahiers nouveaux N°78, August 2011.

- The ‘Bella Vita’ ecodistrict in Waterloo.

X.7.3. *Scenarios envisaged*

.X.7.3.1. *Description of the scenarios*

With regard to the consumption profile described above, four scenarios were identified:

- **Baseline scenario (BS5)**: The baseline scenario (BS5) envisages a situation where each building individually meets its own needs via gas condensing boilers. There is no district heating network. However, this scenario envisages the establishment and cost of a network to be connected to the gas distribution grid.

- **Alternative scenario 1 (SA5.1)**: Alternative scenario 1 (AS5.1) envisages a situation where 38% of the heat needs are covered by gas cogeneration connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.

- **Alternative scenario 2 (SA5.2)**: Alternative scenario 2 (AS5.1) envisages a situation where 89% of the heat needs are covered by a biomass boiler room connected to district heating. The remaining heating needs are covered by supplementary gas heating (serving also as a back-up) connected to district heating.

- **Alternative scenario 3 (SA5.3)**: Alternative scenario 3 (AS5.3) envisages a situation where 37% of the heat needs are covered by heat pumps (in individual homes). The remaining heating needs (blocks of flats, service, etc.) are covered by an individual (decentralised) gas condensing boiler room per building.

X.7.4. *Presentation of technical and financial data*

The table below consolidates the technical and financial data that were taken into account for the model supporting the analysis carried out.

	Baseline scenario (BS5)	Alternative scenario (AS 5.1)	Alternative scenario (AS 5.2)	Alternative scenario (AS 5.3)
General description of scenario	Decentralised condensing boiler for each building (100)	Centralised gas cogeneration + back-up boiler / supplementary district heating	Solid biomass boiler room connected to district heating and central gas boiler (back-up)	Heat pump House + decentralised gas Building
Primary technology	***Gas-fired condensing boiler***	***Gas cogeneration***	***Biomass boiler***	***Individual heat pumps***
Lifespan	15 years	15 years	25 years	15 years
Unit CapEx (EUR/kWth)	281	758	695	1 000
Other installation costs (%CapEx)	n.a.	n.a.	n.a.	n.a.
OpEx (operation) (% CapEx/year)	5%	10%	6%	4%
Seasonal thermal yield on PCS (%)	92%	54%	84%	100%
Electricity yield (%)	n.a.	36%	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	3
Annual thermal production (kWh/year)	4 217 000	1 600 000	3 750 000	1 566 000
Annual electric production (kWh/year)	n.a.	1 065 680	n.a.	n.a.
Thermal power (kW)	2 800	400	1 500	1 305
Electric power (kW)	n.a.	266	n.a.	n.a.
Secondary technology	***n.a.***	***Supplementary central gas boiler***	***Supplementary central gas boiler***	***Gas-fired condensing boiler decentralised***
Lifespan	n.a.	30 years	30 years	
Unit CapEx (EUR/kW)	n.a.	177	177	321
OpEx (operation) (% CapEx/year)	n.a.	4%	4%	4%
Seasonal thermal yield on PCS (%)	n.a.	90%	90%	90%
Electricity yield (%)	n.a.	n.a.	n.a.	n.a.
Performance coefficient (hot or cold)	n.a.	n.a.	n.a.	n.a.
Annual thermal production (kWh/year)	n.a.	2 617 000	467 000	2 651 000
Thermal power (kW)	n.a.	2 000	2 000	2 000
Network	***YES***	***YES***	***YES***	***YES***
Lifespan (years)	50 years	50 years	50 years	50 years
Length of network (m)	6 000	6 000	6 000	2 500
Infrastructure CapEx (EUR/m)	825	1 100	1 100	825
OpEx (operation) (%CapEx/year)	1%	1%	1%	1%
Distribution losses (%)	0%	15%	15%	0%

Table 59: Technical and financial data for profile 5

X.7.5. *Economic analysis*

Updated and annualised value of net costs

Alternative scenarios AS5.1 and AS5.2 have an updated and annualised net cost value lower than the baseline scenario, i.e. scenarios that envisage the installation of a biomass boiler or gas cogeneration. The result obtained for each of the alternative technologies is mainly due to the following reasons:

- **Scenario AS5.1 (gas cogeneration)**: The advantage of this scenario is based on the sale of the electricity generated, i.e. an annual gain of over EUR 15 000 and on the subsidies for capital and operational expenditure (updated and annualised green certificates of EUR 17 000[108]).
- **Scenario AS5.2 (biomass boiler room):** The biomass boiler room is dependent on the high value of capital expenditure needed (technologies and network). This scenario presents updated and annualised capital expenditure of almost EUR 20 000 compared to the baseline scenario (condensing gas boiler). However, subsidies (for operating expenditure and capital expenditure) make it more competitive than the baseline scenario. These subsidies (in updated and annualised terms) amount to over EUR 110 000 per year.
- **Scenario AS5.3 (heat pumps)**: The main drawback of this scenario is its high energy costs (operational expenditure for fuels and electricity purchased on the distribution grid), which accounts for more than 80% of the updated and annualised net cost value.

Scenario	BS5	AS 5.1	AS 5.2	AS 5.3
Updated and annualised value of net costs (EUR/year)	1 170 568	1 135 487	1 107 679	1 406 676
Difference	0	35 081	62 888	-236 108

Table 60: Overall results for profile 5

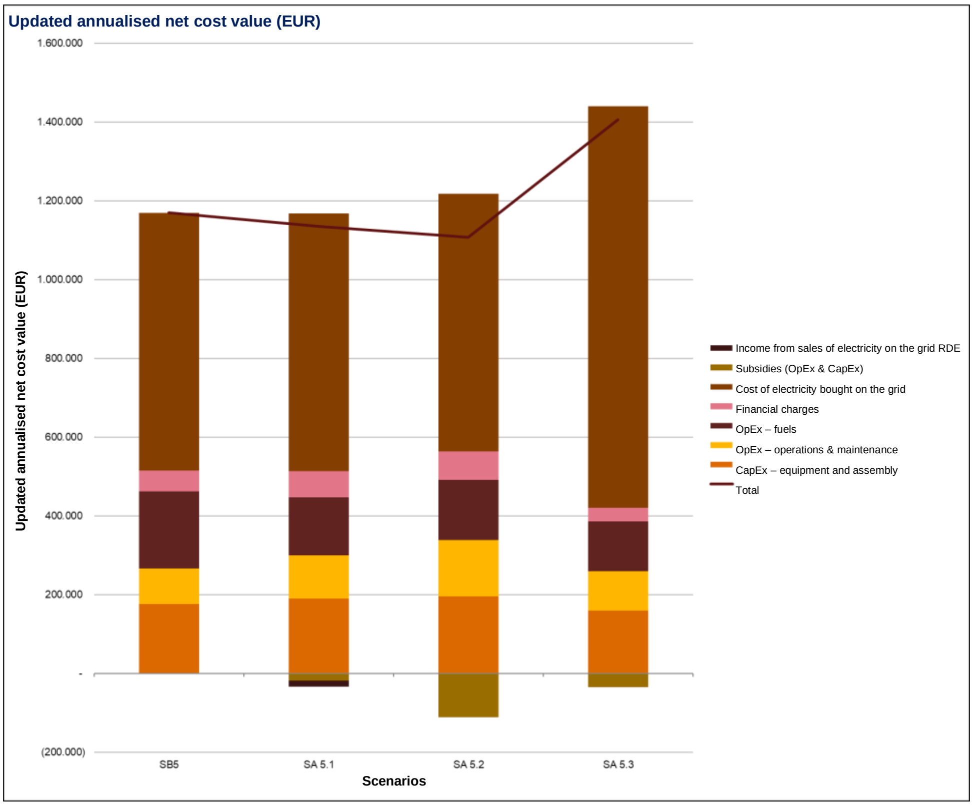


Figure 84: Updated and annualised net value of the four scenarios for profile 5 (EUR/year)

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[108] The number of green certificates:is calculated using the tool provided by the SPW on its website: https://energie.wallonie.be/fr/estimation-du-nombre-de-certificats-verts-en-fonction-du-coefficient-keco.html?IDC=9787&IDD=135639, consulted on 1 July 2020.

Comparison of annualised costs by cost item

An analysis of annualised costs by cost item makes it possible to identify the strengths and weaknesses of each of the scenarios:

- **CapEx - Equipment & assembly**: The capital expenditure for the technologies of the first two alternative scenarios AS5.1 and AS5.2 is higher than for the baseline technology. Note that the investments needed for the district heating network constitute the majority of investments in this scenario (EUR 6 000 000 of initial investment). The capital expenditure for scenario AS5.3 is the lowest, since this scenario doesn't involve building networks (gas or district heating).
- **OpEx – Operation & maintenance** : Operational expenditure (excluding fuels) is slightly higher in the first two alternative scenarios. As with the other profiles studied, operational costs are not the main drivers of costs.
- **OpEx – Fuels**: Alternative scenario AS5.3 shows the lowest capital expenditure. This is due to the technology used, i.e. heat pumps. They mainly consume electricity, which is included in another category. The operational expenditure of the other alternative scenarios is lower than that of the baseline scenario due to a lower fuel price, as demand is centralised and is thus industrial demand.
- **Financial charges:** The financial charges are low compared to other cost items. They follow the same trend as capital expenditure, namely a lower amount for scenario AS5.3.
- **Cost of the electricity purchased on the grid:** The alternative scenario AS5.3 has the highest costs since part of its heat is produced from electricity (via heat pumps), in addition to the basic electrical load. The other scenarios have similar costs since, on the assumption that collective self-consumption does not exist, all scenarios get 100% of their electricity on the distribution grid.
- **Revenue from the sale of electricity on the grid**: Only scenario AS5.1 takes electron-generating technology into account. This production is resold on the distribution grid and generates a revenue of EUR 15 600 in discounted and annualised terms.

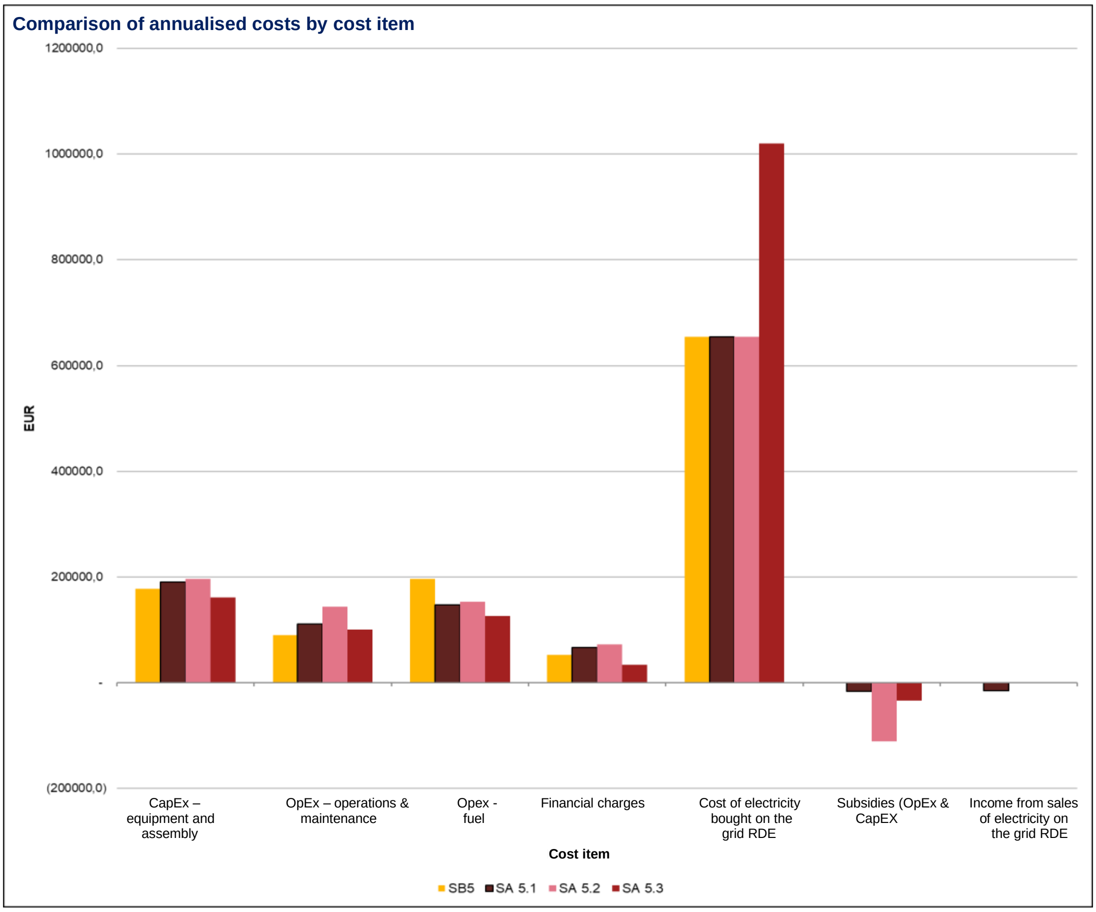

Figure 85: Comparison of annualised costs by cost item for profile 5

Comparison of the cumulative net costs of the three scenarios (EUR)

The figure showing the cumulative net costs for the four scenarios envisaged should be put in perspective with the investments and the life spans of the technologies considered in each of these scenarios. This information makes it possible to understand the 'plateaus' shown in the figure. In the short term, scenario AS5.3 appears to be the most advantageous scenario. As of the 11th year, alternative scenario AS5.1 becomes more attractive than scenario AS5.3, and as of the 15th year, the latter becomes the least attractive of all the scenarios. This is due to the replacement of all the heat pumps.

	Tech. investment Primary (EUR)	Primary tech. lifespan (years)	Supplementary tech. investment (EUR)	Supplementary tech. lifespan (years)
BS5	786 800	15 years	n.a.	n.a.
AS 5.1	303 200	15 years	354 000	30 years
AS 5.2	1 042 500	25 years	354 000	30 years
AS 5.3	1 305 000	15 years	642 000	30 years

Table 61: Investments and lifespans of the profile 5 technologies

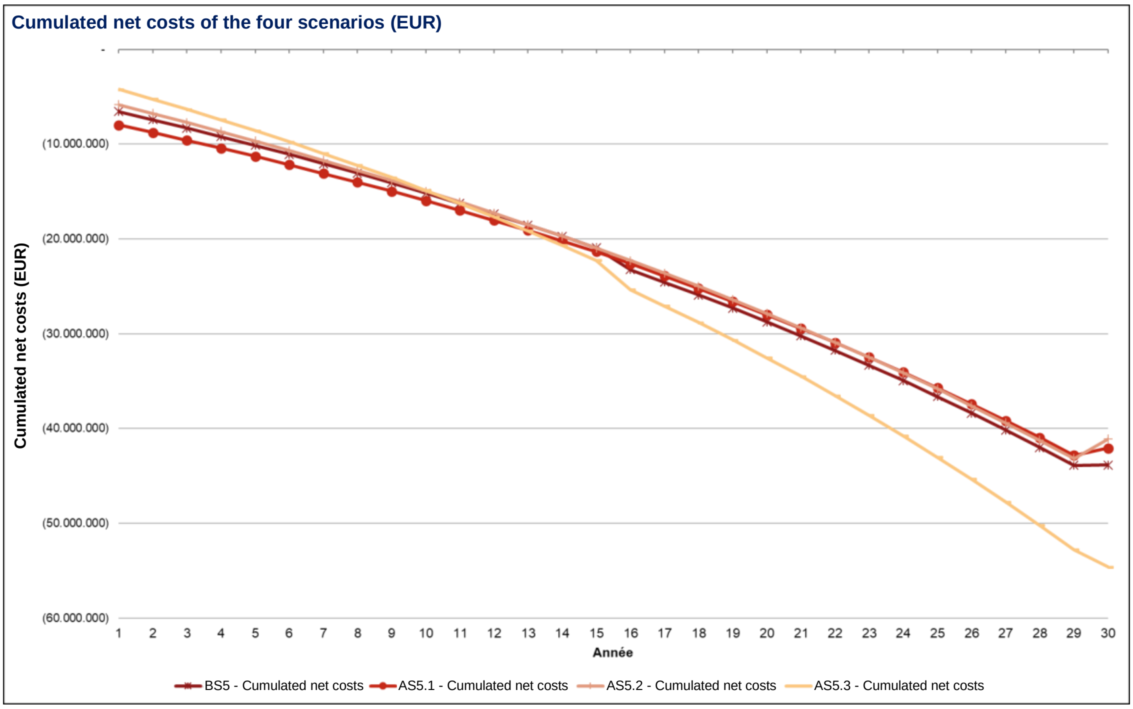

Figure 86: Cumulated net costs of the four scenarios for profile 5

X.7.6. *Sensitivity analysis*

Sensitivity analysis of variations in CapEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in the planned investments (capital expenditure). In the current analysis, investment aid for cogeneration, biomass boilers and district heating has been considered. The figure shows that if this deduction had not been taken into account, the alternative technology [in alternative scenario] AS5.2 would not be able to compete with the baseline technology (condensing gas boiler).

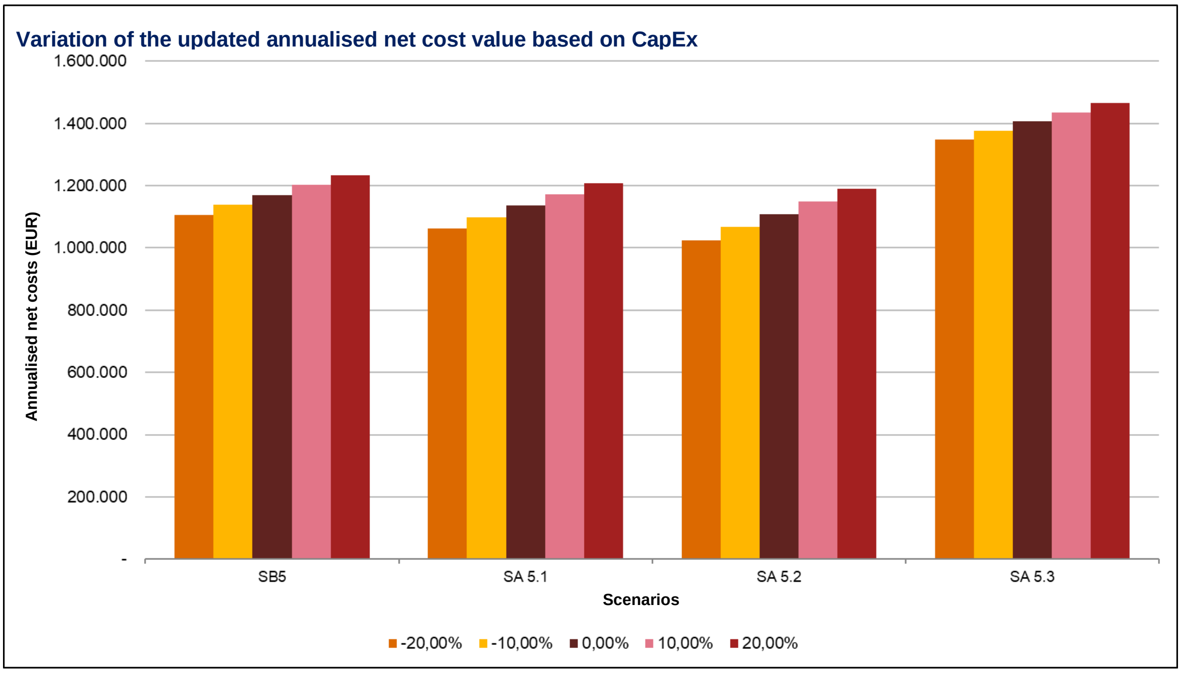

Figure 87: Variation of the updated and annualised net cost value based on the capital expenditure for profile 5

Sensitivity analysis of variations in OpEx

The following figure illustrates the sensitivity of the results presented above to an increase or decrease in operational expenditure (excluding fuels and green certificates). The results of this sensitivity analysis reinforce the conclusions of the results presented above. Operating costs are not the highest cost items. It is thus probable that variations in these will only have a very slight impact on the results obtained. Note that a decrease in the operational expenditure in the alternative scenario AS5.2 could strengthen the position of this technology compared to the baseline technology (condensing gas boiler).

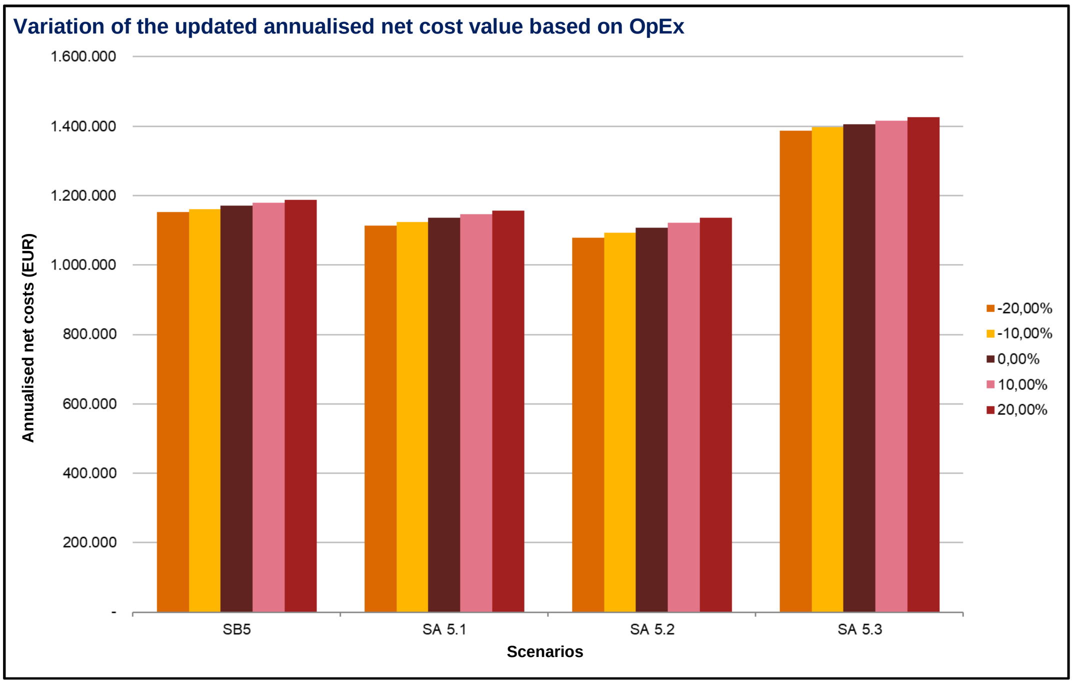

Figure 88: Evolution of the updated net costs based on the operational expenditure for profile 5

Introduction of a CO_2 cost

The graph below illustrates the differences between the alternative scenarios and the baseline scenario if consumers have to pay for the tonnes of CO_2 emitted by the production technologies considered. The analysis considers a price range of EUR 0 to EUR 20 per tonne of CO_2. The findings are:

- Alternative scenario AS5.2 would benefit from the introduction of a carbon tax. This is because the bulk of its heat is produced from a renewable vector.
- Alternative scenarios AS5.1 and AS5.3 would not be affected to a significant extent.
- The introduction of a CO_2 charge would not make scenario AS5.3 competitive with the other scenarios.

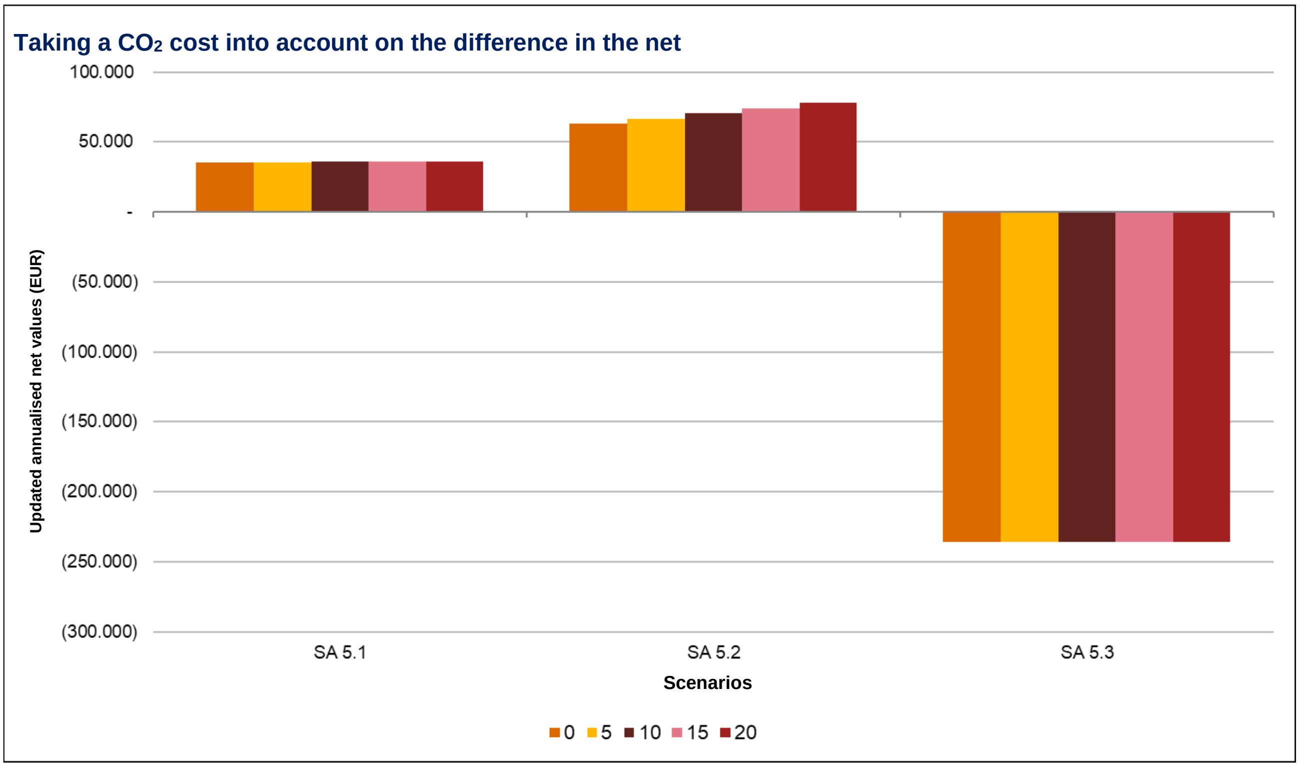

Figure 89: Taking a cost of CO_2 into account for the analysis of profile 5

Variation of the prices of gas and of electricity

The following figure illustrates the results of the scenarios analysed above if gas and electricity costs were higher or lower (range from -20% to + 20%). Baseline scenario BS5 is slightly more sensitive to fuel prices compared to the alternative scenarios. This reflects the fact that this scenario is dependent on gas prices. Alternative scenario AS5.3 is highly sensitive to electricity prices since part of its heat comes from this energy source (via heat pumps). Note also that this analysis makes it possible to assess the impact on the results of taking VAT into account. Depending on the fuels, there may be grounds for considering an increase of around 10% (VAT at 6%) or 20% (VAT at 21%).

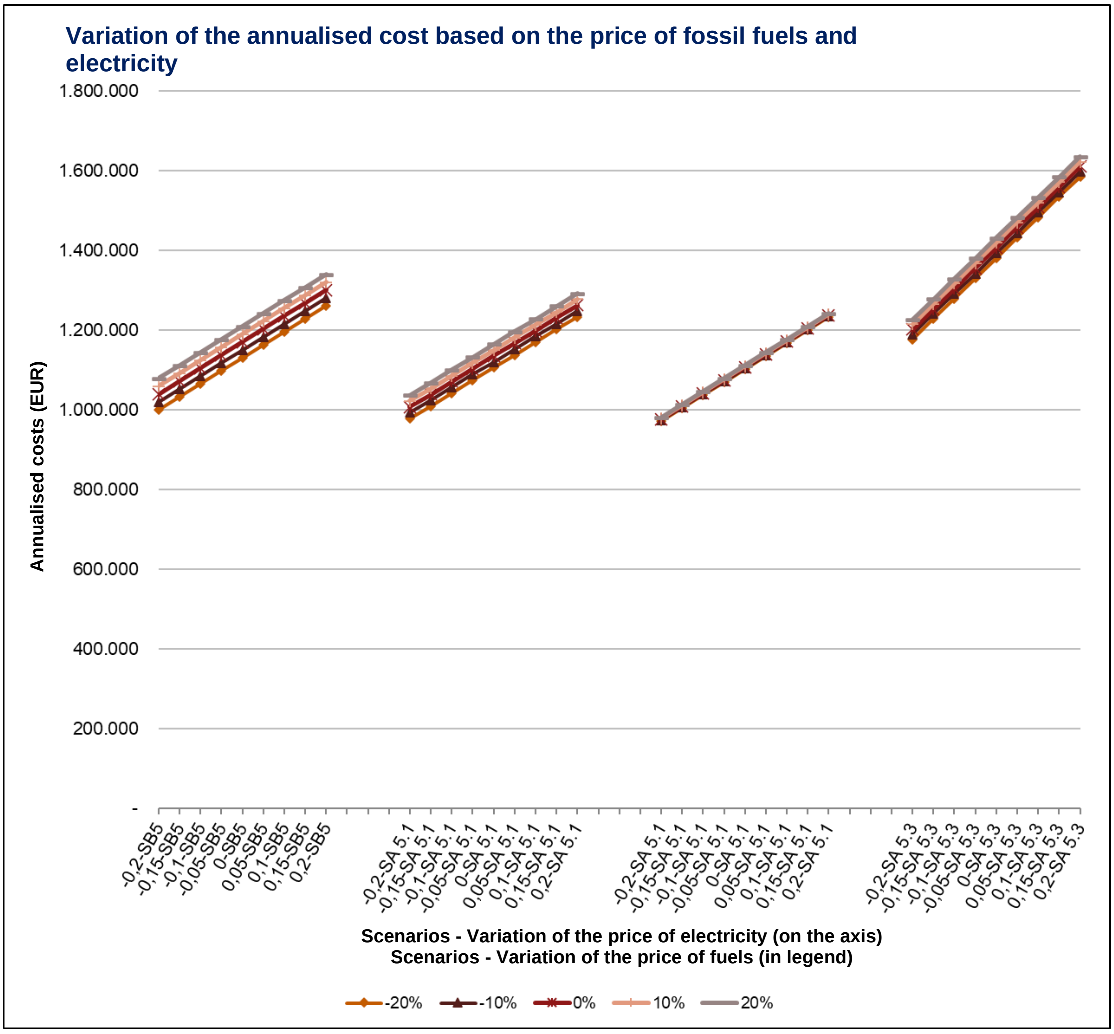

Figure 90: Variation of the gas and electricity prices for the analysis of profile 5

Variation of the increase of the price of gas and of electricity

The next figure considers a variation in the increase in gas and electricity prices (initial assumptions of +2% per year and +4% per year, respectively). It appears that the updated and annualised net cost value for scenario AS5.3 increases when electricity prices increase.

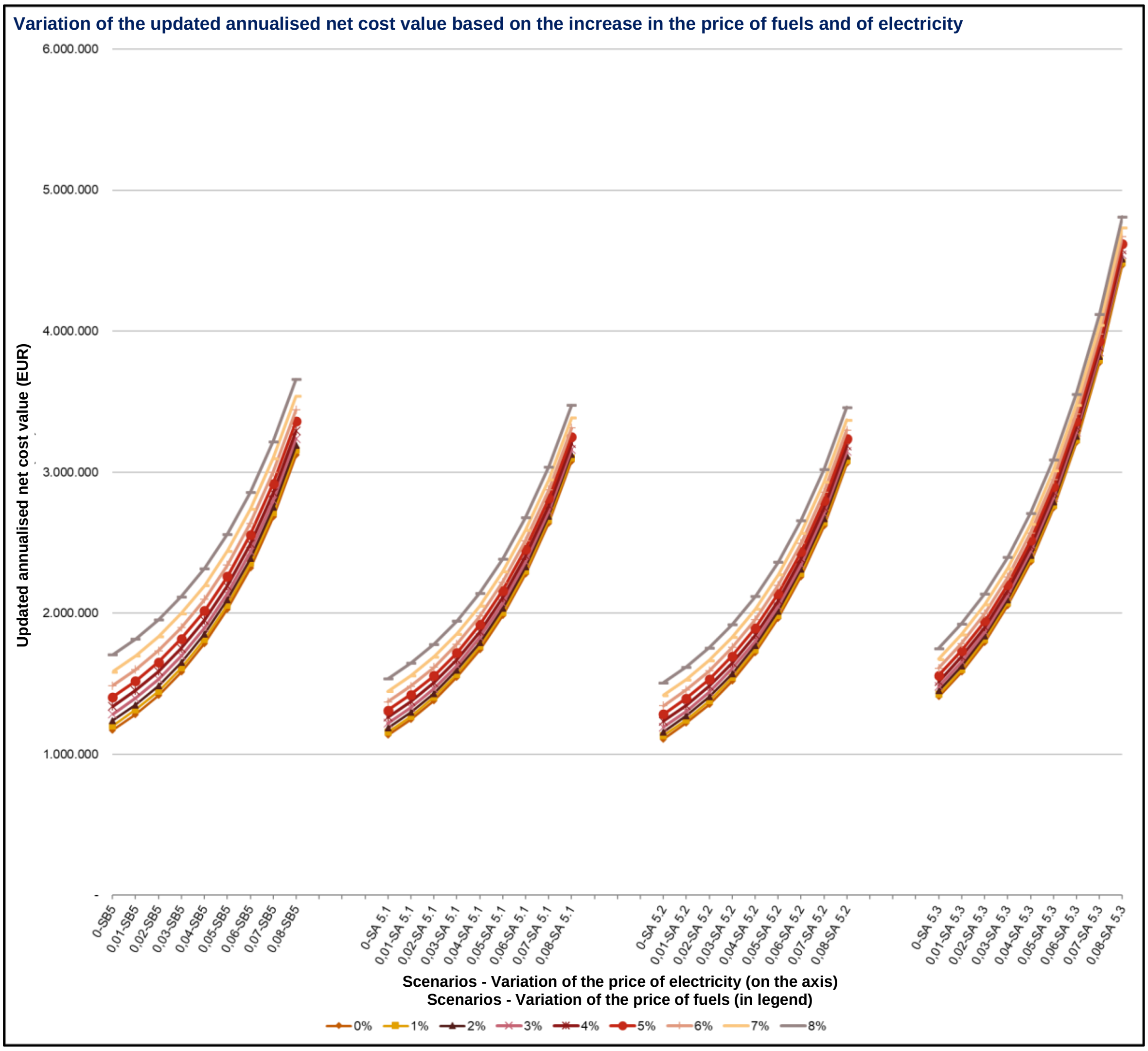

Figure 91: Variation of the increase in gas and electricity prices for profile 5

Sensitivity analysis on collective self-consumption

The following figure shows the updated and annualised net cost value for each scenario in two situations: without collective self-consumption and with collective self-consumption of 100 % of self-generated electricity. Only the scenarios involving cogeneration is concerned, but this result highlights how energy communities could be a potential asset. The main gain of collective self-consumption is at the level of the 'Electricity purchases' item, which is removed by the production of cogenerated electricity. In this situation, the AS5.1 scenario using cogeneration strengthens its position and becomes almost one third cheaper than the baseline scenario by dividing its electricity purchase costs by a factor of 2.

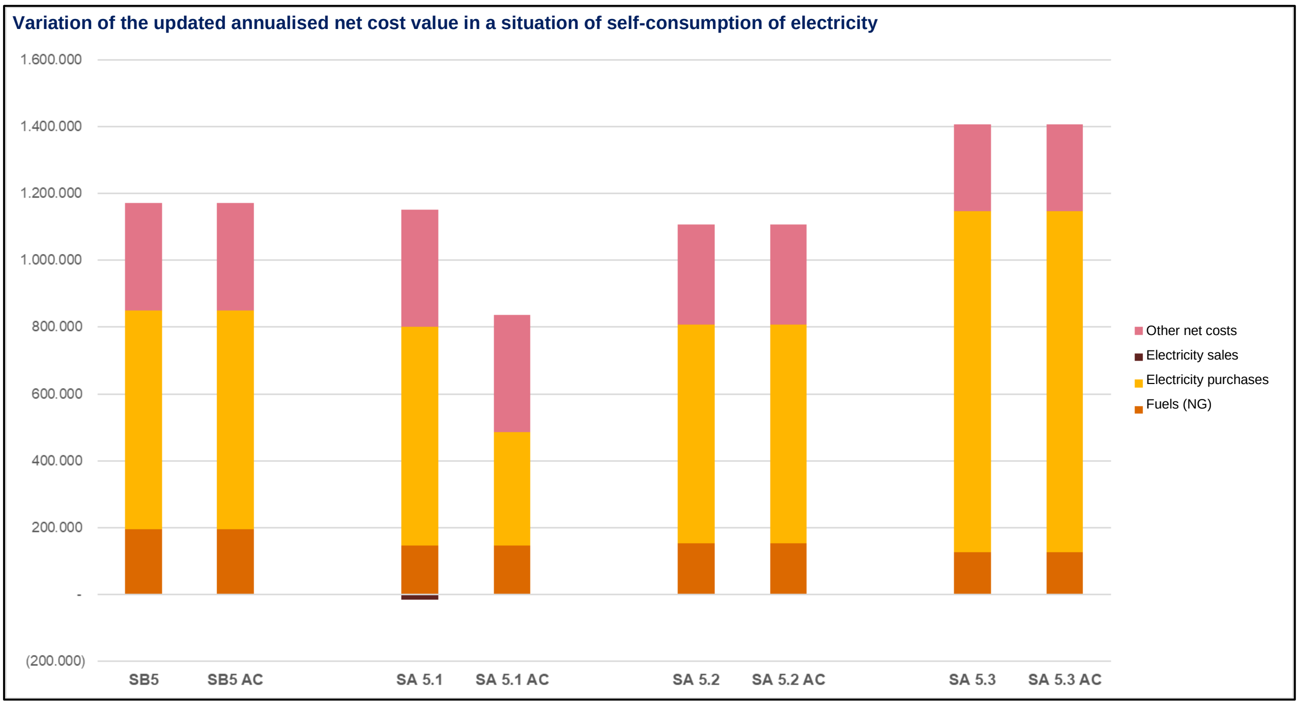

Figure 92: Variation of the costs in a situation of self-consumption of electricity

.X.7.6.1. Environmental review

The baseline scenario shows an annual CO_2 production of over 2 000 tonnes. Scenario AS5.1 shows annual CO_2 emissions lower than the baseline scenario with emissions totalling 1 960 tonnes of CO_2. Alternative scenario AS5.2 shows lower annual emissions of 1 200 tonnes of CO_2. Scenario AS5.2 shows very low CO_2 emissions because the fuel used comes from biomass and is considered as a renewable energy source. Scenario AS5.3 produces approximately the same amount of CO_2 per year as the baseline scenario, that is, 2 000 tonnes.

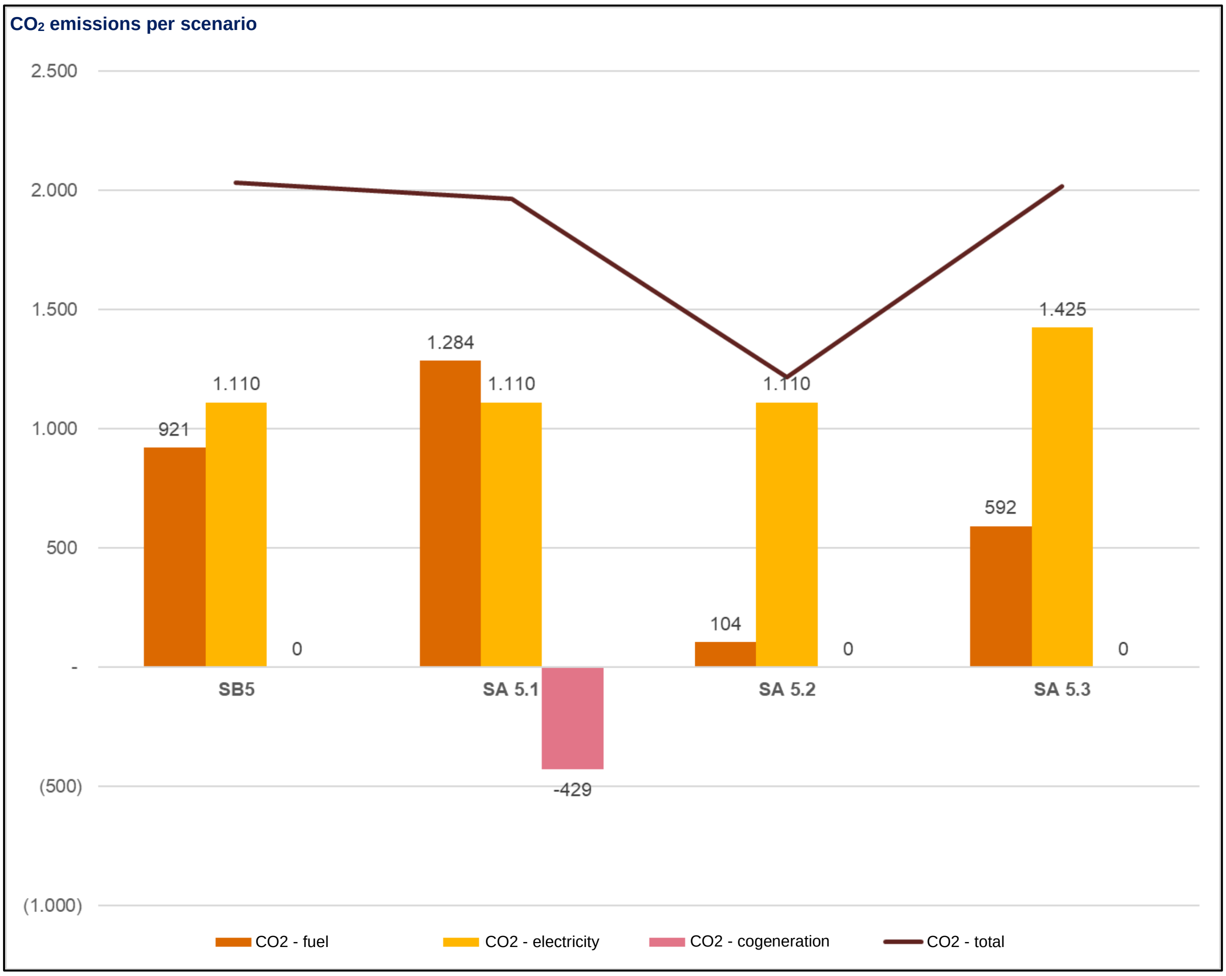

Figure 93: CO_2 emissions per scenario for profile 5

The following graph shows the impact of each investment on CO_2 emissions compared to the baseline scenario. The following approach was used to identify the grams of CO_2 saved per euro invested. For each scenario, the difference in CO_2 emissions from the baseline scenario is divided by its updated and annualised net cost value. AS5.2 appears to be the most effective investment in terms of reducing CO_2 emissions. Each euro invested could reduce CO_2 emissions by 700 g compared to the baseline scenario.

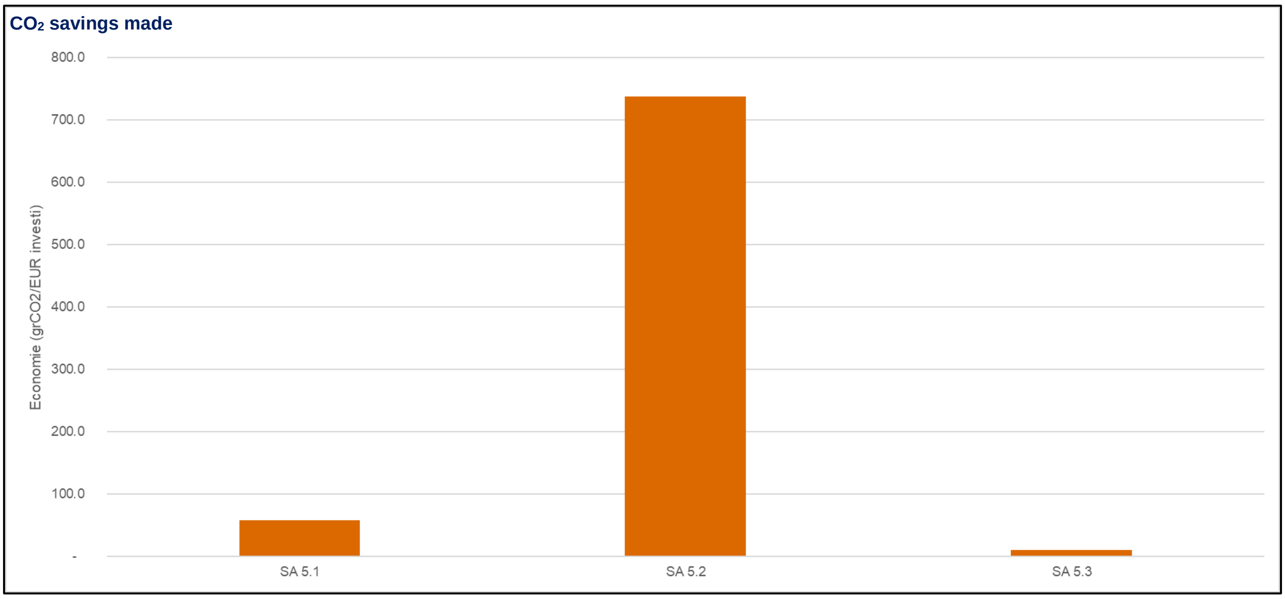

Figure 94: CO_2 savings per scenario for profile 5

X.7.7. Conclusions

The economic and sensitivity analyses carried out above make it possible to identify several points:

1. In the short term, and from an economic point of view only, alternative scenario 3 (heat pumps) makes more sense than all the other scenarios. After ten years, all the scenarios show discounted net costs lower than this scenario and the gap widens after 15 years because of the replacement of all the heat pumps. ;
2. The most relevant scenario, economically and environmentally, is that of the biomass boiler room and the district heating network.
3. The alternative scenarios AS5.1 (gas cogeneration) and AS5.2 (biomass boiler) show discounted net costs that are lower than those of the baseline scenario, taking into account the current support mechanisms.
4. The heat pump scenario consumes a lot of electricity and this makes it very sensitive to changes in the price of electricity, with a significant risk of undermining end consumers.
5. Scenario AS5.2, which consumes biomass, is not very sensitive to changes in the price of fossil fuel. Its sensitivity to variations in the price of electricity is identical to the baseline scenario and alternative scenario 2.
6. Collective self-consumption of electricity strengthens the competitive positioning of the AS1 scenario, integrating gas cogeneration;
7. The ‘centralised biomass boiler room’ scenario (AS5.2) has the strongest impact in terms of CO_2 saved per euro invested.
8. The heat pump investment (AS5.3) does not compete in the long run with the different scenarios in terms of net costs.

X.8. *Summary*

Profile	Optimal scenario	Scenario (2nd)		Scenario (3rd)		Scenario (4th)		Main issues of sensitivity
			Difference compared to optimal scenario (%)		Difference compared to optimal scenario (%)		Difference compared to optimal scenario (%)	
Profile 1 – Urban or peri-urban municipality with high energy density	AS1.3 – Waste heat distributed by DH and central gas-fired back-up boiler	AS1.2 – Solid biomass gasification cogeneration connected to DH and central gas-fired back-up boiler)	**Updated annualised net cost value**: +19% **CO_2 emissions**: +217%	AS1.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler)	**Updated annualised net cost value**: + 22% **CO_2 emissions**: +424%	BS1 – Individual condensing boiler	**Updated annualised net cost value**: + 50% **CO_2 emissions**: +403%	Subsidies (green certificates) Carbon-based fuel prices OpEx prices (upkeep and maintenance) Cost of CO_2
Profile 2 – Residential buildings	AS2.3 – Waste heat distributed by DH and central gas-fired back-up boiler)	AS2.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	**Updated annualised net cost value**: + 29% **CO_2 emissions**: +251%	AS2.2 – Solid biomass boiler connected to DH and central gas-fired back-up boiler	**Updated annualised net cost value**: +55% **CO_2 emissions**: -53%	BS2 - Decentralised condensing boiler for each building	**Updated annualised net cost value**: + 84% **CO_2 emissions**: +224%	Carbon-based fuel prices OpEx prices (upkeep and maintenance) Cost of CO_2
Profile 3 – Industrial site	AS3.1 – Industrial waste heat distributed by DH and central oil-fired back-up boiler	AS3.2 – Solid biomass cogeneration connected to DH and central oil-fired back-up boiler)	**Updated annualised net cost value**: +4% **CO_2 emissions**: -63%	BS3 – Decentralised oil-fired condensing boiler for each building	**Updated annualised net cost value**: + 20% **CO_2 emissions**: +408%	AS3.3 – Centralised biogas cogeneration with oil-fired back-up boiler	**Updated annualised net cost value**: + 75% **CO_2 emissions**: -84%	Carbon-based fuel prices Cost of CO_2
Profile 4 – Municipality with high energy density located in an area where deep geothermal energy is available	AS4.1 – Geothermal installations connected to DH and central gas-fired back-up boiler)	BS4 – Decentralised gas/oil energy mix (individual boilers)	**Updated annualised net cost value**: + 32% **CO_2 emissions**: +318%					Carbon-based fuel prices CapEx prices Cost of CO_2
Profile 5 – Ecodistrict	AS5.2 – Solid biomass boiler room connected to DH and central gas-fired back-up boiler	AS5.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	**Updated annualised net cost value**: + 3% **CO_2 emissions**: +83%	BS5 – Individual gas-fired condensing boiler and installation of a gas distribution network	**Updated annualised net cost value**: + 6% **CO_2 emissions**: +67%	AS5.3 – Individual heat pumps and decentralised condensing gas-fired boiler	**Updated annualised net cost value**: + 27% **CO_2 emissions**: +66%	Carbon-based fuel prices OpEx prices (upkeep and maintenance) Subsidies (green certificates) Cost of CO_2

Chapter 11 : Proposed measures & impact assessment

XI. Introduction

XI.1. *Recap of Annex VIII*

Point 9 of Part IV of Annex VIII to Directive 2012/27/EU on the contents of comprehensive assessments of the potential for efficiency in heating and cooling calls for the following:

> An overview of the new legislative and non-legislative measures aimed at realising the economic potential identified in accordance with points 7 and 8, along with planned measures:
>
> a) Greenhouse gas emission reductions;
> b) Primary energy savings in GWh per year;
> c) Impact on the share of high-efficiency cogeneration;
> d) Impact on the share of renewables in the national energy mix and in the heating and cooling sector;
> e) Links to national financial programming and cost savings for the public budget and market participants;
> f) Estimated public support measures, if any, with their annual budget and identification of the potential aid element.

XI.2. *Introduction*

Section XI.3 provides a description of the different measures identified during the analysis of alternative scenarios as contributing to achieving the economic potential of the technologies presented in Chapter 9 of this assessment. The description includes the following information: type of measure, objective, potential participants in implementing the measures, technology/-ies concerned, findings relating to the analyses carried out under Chapter 10, action envisaged. For each measure, a link is made to the energy policy measures presented in Chapter 9.

Section XI.4 presents a qualitative analysis of the contribution of each measure showing how they contribute to achieving the following objectives: reduction in greenhouse gas emissions, primary energy savings in GWh per year, impact on the share of high-efficiency cogeneration.

XI.3. *Presentation of the proposed measures*

XI.3.1. *List of the proposed measures*

No	Name of measure	Concerning
	In progress	
1	Issue implementing decrees on the organisation of the thermal market and on thermal energy networks	Global RES
2	Allow the establishment of renewable energy communities (heat and electricity)	Global RES
3	Take district heating networks into account in the calculation of the EPB	District heating network
4	Subsoil decree	Geothermal energy
	Priority measures	
5	Stop all subsidisation of fossil fuels in connection with Wallonia's objectives	Global RES
6	Support the recovery of RES and waste heat	RES heat
	Measures with significant impacts	
7	Set up an online platform, by sector of activity (residential, service, industry), to facilitate procedures necessary to realise a project	Global RES
8	Develop AMURE and UREBA aid	Global RES
9	Maintain and adapt investment aid (UDE)	Global RES
10	Encourage maintenance of the performance of RES production facilities	Global RES
11	Provide a financing mechanism adapted to a long lifespan for district heating/cogeneration equipment	District heating network
12	Review the depreciation period of DHNs for accounting purposes	District heating network
13	Incorporate local or neighbourhood study requirements for DHNs and renewable energy in the context of major construction projects	District heating network
14	Creation of a guarantee fund for the decontamination of excavated soil	District heating network
15	Development of a cartographic system (GIS) identifying heating needs, district heating networks and technical installations	District heating network
16	Extension of the duties of the industry facilitator by including a waste heat recovery component	Waste heat
17	Creation of a guarantee fund against the industrial risk associated with waste heat recovery projects	Waste heat
18	Promotion of the development of installations supplying district heating networks (deep geothermal energy, mining geothermal energy and shallow open system geothermal energy)	Geothermal energy
19	Modification of the permit system for open systems in shallow geothermal energy and biomass gasification	Geothermal energy, biomass

No	Name of measure	Concerning
20	Measures to reduce the geological risk associated with deep geothermal projects	Deep geothermal installations
	Measures with moderate impacts	
21	Professionalisation of the 'Cogeneration', 'District heating network', 'Geothermal energy' and 'Biomass' sectors	Global RES
22	Integration of a facilitator/expertise system directly into the administration - with field staff	Global RES
23	Establishment of an effective system for monitoring underground installations	District heating network
24	Organisation of an ash collection and treatment / recovery process	Solid biomass
25	Promotion of quality biomass with low emissions of fine particles (possibly of Walloon origin)	Solid biomass
	Measures requiring further analysis	
26	Planning of the phase-out of fuel oil and natural gas	Global RES
27	Analysis of the benefits of developing solar thermal installations that supply district heating networks	District heating network
28	Setting up of a recovery policy for Solid Recovered Fuels (SRF)	Global RES

The proposed measures do not compromise the plans already approved by the Government. Where it is possible to implement those plans and also take the measures proposed below into account, the measures will be included (for example, via a circular, for projects that have not yet been finalised, etc.).

XI.3.2. *Measures in progress*

The measures presented in this chapter have already been launched. In some cases they have been transposed into legislation while other measures are still under discussion. However, they all need to be followed up and approved by the Walloon Government before they can be finalised.

Measures in progress	
Measure sheet # 1	**Issue implementing decrees on the organisation of the thermal market and on thermal energy networks**
Type of measure	Legal (short-term)
Objective	In general, to transpose European obligations relating to metering and information on billing and pricing. More specifically, to deal with thermal energy networks subject to certain obligations when energy is sold to one or more consumers.
Potential participants	SPW TLPE – WG
Technology(ies) concerned	District heating network
Findings Chap. 10	The profitability of a district heating network is subject to many risks, in particular with regard to the resale of thermal energy. There is a need for a clear legal framework.
Proposed actions	• Establish a legal framework for district heating networks • Transpose the provisions of the Directives of the Clean Energy for All Europeans package to comply with standards in terms of metering, customer information, the right to disconnect and the guaranteeing of this right and with regard to thermal energy networks with sale.
Strategy link	PWEC 2030 (district heating networks are a relevant option for recovering renewable heat) PACE 2016-2022 (support measure for green heating, in particular through district heating networks)

Measures in progress	
Measure sheet # 2	**Allow the establishment of renewable energy communities (heat and electricity)**
Type of measure	Legal (medium-term)
Objective	To encourage collective self-consumption of electricity and heating
Potential participants	SPW TLPE – CWAPE – WG – WP
Technology(-ies) concerned	Cogeneration, district heating networks
Findings **Chap. 10**	The development of a 'heating' energy community has real potential to deliver a local and societal economy project, for example by also integrating fuel production. Sensitivity analyses have demonstrated the value of recovering RES electricity at a fair price for the development of cogeneration systems linked to a district heating network. The calculation of the rate at which green certificates are granted takes into account a significant portion of self-consumed electricity, which is valued at a higher price than that of resale on the market. A high self-consumption rate is only rarely achieved in a district heating network because the production of heat is shared between consumers, but the current electricity framework does not allow it. This obstacle will be partially lifted with the establishment of energy communities. Many district heating networks do not include cogeneration because this investment is economically unviable due to the low cost of buying back electricity injected into the network. The other possibilities for recovering electricity (supply licence or resale to an aggregator) are too complex to implement for medium-sized projects. The forthcoming implementation of 'electricity' energy communities will resolve this issue under certain specific conditions (fossil cogeneration excluded, cogeneration must be owned by the EC, only new installations). Other means of recovering this electricity must thus be considered.
Proposed actions	• Public contract in progress relating to technical and legal support to promote the development of different forms of energy sharing in Wallonia • Implement regulatory provisions governing the sale of thermal energy to one or more consumers • Transpose Article 22 of the RED II Directive under which Member States must ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community while maintaining their rights or obligations as final customers, and without being subject to unjustified or discriminatory conditions or procedures (…). • Incorporate the specific case of renewable district heating networks into current discussions on the implementation of energy communities and on the implementation of the 'peer-to-peer' mechanism (REDII Article 2(18)).
Strategy link	Link with the PWEC 2030 ('Framework for the deployment of decentralised sources aiming at maximising collective well-being, in particular via collective self-consumption schemes') and the PACE 2016-2022 ('Creation of favourable conditions for the development of renewable energy communities')

Measures in progress	
Measure sheet # 3	**Taking district heating networks into account in the calculation of the EPB**
Type of measure	Communication (short-term)
Objective	To make district heating networks attractive to property developers
Potential participants	SPW TLPE
Technology(ies) concerned	District heating network, cogeneration
Findings Chap. 10	As regards new subdivisions of single-family houses, many new dwellings are equipped by default with a heat pump. However, analysis has shown that this type of equipment is not the most profitable in the long term, neither economically nor environmentally. Historically, for the calculation of their EPB (energy performance), buildings connected to a district heating network were negatively impacted by an energy factor by default. The implementation of a district heating network for new homes, which must comply with the EPB requirement, was therefore almost impossible. A new tool allows the performance of district heating networks to be more objectively considered.
Proposed actions	• Communicate on the existence of the EPB tool for district heating networks • Establish a link between the district heating network EPB declarations and the reporting to the Administration provided for in the 'Decree/WGD on Thermal Energy' currently being validated
Strategy link	Link with measure 14 of Chapter 8 ('Continue to strengthen (EU) energy standards in compliance with European directives') and measure 17 ('Implement the building passport') based on PACE 2016-2022, the PWEC 2030, AEER and SWR

Measures in progress	
Measure sheet # 4	**Subsoil decree**
Type of measure	Legal (short-term)
Objective	Global regulations for the exploration and exploitation of Walloon subsoil resources
Potential participants	SPW TLPE – SPW ARNE – WG – WP
Technology(ies) concerned	Geothermal energy
Action	The purpose of the project is to establish a clear and precise framework of activities and installations aimed at exploring and exploiting the resources of Walloon subsoil. The objective of this project is to determine a clear legal framework for geothermal energy intended to attract investors who are reluctant to enter the market because of the current legal vacuum. The SPW TLPE is therefore in favour of their integration into the draft subsoil decree to avoid any redundancy and ensure complementarity and legal certainty. It was also logical to consider the provisions on geothermal energy as part of environmental law given that exploitation cannot be carried out without the required environmental permit and in view of the possible effects of this activity, particularly at the time of drilling, on groundwater bodies. In addition, the interaction between the exploitation of geothermal energy and the other possible uses of subsoil had to be addressed in a coherent framework. The options proposed by the subsoil resource codification project ensured that a common core could be established for 'strategic' resources, making it possible to grant to the explorer and/or operator candidate the exclusivity needed to secure investments, thereby promoting private sector initiatives, which are essential in this area. This is all the more important as it will improve the public authorities' knowledge of the Walloon subsoil and its potential, including with respect to energy.
Strategy link	PWEC 2030, PNEC 2030 and PACE 2016-2022 (the geothermal component is addressed in these strategies by removing the obstacles to its development through a clear legal framework)

XI.3.3. *Priority measures*

Priority measures	
Measure sheet # 5	**Stop all subsidisation of fossil fuels in connection with Wallonia's objectives**
Type of measure	Economic
Objective	To eliminate aid that promotes the competitiveness of fossil fuels
Potential participants	SPW TLPE - CWaPE - SPW-Économie - WG - WP - Federal level (non-regionalised powers, e.g. taxation)
Technology(ies) concerned	All RES technology
Findings Chap. 10	• Fossil energy 'heating' projects generally benefit from a more advantageous payback time in the short term. They do not need any financial support. • Support for the production of electricity from fossil fuels (natural gas) via Green Certificates is marginal on the VAACN. • The Walloon Region is aiming for its public housing stock to reach a carbon-free 'A-rated' energy performance by 2040; the remaining residential buildings are expected to achieve this by 2050, while for the service sector, the ambition is to strive for buildings with a zero annual energy and carbon balance for heating, domestic hot water, cooling and lighting by 2040.
Proposed actions	• Creation of a registry to identify all fossil fuel subsidies • In connection with the discussions and phase-out of the use of fossil fuels, modify the WGDs concerned by eliminating this aid to fossil fuels by 2025 at the latest, provided that there are sustainable alternatives, or by transforming it into aid for renewable energy • Eliminate the aid already identified where there are alternatives • Given the long lifespan of some of the subsidised projects and the WG's desire to achieve 100% renewable energy by 2050, encourage all projects that have not yet been finalised to opt for a carbon-free energy source.
Strategy link	PACE 2016-2022 PWEC 2030 (Link with measure 4 of Chapter 8: 'Encourage the population to switch to less polluting fuel')

Priority measures	
Measure sheet # 6	**Support the recovery of RES and waste heat**
Type of measure	Economic
Objective	To increase the share of heat recovered from renewable and/or waste sources
Potential participants	SPW TLPE - CWaPE - Walloon Union of Enterprises - WG
Technology(ies) concerned	All RES heat production technologies
Findings Chap. 10	Support for electricity production without specific support for heating distorts the short-term competitiveness of RES technologies, in particular the recovery of waste energy. However, industries do not invest in technologies with a payback period of more than 3 years and therefore lack any incentive to use their waste heat beyond their own needs.
Proposed actions	• Evaluate the appropriateness of extending the discussions on Sector Agreements beyond 2023 to include the issue of heating, including for the service sector. • Continue and extend the establishment of a registry of renewable heat production in Wallonia • Set up a registry of waste heat in Wallonia: technical potential, connection with heating and cooling needs that can be substituted nearby • Develop a certification system for the renewable or sustainable nature of heat production installations (via Guarantees of Origin - 'Heating' WGD in the process of being approved) • Develop support mechanisms for the recovery of RES or waste heat to make it at least as profitable as heat produced directly by fossil fuels: aid for setting up installations, financial support for heat energy recovered and used (via LGOs). • Develop subsidy mechanisms adapted to the payback time of the technology investment and reduce the risk for private investors • Develop communication activities around the subject of renewable heating aimed at industry, project owners and the general public, possibly with the designation of a SPOC at the administration level • Ensure the sustainability of funding for RES support by setting up independent funding for electricity consumption. No longer allow installations to be dimensioned without considering heat recovery. • Condition the allocation of subsidies on technical, ecological and performance factors over the long term.
Strategy link	PACE 2016-2022 PWEC 2030 (Support for green heating, in particular through district heating networks)

XI.3.4. *Measures with significant impacts*

Measures with significant impacts	
Measure sheet # 7	**Set up an online platform, by sector of activity (residential, service, industry), to facilitate procedures necessary to realise a project**
Type of measure	Administrative simplification
Objective	Centralisation of information and procedures
Potential participants	SPW TLPE – EWBS – Renowatt
Technology(ies) concerned	All RES technologies
Findings Chap. 10	• RES projects are subject to a series of administrative obligations during their implementation and lifetime, unlike 'fossil' projects. • These obligations are managed by different departments and entities, which creates additional complexity • A framework is necessary for RES sectors but the impact must be limited as much as possible on the development of projects (cost, complexity and duration of the procedures)
Proposed actions	After considering the procedures, set up an online platform containing: • A single, consolidated source of information on procedures for project owners • A single tool for monitoring the administrative procedures of the various services (SPW TLPE, Cross-functional Biomass Committee (CTB), Permits and Authorisation Department (SPW-ARNE, SPW-Économie, etc.) • A single tool to process study-type and investment-type grant applications based on a 'virtuous' workflow: Audit -> Study -> Investment -> operating support. (Functional tools are already available on the market and would allow rapid deployment) • A single tool for collecting information on the operation of RES equipment (encoding Green Certificates, monitoring of emissions, energy consumption and performance [assessment, Thermal Energy Decree, etc.], monitoring of sustainability [REDII Directive], etc.) Strengthen synergies between existing tools and services within the Walloon Region (AMURE, UDE, UREBA, Infrasport, Sowalfin, SRIW, Renowatt, etc.). Work on communication and mutual recognition of the services offered.
Strategy link	PWEC 2030 and PACE 2016-2022 (Remove administrative and regulatory barriers to promote renewable energy)

Measures with significant impacts	
Measure sheet # 8	**Develop AMURE and UREBA aid**
Type of measure	Economic
Objective	To support the development of RES in Wallonia, in particular improving the quality of projects studied within the framework of AMURE and UREBA aid to better target projects to be subsidised for investment.
Potential participants	SPW TLPE - SPW EER (Department of Investment Programs (DPI)) - WG
Technology(ies) concerned	District heating network, cogeneration
Findings Chap. 10	Problems highlighted by the analysis
Proposed actions	• With some exceptions (for example for certain types or sizes of investments), require that a (pre-)feasibility study be carried out by an auditor approved by Wallonia for any investment aid relating to thermal energy production systems. This study should highlight the relevance of the project in achieving Wallonia's environmental objectives. • Impose the unified audit methodology proposed by the Walloon Region on its website for carrying out studies and audits (currently proposed but not imposed) in order to make the analyses comparable. • Extend the possibility of subsidising feasibility studies beyond companies with sector agreements, in particular so that SMEs can benefit from them • Support the creation of specifications and site monitoring by independent consultancy offices for certain particularly complex RES projects (Cogeneration, Biomass, Geothermal Energy, district heating network) • Stop subsidising studies for sectors relating to fossil fuels (e.g. replacement of boilers, gas cogeneration). • Impose and subsidise the implementation of annual performance audits for RES production equipment, with reporting to the Administration (for example reporting under the 'Thermal energy' Decree). For projects with operating subsidies, link this subsidy to carrying out the audit and maintaining performance (tolerance ranges to be agreed). • Stop all fossil fuel subsidies by 2025 at the latest, provided that there are sustainable alternatives or transform them into support for renewable energies • Analyse the subsidisation rules for investments between UDE Energie and UREBA aid, and ensure the consistency of the mechanisms. • Strengthen synergies between existing tools and services within the Walloon Region (AMURE, UDE, UREBA, Infrasport, Sowalfin, SRIW, Renowatt, etc.). Work on communication and mutual recognition of the services offered.
Strategy link	PACE 2016-2022 AEER SWR (Link with measures 27, 28 and 29 of Chapter 8: 'Optimising the system of aid for energy studies for SMEs/VSEs, local authorities and the non-profit sector'; 'Launch a new programme for the renovation of exceptional UREBA public buildings' and

	‘Create a financing mechanism to promote the energy efficiency of buildings in the public sector and the non-profit sector (interest-free loan)’

Measures with significant impacts	
Measure sheet # 9	**Maintain and adapt investment aid (UDE)**
Type of measure	Economic
Objective	To promote energy investments
Potential participants	SPW TLPE - SPW-Economie - Investment Programs Department (DPI) - WG
Technology(ies) concerned	All
Findings Chap. 10	As long as fossil fuel prices are low, RESs will remain heavily dependent on investment support. District heating networks are eligible for UDE investment aid, but only SME-type project owners are eligible. A large company that has waste heat therefore does not benefit from any support for recovering this heat. There is no support for connecting residential buildings to a district heating network. However, diversity of consumption profiles is what makes this type of project profitable. The contribution rates are fixed and no longer correspond to the reality of the market.
Proposed actions	• Review the lump sum amounts of eligible additional costs and incorporate a specific category for RES district heating networks. • Provide a mechanism for rapidly reviewing lump sums in order to follow market trends. • Condition the subsidy on the profitability of the technology (rule out unprofitable projects even over the lifetime of a machine) • Provide the necessary resources for on-site monitoring of subsidised projects, 2 or 3 years after their start-up. Make use of performance audits, carried out via AMURE or UREBA auditors, for example, to guarantee the sustainability of the funds invested by Wallonia • Establish high ceilings for subsidisation by technology to avoid over-financing non-mature technologies, which may benefit from other research aid. • Provide a subsidy for connection to any efficient district heating network (possibly conditional on the energy vector being RES and deemed relevant for the municipality in question). This allowance was previously in place (http://forms6.wallonie.be/DGO4_Energie_v17.07.01/formulaire31.pdf) The allowance is requested by the district heating network manager responsible for connecting the new consumer. • Study the possibility of opening the UDE allowance system to real estate companies for H-RES projects with a district heating network and to large companies for waste heat recovery.
Strategy link	PWEC 2030 PACE 2016-2022 (Link with measure 1 of Chapter 8: ‘Maintain investment allowances for installations that use renewable energies’)

<table>
<tr><th colspan="2">Measures with significant impacts</th></tr>
<tr><td>Measure sheet # 10</td><td>Encourage good maintenance of RES production facilities</td></tr>
<tr><td>Type of measure</td><td>Economic</td></tr>
<tr><td>Objective</td><td>To provide financial support for the development of efficient installations</td></tr>
<tr><td>Potential participants</td><td>SPW TLPE – CWaPE – WG</td></tr>
<tr><td>Technology(ies) concerned</td><td>District heating network, cogeneration</td></tr>
<tr><td>Findings
Chap. 10</td><td>RES installations are economically and environmentally more efficient when the entire service life of the installations is taken into account. Achieving savings objectives thus depends on maintaining high performance production tools.

There is currently no framework, no aggregation and no support for quality maintenance of RES installations subsidised by Wallonia.</td></tr>
<tr><td>Proposed actions</td><td>Support/mandate the implementation of a performance audit of COGEN, RES and DHN installations to ensure long-term performance and the organisation of reporting to Wallonia. Conducting this audit would make it possible to define the amount of aid (for investment and/or operation) or even to spread it out and reduce the risk of a financial bubble.
Organise financial support based on the performance of the installations receiving support: need to establish precise criteria that can be verified by field staff. Field staff can be the energy auditors already recognised by Wallonia for the AMURE and UREBA schemes.</td></tr>
<tr><td>Strategy link</td><td>PWEC 2030
PACE 2016-2022
(These strategies focus on improving the energy performance of installations)</td></tr>
<tr><td>Indicators</td><td>Average efficiency observed by certification bodies during installation performance audits</td></tr>
</table>

Measures with significant impacts	
Measure sheet # 11	**Provide a financing mechanism adapted to a long lifespan for district heating/cogeneration equipment**
Type of measure	Economic
Objective	To facilitate the financing of DHNs and Cogen RESs
Potential participants	SRIW – BEI – SPW TLPE – WG
Technology(ies) concerned	District heating network, cogeneration
Findings Chap. 10	RES district heating networks are always more attractive in the long term, financially and environmentally, but in the short term their competitiveness is weak due to the high CAPEX required and the risks associated with supplying heating. A mechanism is thus essential to smooth out CAPEX investments over the long life of the equipment and to reduce the risks associated with the disappearance of any participants in the district heating networks.
Proposed actions	• Facilitate the third-party investor system within the framework of RES district heating/cogeneration projects • Set up financing systems over periods adapted to the lifespan of district heating networks • Establish conditions for accessing financing set by Wallonia involving management of the development of the Walloon infrastructure network specific to heating • Consider setting up a network social support system: Inter-district heating network solidarity factor (the most profitable finance the least profitable) • Consider the financing of district heating networks (transmission infrastructure) by local authorities, as for gas and electricity.
Strategy link	PWEC 2030 PACE 2016-2022 (In order to allow district heating networks to be economically competitive with respect to traditional technologies, a financing mechanism must be set up)

Measures with significant impacts	
Measure sheet # 12	**Review the depreciation period of DHNs for accounting purposes**
Type of measure	Legal
Objective	To match the financial profitability of DHNs from an accounting point of view with reality
Potential participants	SPW TLPE - Federal (Finance FPS) - institute of auditors - WG
Technology(ies) concerned	District heating network
Findings Chap. 10	Given that district heating networks have a minimum lifespan of 50 years, project assessments covering a period of 30 years are disadvantageous when considering the financial burden of district heating networks.
Proposed actions	• Organise a consultation with the federal authorities and the institute of auditors to make them aware of the depreciation period of DHNs which should be taken into account (50 years) • Take into account the IAS 16 standard indicating that accounting depreciation depends on the effective life of the asset (it should be 50 years as for gas networks). • Indicate in the decree or 'Thermal energy' WGD the lifespan of the DHNs to be taken into account for depreciation (in the same way as the gas & electricity methodologies include the lifespan of the various fixed assets)
Strategy link	PWEC 2030 PACE 2016-2022 (With a view to supporting green heating, district heating networks must be able to become competitive with respect to traditional technologies)

Measures with significant impacts	
Measure sheet # 13	**Incorporate local or neighbourhood study requirements for DHNs and renewable energy in the context of major construction projects**
Type of measure	Legal
Objective	To take advantage of major construction projects to pool the costs linked to the opening of roads. To do this, it is necessary to have previously studied the potential of district heating networks at municipal or district level
Potential participants	SPW TLPE and Municipalities (POLLEC) - WG
Technology(ies) concerned	District heating network
Findings Chap. 10	Wallonia has numerous areas that are suitable for the installation of a district heating network but which are not exploited.
Proposed actions	• Incorporate a study carried out independently on district heating networks and renewable energy sources during the construction or renovation of thermal energy production systems in public buildings, thermal energy production systems in buildings with a high and constant consumption or during the construction of new subdivisions; • Incorporate a study carried out independently on district heating networks and renewable energy sources during road works or extension of the gas network, including when passing in front of service-sector buildings or industries; • Incorporate a study carried out independently on district heating networks and renewable energy sources as part of the 2025-2030 public housing renovation plans, the future envelope available for building public housing and neighbourhood renovation projects. • As far as possible, on the basis of the renovation plans submitted by the SLSPs, also consider the creation of district heating networks as part of ongoing renovations to public housing under the 2020-2024 plan; • Consider an expansion of co-financing for carrying out (pre-)feasibility studies at SLSPs. Depending on the situation, these studies listed above will be supported by the owner of the renovation or construction project. • While municipalities are drawing up their various plans relating to energy and decarbonisation, evaluate the suitability of an efficient district heating network in those municipalities by directly involving the municipal urban planning services.
Strategy link	PWEC 2030 PACE 2016-2022 (With a view to supporting green heating, this technological solution must be studied when possible)

Measures with significant impacts	
Measure sheet # 14	**Creation of a guarantee fund for the decontamination of excavated soil**
Type of measure	Communication and funding
Objective	To avoid passing the cost of any soil pollution on to the owners of district heating network projects.
Potential participants	SPW TLPE – SPW ARNE – WG
Technology(ies) concerned	District heating network
Findings Chapter 10	The Soil Decree (1/03/2018) currently provides for a soil analysis in all district heating network projects that require soil excavation. In the event of pollution from an unknown source, it is up to the project owner to assume the decontamination costs. A significant fixed additional cost has therefore been charged to all scenarios comprising a district heating network. Note that in some regions, this additional cost can represent up to 30% of the cost of the district heating network.
Proposed actions	• Identify Wallonia's tools for analysing the level of soil pollution at the level of district heating networks, draw up practical information sheets on using those tools, and communicate on them. • Study the possibility of setting up a guarantee fund for the decontamination of excavated soil via the Interregional Soil Remediation Commission • Analyse stakeholder interest in this type of fund and possible public-private partnerships for setting it up • Carry out an economic study identifying the costs incurred by the project due to the risk of soil pollution, including the costs related to the management and traceability of excavated soil: type of treatment according to the type of pollution, consequences for the financial status of projects in order to ensure a certain proportionality
Strategy link	N/A

Measures with significant impacts	
Measure sheet # 15	**Development of a geographic information system (GIS) identifying heating needs, district heating networks and technical installations**
Type of measure	Communication
Objective	To improve the recording, particularly location recording, of technical installations related to heating and its transmission
Potential participants	SPW TLPE – SPW ARNE – SPW SG (geomatics department)
Technology(ies) concerned	All
Findings Chap. 10	The promotion of RES technology via incentives requires good visibility of the market, its liabilities and its development. The collection of information for this report was a very complex process.
Proposed actions	Creation of a database, including the recording of geographical locations, with input from • Energy audits • Sector statistics from the SPW TLPE (Gas & Electricity Markets Department) • Environmental permit data for installations related to heating and its distribution • Existing registries • Studies carried out by or for the public service • Subsidised studies carried out by approved auditors in Wallonia
Strategy link	PWEC 2030 PACE 2016-2022 (In order to allow district heating networks to be set up and therefore to maximise the use of green heating, it would seem logical to develop a mapping system)

Measures with significant impacts	
Measure sheet # 16	**Extension of the duties of the industry facilitator by including a waste heat recovery component**
Type of measure	Technical
Objective	To improve communication and the development of waste heat recovery. Field support from the industry facilitator would make it possible to respond to or raise the variety of issues specifically affecting companies and thus facilitate this intra- and inter-company optimisation.
Potential participants	SPW TLPE - Industry / Business Facilitators - WG
Technology(ies) concerned	District heating network
Findings Chap. 10	The potential for waste heat recovery is significant and lucrative. However, it has not been exploited to date, in particular because achieving profitability takes longer than 3 years.
Proposed actions	• Develop technical publications for the recovery and use of waste heat • Identify exploitable incentives to promote waste heat • Appoint a competent point of contact to answer questions from industrial operators, in particular on the subject of waste heat recovery • Propose technical options for estimating recoverable waste heat and carrying out the recovery
Strategy link	PWEC 2030 PACE 2016-2022 (The objective is to be able to set up support mechanisms for the use of waste heat)

Measures with significant impacts	
Measure sheet # 17	**Creation of a guarantee fund against the industrial risk associated with waste heat recovery projects**
Type of measure	Financial incentive
Objective	To reduce the risks relating to waste heat recovery projects
Potential participants	SPW TLPE – WG – WP
Technology(ies) concerned	Waste heat recovery installations
Findings Chap. 10	Waste heat recovery projects have great potential because they allow industrial energy to be harnessed at a cost much lower than fossil fuels. The exploitation of this resource, in suitable areas, makes it possible to cover almost all of the area's heating needs. However, the depreciation period of such a recovery project is incompatible with the financial and time constraints of an industry. This incompatibility generates an industrial risk which has held back the development of such projects.
Proposed actions	• Examine setting up a guarantee fund or other mechanism to reduce the industrial risk associated with the recovery of waste heat. • Analyse stakeholder interest in this type of fund and possible public-private partnerships for setting it up • Define measures to cover the risks of losing key economic stakeholders associated with district heating networks (producer, consumer).
Strategy link	PWEC 2030 PACE 2016-2022 PM4 (In connection with measure 42 ‘Support self-production of energy’ through its objective ‘Analyse and adapt regulations relating to self-production of energy and the expansion of Renewable Energy (RE) for the industrial sector (including finalising the reforms already underway). ‘)

Measures with significant impacts	
Measure sheet # 18	**Promotion of the development of installations supplying district heating (deep geothermal energy, mining geothermal energy and shallow open system geothermal energy)**
Type of measure	Financial
Objective	To develop district heating networks supplied by geothermal resources
Potential participants	SPW TLPE - SRIW - BEI - SPW ARNE (Geological Survey of Wallonia) - WG
Technology(ies) concerned	Open system deep geothermal, mining geothermal and shallow geothermal installations
Findings Chap. 10	Geothermal projects (deep, mining and shallow) have great local and long-term potential for exploiting energy contained in the subsoil at a cost much lower than fossil fuels. The use of this resource, in suitable areas, makes it possible to cover almost all of the area's heating needs.
Proposed actions	• Develop knowledge of geothermal resources (heat from geothermal fluid) in the Walloon subsoil, which are still very poorly understood, and define areas for the exploitation of geothermal resources • Set up pilot projects in Wallonia (mainly mining geothermal energy in three coalfields, i.e. Mons, Charleroi and Liège) and shallow geothermal energy with open systems. • Develop subsidy mechanisms adapted to the payback time of the technology investment and reduce the risk for private investors
Strategy link	PWEC 2030 (district heating networks are a relevant option for recovering renewable heat) PACE 2016-2022 (support measure for green heating, in particular through district heating networks)

Measures with significant impacts	
Measure sheet # 19	**Modification of the permit system for open systems in shallow geothermal energy and biomass gasification**
Type of measure	Legal
Objective	To facilitate the development of: - Shallow geothermal energy, for open systems; - The biomass gasification sector.
Potential participants	SPW TLPE – SPW ARNE – AWAC – DPA
Technology(ies) concerned	Open system shallow geothermal installations Biomass gasification cogeneration plants
Findings Chap. 10	Very little of the potential of shallow geothermal energy and biomass gasification is being exploited in Wallonia. Geothermal energy: this is restricted by the class 1 permits issued for carrying out injection tests (section 41.00.04), which require an impact study. The procedure is too long, too expensive and complicated for projects and above all undermines their profitability. Biomass gasification: this is restricted by the default application of section 40.20.01.02 for environmental permits, applicable to any gas, fossil fuel or renewable producer, with or without storage. This section imposes a class 1 permit for an equivalent of 50 kWe, which destroys the profitability of the project due to the high cost of the environmental study and the additional procedures required for this type of permit.
Proposed actions	Overall, set up a technical committee between the SPW TLPE and ARNE and AWAC administrations to assess the various changes to be made to the legislation in force. As part of the general revision of environmental permit sections, pay particular attention to the obligations that apply to open system shallow geothermal projects and biomass gasification, in order to limit the obligations to what is appropriate for such projects. Regarding biomass gasification in particular, create specific permit sections, as for biomethanisation, so that gasification does not fall by default into an unsuitable section in terms of technological risk. Regarding open system shallow geothermal energy, • Identify favourable areas for the development of open system shallow geothermal energy, in order to specify the real potential of these projects to the DPA; • It would be advisable to have a single licensing process that would make the issuance of an operating licence conditional on the production of a comprehensive and high quality hydrogeological study to determine the impacts of the system and its long-term sustainability.
Strategy link	N/A

Measures with significant impacts	
Measure sheet # 20	**Measures to reduce the geological risk associated with deep geothermal projects**
Type of measure	Financial - Guarantee fund to mitigate geological risk (determination of underground geothermal resources)
Objective	The geological risk with regard to determining geothermal resources is a significant risk which is partly out of the hands of project owners. Given the high investment costs at the start of a project, the risk of not accessing the expected geothermal resource and the lack of an insurance policy covering this 'natural' risk, one of the options being studied is to set up a guarantee fund system, or join an already existing guarantee system, in order to create an investment climate that favours the production of renewable heat from deep geothermal energy.
Potential participants	SPW TLPE – WG – WP
Technology(ies) concerned	Deep geothermal installations
Findings Chap. 10	The CAPEX needed to build a deep geothermal installation depends to a large extent on the risk taken by the project owner for the initial drilling. The expected geothermal resource depends on the flow rate and the temperature resulting from the borehole. The risk is therefore linked to these two parameters and their impact on the project to exploit the resource. The risk is certainly high during the initial development phases of a project, but it gradually reduces after completion of the first exploratory drilling. It is this initial drilling that will confirm whether or not there is a geothermal resource at the targeted location, and hence the success of a deep geothermal project.
Proposed actions	• Work on gaining a better understanding of the thermal resources (heat from geothermal fluid) of Walloon subsoil via geophysical surveys, feasibility studies and exploratory prospecting. • Study different options to guarantee the financial risk associated with initial drilling, including the implementation of a Walloon guarantee. • Analyse stakeholder interest in this type of fund and possible public-private partnerships for setting it up
Strategy link	PWEC 2030 PACE 2016-2022 (A regional guarantee fund will be set up for technologies with a high risk but attractive return [e.g. geothermal energy])

XI.3.5. *Measures with moderate impacts*

Measures with moderate impacts	
Measure # 21	**Professionalisation of the 'Cogeneration', 'District heating network', 'Geothermal energy' and 'Biomass' sectors**
Type of measure	Technical
Objective	To energise the market by improving and recognising the technical skills of participants in the sector
Potential participants	SPW TLPE - WG - Walloon training centres
Technology(ies) concerned	All
Findings Chap. 10	The profitability of RES technologies is very sensitive to the correct sizing of installations. Massive deployment of these technologies requires a large number of serious, well-trained participants on the market, which is not the case today.
Action	• Recognise or organise training/information sessions for project owners • Through AMURE and UREBA authorisations, recognise the skills of experts trained in the areas of cogen/district heating/geothermal/biomass • In collaboration with training operators, in particular skills centres, work to set up cross-border partnerships for the organisation or recognition of specialised training • Produce handbooks or course materials for installers (more sustainable than training) • Raise awareness of the importance of maintenance, follow-up and monitoring • Focus these tools on technical and financial aspects, including formalisation of the profitability calculation methodology to allow the comparison of projects and avoid 'commercial' studies. • Set up a certification/labelling system for RES operators
Strategy link	AEER SWR PACE 2016-2022 (Link with measures 18 'Promote the sustainable buildings handbook' and 41 'Raise awareness, train and certify professionals')

Measures with moderate impacts	
Measure sheet # 22	**Integration of a facilitator/expertise system directly into the administration - with field staff**
Type of measure	Technical
Objective	Centralisation of know-how
Potential participants	SPW TLPE - Wallonia energy portals - Renowatt
Technology(ies) concerned	All
Findings Chap. 10	Projects related to heat recovery, RES heat production and the installation of district heating networks are complex from a technical and financial point of view. Significant funds are required to deploy these technologies and the funds available are limited. Wallonia therefore requires a neutral and effective arbitration tool to advise project owners as best as possible and to prioritise any injection of public funds.
Proposed actions	• Set up a facilitator system within the administration, including centralisation of requests and distribution to the experts concerned (who may be external); • Set up different response lines depending on the complexity of the request; These two stakeholders would have the task of answering any questions asked and providing information, as well as offering the possibility of sending professionals to carry out field visits.
Strategy link	PWEC 2030 PACE 2016-2022 SWR (Provision of facilitator services)

Measures with moderate impacts	
Measure sheet # 23	**Establishment of an effective system for monitoring underground installations**
Type of measure	Technical and communication
Objective	To allow the plans of underground installations to be made available by all stakeholders concerned within a reasonable time frame
Potential participants	SPW TLPE – asbl Powalco – asbl KLIM-CICC – WG
Technology(ies) concerned	District heating networks
Findings	To set up a district heating network, road works are necessary. A precise plan of the location of underground installations would therefore help to set up any such networks and reduce the CAPEX. • **The Powalco platform is not up to date (for the oldest underground installations)** However, according to the decree on underground installations, the stakeholders referred to in Article 8 are required to register with the platform (managers of roads, pipes, cables). In addition, they must respond within 15 days to requests, but only in the event of possible coordination. • **Insufficient geographical scope of files** It should be possible to obtain data covering more than one area only. For example for an entire city. As an area could potentially be selected, it should be possible to obtain data for an entire city. • Project owners are not sufficiently aware of this tool and therefore fewer underground installations are likely to use it
Action	• Organise the exchange of feedback between project owners and the Powalco platform • Incorporate district heating network infrastructure into the Powalco platform • Check if the mapped areas are large enough to select all relevant underground installations throughout an entire district heating network (1 - 10 km) • Define reasonable deadlines for declaring additional underground installations
Strategy link	PWEC 2030 PACE 2016-2022 (Link with support for green heating conveyed by a district heating network; the location of underground installations must be known before this type of solution can be envisaged)

Measures with moderate impacts	
Measure sheet # 24	**Organisation of an ash collection and treatment / recovery process**
Type of measure	Legal and economic
Objective	To increase the economic and environmental attractiveness of recycling ash as bio-based material To allow ash to be returned to the forest
Potential participants	SPW TLPE – SPW ARNE - Valbiom – Febhel – DNF – FRW – CRAW – WG
Technology(ies) concerned	Technologies using biomass as an energy vector
Findings **Chap. 10**	Ash from the combustion of biomass, whether or not the latter is polluted, is currently considered waste intended exclusively for technical landfill. This can represent a significant cost in the OPEX of projects, with the risk of improper and uncontrolled disposal in agricultural or forest areas.

Proposed actions	• Study the possibility of setting up a recovery system based on the recovery system for sewage sludge (exogenous materials) in line with the fertiliser regulation and with legislation on by-products that are no longer considered waste. To do this:
	  ○ Estimate the potential of the ash recovery resource (gross, net, plausible) in Wallonia (production, content, quality), establish its location and set up a register of installations that generate ash;
	  ○ Clarify the classification of ash produced from different categories of wood waste (WGD of 28 February 2019 implementing Article 4a of the Decree of 27 June 1996 on waste as regards the recognition of by-products;
	  ○ Study the potential uses and applications for this resource and highlight the opportunities to be exploited and the obstacles (economic, environmental, legal) to be eliminated;
	  ○ Estimate the energy-related and environmental repercussions in Wallonia.
	• Adopt the implementing decree of the forestry code to allow the return of unpolluted ash to the forest
	• Facilitate access to qualitative laboratory analyses of ash with a view to its recovery
	• Facilitate the procedures for returning clean ash to the soil, create synergies between stakeholders (exchange platform, link with existing cartography of the trophic state of soils (http://geoportail.wallonie.be/ - https://www.fichierecologique.be/#!/, etc.)
	• Communicate on the environmental benefits of returning unpolluted ash to agriculture, horticulture or forests

Strategy link	Implementation of a biomass strategy (CTB)

Measures with moderate impacts	
Measure sheet # 25	**Promotion of quality biomass with low emissions of fine particles (possibly of Walloon origin)**
Type of measure	Economic
Objective	To facilitate the development of local biomass production while guaranteeing its quality
Potential participants	SPW TLPE – Walloon Economic Office for Wood - Febhel - EDORA – TWEED – FRW – AWAC - ISSeP – WG
Technology(ies) concerned	Solid biomass installations
Findings **Chap. 10**	The combustion of biomass is often criticised due to its flue gas emissions. This barrier to the roll-out of the technology is not always properly understood, especially in service-sector and industrial installations. However, by using quality biomass, it is possible to better control the parameters of flue gases, including fine particles. Standard (ISO - 17225) and certification tools exist (DIN +, ENplus, Goodchips, etc.). The wood chip industry is subject to strong pressure from market prices to the detriment of quality. This is mainly due to a lack of understanding among consumers, first and foremost public authorities. Good quality fuel is available on the market, but is going largely unnoticed.
Proposed actions	• Provide project owners (public and private) with tools and training to understand, assess and monitor the quality of the biomass purchased. • Work on the role model function of public authorities by supervising public supply contracts: o Price cannot be the only award criterion o Impose deliveries by unit of energy (kWh) instead of volume (stacked cubic meter) o Carry out local qualitative monitoring of projects • Work in collaboration with the Health FPS on the Royal Decrees on ‘pellets’ (RD of 5/04/2011 - C-2011/24112) and ‘heating’ (RD of 24/11/2010 - C-2010/24412) • Set up an incentive mechanism for the certification of producers • Set up an incentive mechanism for the use of certified biomass by consumers
Strategy link	PWEC 2030 PACE 2016-2022 (Link with measure 8 of Chapter 8 ‘Better characterise and reduce particulate emissions from heaters supplied with solid fuels and improve their energy efficiency’)

XI.3.6. *Measures requiring further analysis*

Measures requiring further analysis	
Measure sheet # 26	**Planning of the phase-out of fuel oil and natural gas**
Type of measure	Legal
Objective	Planning of the phase-out of fuel oil and natural gas
Potential participants	SPW TLPE - CWAPE - Distribution network managers - WG
Technology(ies) concerned	All
Proposed actions	• Benchmark the strategies used in other countries/regions (including Flanders) to phase out fossil fuels • Determine the preferred method for phasing out fossil fuels (stopping sales of installations, stopping connections, stopping sales of the vector) • Differentiate by sector • Determine a phasing out time line • Objectively analyse from an energy point of view, for areas not currently supplied with gas, the benefits of creating a district heating network • Identify the potential of reusing the existing gas network for renewable gases (biomethane, hydrogen, etc.)
Strategy link	PWEC 2030 PACE 2016-2022 (Link with measure 4 of Chapter 8 ‘Encourage people to switch to less polluting fuel’)

Measures requiring further analysis	
Measure sheet #27	**Analysis of the benefits of developing solar thermal installations that supply district heating networks**
Type of measure	Subsidisation - Mechanism
Objective	To develop district heating networks and a supply sourced from solar thermal installations
Potential participants	SPW TLPE – SRIW – BEI – WG
Technology(ies) concerned	Solar thermal installations
Findings Chap. 10	Given the low consumption from district heating networks during the summer, a supply using 'fuel' resources entails considerable losses. By using a resource such as solar energy, these losses can be eliminated, thereby substantially improving the efficiency of district heating networks.

Proposed actions	• Study different possible subsidy mechanisms:
	  • Define potential beneficiaries
	  • Determine how the subsidies will be funded
	• Condition the allocation of subsidies on technical, ecological and performance factors
	• Analyse the appropriateness of an obligation for district heating networks to draw a share of their heat supply from renewable sources

Strategy link	PWEC 2030 PACE 2016-2022 (Solar thermal is a potential source of renewable heat that can be exploited by a district heating network. The benefits of this type of installation thus need to be assessed)

Measures requiring further analysis	
Measure sheet # 28	**Setting up of a recovery policy for Solid Recovered Fuels (SRF)**
Type of measure	Economic
Objective	To develop the SRF sources present in Wallonia with a view to reducing dependence on fossil fuels
Potential participants	SPW TLPE – AWAC – SPW-ARNE - DSD – WG
Technology(ies) concerned	District heating network, cogeneration
Findings Chap. 10	At present, it is only possible for large installations to use solid recovered fuels (SRF) because permits insist on very specific combustion parameters and hence significant investments. Due to this high CAPEX, profitability is only guaranteed with high-capacity installations. Heat recovery is often problematic due to an insufficient number of consumers nearby. Other types of waste, currently exported on a large scale, can be recovered via smaller-capacity installations and are thus more compatible with district heating networks. SRF (solid recovered fuel) is one waste to be analysed among others. SRFs are currently subject to a landfill or incineration requirement under conditions not technically feasible from units geared towards energy recovery.
Action	• Identify the potential for SRF: consultation of existing statistics to identify the potential of SRF for energy recovery, and the impact of this on landfill. • Consultation of local stakeholders to identify the obstacles and opportunities relating to the development of the sector (environmental, legal, etc.) • Identify the measures and mechanisms needed to develop the SRF sector (waste sorting, conditioning, transport, etc.) • Implementation of measures allowing SRF to be recovered as an energy vector and used for supplying energy to companies (financial aid, subsidies, tax aid, etc.)
Strategy link	PACE 2016-2022 (Measures to regulate and recover green waste) PWEC 2030 (Recovery of certain types of waste for biomethanisation).

XI.4. *Analysis of the potential impacts of the measures*

Table 62 below identifies how the different measures will contribute to achieving the different indicators.

These indicators are:

- Greenhouse gas reduction (GHG reduction)
- Primary energy savings (Pe savings)
- Impact on the share of high-efficiency cogeneration (% COGEN/Global)
- Impact on the share of renewables in the national energy mix and in the heating and cooling sector (% RES/Global).
- Estimated impact on public finances

In this context, we have taken into account three types of impact:

- Direct impacts: Implementing the measure will impact directly the indicator considered.
- Indirect impacts: If implementing a measure will have indirect impacts even if the intention is not to contribute to the achievement of the indicators considered.
- Potential impact: It is likely that implementing the measure will impact the indicators considered, though to what degree depends on the decisions that will be taken (for example: choice of fuels).

Table 62: Contribution of the measures identified towards achieving the different indicators

		GHG reduction	Pe savings	% COGEN/Global	% RES/Global	Impact on public finances
Measure # 1	Issue implementing decrees on the organisation of the thermal market and on thermal energy networks	Potential impact (depending on the energy vectors used)	Potential impact (depending on the energy vectors used)	Indirect impact	Potential impact (depending on the energy vectors used)	Follow-up by the Administration
Measure # 2	Allow the establishment of renewable energy communities (heat and electricity)	Potential impact (depending on the energy vectors used)	Potential impact (depending on the energy vectors used)	Direct impact	Potential impact (depending on the energy vectors used)	Follow-up by the Administration
Measure # 3	Taking district heating networks into account in the calculation of the EPB	Potential impact	Potential impact	Potential impact	Potential impact	+
Measure # 4	Subsoil decree	Direct impact	Direct impact	Potential impact	Direct impact	Follow-up by the Administration (SPW-ARNE-SPW TLPE
Measure # 5	Stop all subsidisation of fossil fuels in connection with the objectives of the WR	Direct impact	-	Indirect impact	Direct impact	+
Measure # 6	Support the recovery of RES and waste heat	Direct impact	Direct impact	Direct impact	Direct impact	+++
Measure # 7	Set up an online platform, by sector of activity (residential, service, industry), to facilitate procedures necessary to realise a project	Potential impact	Potential impact	Direct impact	Direct impact	++
Measure # 8	Develop AMURE and UREBA aid	Potential impact (depending on the energy vectors used)	Direct impact	Direct impact	Direct impact	+
Measure # 9	Maintain and adapt investment aid (UDE)	Potential impact (depending on the energy vectors used)	Direct impact	Direct impact	Direct impact	+ (Funding that is more targeted)

		GHG reduction	Pe savings	% COGEN/Global	% RES/Global	Impact on public finances
Measure # 10	Encourage maintenance of the performance of RES production facilities	Potential impact (depending on the energy vectors used)	Direct impact	Direct impact	Direct impact	+
Measure # 11	Provide a financing mechanism adapted to a long lifespan for district heating/cogeneration equipment	Potential impact (depending on the energy vectors used)	-	Direct impact	Direct impact	+ (Activation of external funds)
Measure # 12	Review the depreciation period of DHNs for accounting purposes	Potential impact (depending on the energy vectors used)	Potential impact (depending on the energy vectors used)	Indirect impact	Potential impact (depending on the energy vectors used)	N/A
Measure # 13	Incorporate local or neighbourhood study requirements for DHNs and renewable energy in the context of major construction projects	Direct impact	Direct impact	Potential impact (depending on the technology envisaged)	Direct impact	Low
Measure # 14	Creation of a guarantee fund for the decontamination of excavated soil	Potential impact (depending on the energy vectors used)	Direct impact	Indirect impact	Potential impact (depending on the energy vectors used)	Follow-up by the Administration
Measure # 15	Development of a geographic information system (GIS) identifying heating needs, district heating networks and technical installations	Potential impact	Potential impact	Potential impact	Potential impact	+
Measure # 16	Extension of the duties of the industry facilitator by including a waste heat recovery component	Direct impact	Direct impact	Direct impact	Direct impact	+
Measure # 17	Creation of a guarantee fund against the industrial risk associated with waste heat recovery projects	Direct impact	Direct impact	Potential impact	Direct impact	++

		GHG reduction	Pe savings	% COGEN/Global	% RES/Global	Impact on public finances
Measure # 18	Promotion of the development of installations supplying district heating (deep geothermal energy, mining geothermal energy and shallow open system geothermal energy)	Direct impact	Direct impact	Direct impact	Direct impact	+++
Measure # 19	Modification of the permit system for open systems in shallow geothermal energy and biomass gasification	Direct impact	Direct impact	Direct impact	Direct impact	Follow-up by the Administration
Measure # 20	Measures to reduce the geological risk associated with deep geothermal projects	Direct impact	Direct impact	Potential impact	Direct impact	Follow-up by the Administration
Measure # 21	Professionalisation of the 'Cogeneration', 'District heating network', 'Geothermal energy' and 'Biomass' sectors	Potential impact	Potential impact	Potential impact	Potential impact	+
Measure # 22	Integration of a facilitator/expertise system directly into the administration - with field staff	Potential impact	Potential impact	Potential impact	Potential impact	Follow-up by the Administration
Measure # 23	Establishment of an effective system for monitoring underground installations	-	-	-	Potential impact	Follow-up by the Administration
Measure # 24	Organisation of an ash collection and treatment / recovery process	-	Direct impact	Potential impact	Indirect impact	N/A
Measure # 25	Promotion of quality biomass with low emissions of fine particles (possibly of Walloon origin)	Direct impact	Direct impact	Direct impact	Direct impact	+
Measure # 26	Planning of the phase-out of fuel oil and natural gas	Indirect impact	Indirect impact	Indirect impact	Indirect impact	
Measure # 27	Analysis of the benefits of developing solar thermal installations that supply district heating networks	Potential impact	Potential impact	Direct impact	Potential impact	+

		GHG reduction	Pe savings	% COGEN/Global	% RES/Global	Impact on public finances
Measur e # 28	Setting up of a recovery policy for Solid Recovered Fuels (SRF)	Potential impact	Direct impact	Potential impact	Direct impact	++

XI.5. Contribution of the measures towards achieving alternative scenarios defined at the level of different profiles

XI.5.1. Estimated impacts at profile level

Here we analyse the relationship between the measures and the different alternative scenarios proposed so as to identify the impact of those measures on the implementation of the different scenarios and thus its consequences on Wallonia's energy consumption and CO_2 emissions.

As a reminder, the table below provides a description of the various profiles and scenarios envisaged:

Scenarios	Profile 1 – Urban or peri-urban municipality with high energy density	Profile 2 – Residential buildings	Profile 3 – Industrial site	Profile 4 – Municipality with high energy density located in an area where deep geothermal energy is available	Profile 5 – Ecodistrict
Baseline scenarios	BS1 – Individual condensing boiler	BS2 - Decentralised condensing boiler for each building	BS3 – Decentralised oil-fired condensing boiler for each building	BS4 – Decentralised gas/oil energy mix (individual boilers)	BS5 – Individual gas-fired condensing boiler and installation of a gas distribution network
Alternative scenario 1	AS1.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	AS2.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler	AS3.1 – Industrial waste heat distributed by DH and central oil-fired back-up boiler	AS4.1 – Geothermal installations connected to DH and central gas-fired back-up boiler	AS5.1 – Gas cogeneration connected to DH and central gas-fired back-up boiler
Alternative scenario 2	AS1.2 – Solid biomass gasification cogeneration connected to DH and central gas-fired back-up boiler	AS2.2 – Solid biomass boiler connected to DH and central gas-fired back-up boiler	AS3.2 – Solid biomass cogeneration connected to DH and central oil-fired back-up boiler	/	AS5.2 – Solid biomass boiler room connected to DH and central gas-fired back-up boiler
Alternative scenario 3	AS1.3 – Waste heat distributed by DH and central gas-fired back-up boiler	AS2.3 – Waste heat distributed by DH and central gas-fired back-up boiler)	AS3.3 – Centralised biogas cogeneration (obtained by biomethanisation) with oil-fired back-up boiler	/	AS5.3 – Individual heat pumps and decentralised condensing gas-fired boiler

Table 63: Scenario matrix and profiles considered

.XI.5.1.1. Impact of the measures on alternative scenarios

	Impact on AS 1.1	Impact on AS 1.2	Impact on AS 1.3	Impact on AS 2.1	Impact on AS 2.2	Impact on AS 2.3	Impact on AS 3.1	Impact on AS 3.2	Impact on AS 4.1	Impact on AS 5.1	Impact on AS 5.2	Impact on AS 5.3
Measure # 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 4	No	No	No	No	No	No	No	No	No	No	No	Yes****[109]
Measure # 5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 8	Yes***[110]	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Measure # 9	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Measure # 10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[109] If the heat pump is connected to a geothermal installation
[110] If the renewable energy in question is taken into account in the subsidies

	Impact on AS 1.1	Impact on AS 1.2	Impact on AS 1.3	Impact on AS 2.1	Impact on AS 2.2	Impact on AS 2.3	Impact on AS 3.1	Impact on AS 3.2	Impact on AS 4.1	Impact on AS 5.1	Impact on AS 5.2	Impact on AS 5.3
Measure # 11	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Measure # 12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Measure # 13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Measure # 14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Measure # 15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 17	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No
Measure # 18	Yes++[111]	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++	Yes++
Measure # 19	Yes*****[112]	Yes*****	Yes*****	Yes*****	No	Yes*****	No	No	Yes	Yes*****	Yes*****	Yes****
Measure # 20	No	No	No	No	No	No	No	No	No	No	No	Yes****
Measure # 21	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[111] Geothermal energy works very well with district heating networks and HPs
[112] If the gas used is biogas

	Impact on AS 1.1	Impact on AS 1.2	Impact on AS 1.3	Impact on AS 2.1	Impact on AS 2.2	Impact on AS 2.3	Impact on AS 3.1	Impact on AS 3.2	Impact on AS 4.1	Impact on AS 5.1	Impact on AS 5.2	Impact on AS 5.3
Measure # 22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 23	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Measure # 24	No	Yes	No	No	Yes	No	No	Yes	No	Yes	No	No
Measure # 25	No	Yes	No	No	Yes	No	No	Yes	No	Yes	No	No
Measure # 26	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Measure # 27	Yes+[113]	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	Yes+	No
Measure # 28	No	Yes*[114]	No	Yes**[115]	Yes*	Yes**	Yes*	Yes*	No	Yes*	No	No

Table 64: Impact of each measure envisaged on the scenarios

113 Solar thermal installations are compatible with and efficient on district heating networks
114 If SRFs are considered renewable
115 If SRFs are considered waste and waste heat is recovered in the incinerator

.XI.5.1.2. Implications of developing alternative scenarios

Implementing the different measures outlined above will encourage the development of alternative scenarios for each of the profiles envisaged. Those profiles will then result in a reduction in energy consumption and in the related CO_2 emissions.

.XI.5.1.2.1. Profile 1

	CO_2emissions (T)	CO_2 savings electricity production (T)	CO_2 emissions (total) (T)	CO_2 savings compared to BS	CO_2 savings in Wallonia	
					Low range	High range
BS 1	6394	0	6394	-	-	-
AS 1.1	7010	871	6139	4%	0%	1%
AS 1.2	3544	1782	1762	72 %	7 %	22 %
AS 1.3	1272	0	1272	80 %	7 %	24 %

Table 65: CO_2 study for profile 1

.XI.5.1.2.1.1. Alternative scenario 1.1

Alternative scenario 1.1. (AS 1.1) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 4% compared to the basic scenario. As this basic scenario is representative of between 9% (low) and 30% (high) of the total share of heating needs in the residential and service sectors in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of 0% to 1% in those sectors.

.XI.5.1.2.1.2. Alternative scenario 1.2

Alternative scenario 1.2. (AS 1.2) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 23, 24, 25, 26, 27, 28

Implementing this scenario could reduce CO_2 emissions by nearly 72% compared to the basic scenario. As this basic scenario is representative of between 9% (low) and 30% (high) of the total share of heating needs in the residential and service sectors in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of 7 % to 24 % in those sectors.

.XI.5.1.2.1.3. Alternative scenario 1.3

Alternative scenario 1.3. (AS 1.3) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19, 20, 22, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 80 % compared to the basic scenario. As this basic scenario is representative of between 9% (low) and 30% (high) of the total share of heating needs in the residential and service sectors in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of 7 % to 24 % in those sectors.

.XI.5.1.2.2. Profile 2

	CO_2emissions (T)	CO_2 savings electricity production (T)	CO_2 emissions (total) (T)	CO_2 savings compared to BS	CO_2 savings in Wallonia	
					Low range	High range
BS 2	1355	0	1355			
AS 2.1	1697	572	1125	17%	2%	2%
AS 2.2	195	0	195	86%	9%	10%
AS 2.3	418	0	418	69%	8%	8%

Table 66: CO_2 study for profile 2

.XI.5.1.2.2.1. Alternative scenario 2.1

Alternative scenario 2.1. (AS 2.1) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 17% compared to the basic scenario.

As this basic scenario is representative of between 11% (low) and 12% (high) of the total share of heating needs in the residential sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of 2% in that sector.

.XI.5.1.2.2.2. Alternative scenario 2.2

Alternative scenario 2.2. (AS 2.2) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 23, 25, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 86% compared to the basic scenario.

As this basic scenario is representative of between 11% (low) and 12% (high) of the total share of heating needs in the residential sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of 9% to 10% in that sector.

.XI.5.1.2.2.3. Alternative scenario 2.3

Alternative scenario 2.3. (AS 2.3) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19, 20, 22, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 69% compared to the basic scenario.

As this basic scenario is representative of between 11% (low) and 12% (high) of the total share of heating needs in the residential sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of about 8% in that sector.

.XI.5.1.2.3. Profile 3

	CO_2emissions (T)	CO_2 savings compared to BS	CO_2 savings in Wallonia
BS 3	5432		
AS 3.1	1068	80%	35%
AS 3.2	1068	111%	48%
AS3.3	2828	87%	38%

Table 67: CO_2 study for profile 3

.XI.5.1.2.3.1. Alternative scenario 3.1

Alternative scenario 3.1. (AS 3.1) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 20, 22, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 80% compared to the basic scenario.

As this basic scenario is representative of 43% of the total share of substitutable heating needs of the industrial sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of nearly 35% in that sector.

.XI.5.1.2.3.2. Alternative scenario 3.2

Alternative scenario 3.2. (AS 3.2) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 23, 25, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 111% compared to the basic scenario.

As this basic scenario is representative of 43% of the total share of substitutable heating needs of the industrial sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of nearly 48% in that sector.

.XI.5.1.2.3.3. Alternative scenario 3.3

Implementing this scenario could reduce CO_2 emissions by nearly 87% compared to the basic scenario.

As this basic scenario is representative of 43% of the total share of substitutable heating needs of the industrial sector in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of nearly 38% in that sector.

.XI.5.1.2.4. Profile 4

	CO_2emissions (T)	CO_2 savings compared to BS	CO_2 savings in Wallonia
BS 4	7091		
AS 4.1	1695	76%	8%

Table 68: CO_2 study for profile 4

.XI.5.1.2.4.1. Alternative scenario 4.1

Alternative scenario 4.1. (AS 4.1) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19, 20, 21, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 76% compared to the basic scenario.

As this basic scenario is representative of 10% of the total share of substitutable heating needs of the residential and service sectors in Wallonia, developing this scenario would lead to a reduction in CO_2 emissions of nearly 8% in those sectors.

.XI.5.1.2.5. Profile 5

	CO_2 emissions (T)	CO_2 savings compared to BS
BS 5	2031	
AS 5.1	2394	3%
AS 5.2	1214	40%
AS 5.3	2016	1%

Table 69: CO_2 study for profile 5

.XI.5.1.2.5.1. Alternative scenario 5. 1

Alternative scenario 5.1. (AS 5.1) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 23, 24, 25, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by 1% compared to the basic scenario.

In the absence of registers and therefore statistics on ecodistricts in Wallonia, it is not possible to assess the representativeness of this type of profile for Wallonia. Besides, these types of neighbourhoods are low-energy by definition, meaning that the share of Walloon energy consumption attributed to them would be relatively small. Owing to these various factors, it is not currently possible to estimate how much the development of alternative scenarios for this profile would reduce CO_2 emissions.

.XI.5.1.2.5.2. Alternative scenario 5.2

Alternative scenario 5.2. (AS 5.2) could be facilitated by the implementation of the following measures: 1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24, 26, 27, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 40% compared to the basic scenario.

In the absence of registers and therefore statistics on ecodistricts in Wallonia, it is not possible to assess the representativeness of this type of profile for Wallonia. Besides, these types of neighbourhoods are low-energy by definition, meaning that the share of Walloon energy consumption attributed to them would be relatively small. Owing to these various factors, it is not currently possible to estimate how much the development of alternative scenarios for this profile would reduce CO_2 emissions.

.XI.5.1.2.5.3. Alternative scenario 5.3

Alternative scenario 5.3. (AS 5.3) could be facilitated by the implementation of the following measures: 1, 2, 4, 6, 7, 8, 9, 18, 20, 24, 28.

Implementing this scenario could reduce CO_2 emissions by nearly 1% compared to the basic scenario.

In the absence of registers and therefore statistics on ecodistricts in Wallonia, it is not possible to assess the representativeness of this type of profile for Wallonia. Besides, these types of neighbourhoods are low-energy by definition, meaning that the share of Walloon energy consumption attributed to them would be relatively small. Owing to these various factors, it is not currently possible to estimate how much the development of alternative scenarios for this profile would reduce CO_2 emissions.

Annexes

Annex to Chapter 6

XII. Methodology for heat consumption projections in the residential sector

Sources and methods

Changes in heat consumption in the residential sector are estimated on the basis of the projected annual changes in heat consumption in the sector in 2016 (i.e. ‘g’ in equation 1).

Equation 1: Projection of the heat consumption growth rate in the residential sector

$CC_{t2}^{R} = CC_{t1}^{R}$ * (1 + g) → g = $\frac{CC_{t2}^{R}}{CC_{t1}^{R}}$ - 1

$With\ CC = [\ \frac{CC}{m^2}\ ] * [\frac{m^2}{Log}] * [Log]$

$g = \{(1 + \Delta\frac{CC}{m^2}) * (1 + \Delta\frac{m^2}{Log}) * (1 + \Delta\ Log)\} - 1$

Key: CC = heat consumption; g = annual change in heat consumption; Log = dwellings

Equation 1 Projection of the heat consumption growth rate in the residential sector

The above equation[116] shows that the development of heat consumption in the residential sector depends on changes in the energy performance of buildings, in the average surface area of dwellings and in the number of dwellings (and consequently in the share of new housing). Therefore, in order to be able to estimate heat consumption up to 2030 and 2050, it is necessary to have an estimate of the annual variations in heat consumption per square metre, the average size of dwellings and the number of dwellings.

Estimated change in energy performance

As requested by the Commission, projections should take into account Directive 2018/844/EU. Under that Directive, each Member State must establish a long-term renovation strategy to support ‘*the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy-efficient and decarbonised building stock by 2050*’. Wallonia complies with this Directive through the Walloon renovation strategy established in 2017. An update to that renovation strategy is currently under way but has not been taken into account in this study.

The estimated energy performance for 2030 and 2050 as well as the rate of change are presented in the table below. The figures have been obtained by applying a correction coefficient that takes into account changes in the building stock up to 2030 and the consumption target defined in the renovation strategy for 2050.

	2016	2030	2050

[116] Energy Efficiency Directive 2012/27 – Art. 14 – Strategy for district heating and cooling powered by cogeneration and waste energy (PwC, ICEDD, Deplasse & Associés, 2015), p.28

Heat consumption (kWh/m²/year)[117]	172.75	145.39	85.48
Overall change over the period	-15.84%	-41.21%	
Average annual change over the period	**-1.22%**	**-2.62%**	

Estimated change in the average surface area of dwellings

The following parameters were included when estimating changes in the average area of dwellings:

- Changes in the total surface area of dwellings, with a distinction made between existing and new dwellings.
- Projections for the average surface area of new dwellings were made using data on the progression of the average surface area of new dwellings recorded between 2000 and 2014 in Wallonia from the FPS Economy land registry database[118]. Overall there was an average decrease of 0.98% per year in the average surface area of new dwellings between 2000 and 2014.
- Changes in the number of dwellings that are occupied (for more information on this subject, see the next section).

Taking into account changes in the total surface area of dwellings (existing and new dwellings) and in the number of dwellings that are occupied, it can be assumed that the average surface area of dwellings will follow the trend shown in the graph below, falling from an average of 100.66 m²/dwelling in 2016 to 99.1 m²/dwelling in 2050.

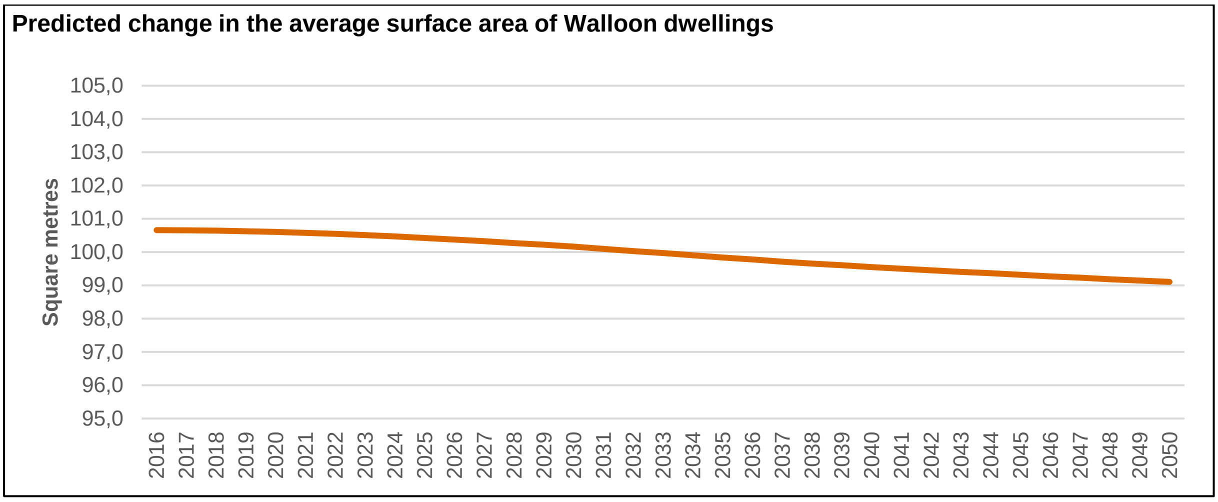

Figure 95: Change in the average surface area of Walloon dwellings

[117] Consumption includes cooking needs.
[118] https://statbel.fgov.be/fr/themes/construction-logement/occupation-du-sol-selon-le-registre-cadastral#figures

Estimated change in the number of dwellings

Changes in the number of occupied dwellings are based on trends in the number of households in Wallonia up to 2050 as presented in projections made up to 2070 by the Federal Planning Bureau (BFP) and Statbel (BFP, 2019)[119]. According to these projections, the number of Walloon households will increase by 7.8% between 2016 and 2030 (on average 0.54% annually), from 1 554 771 Walloon households in 2016 to 1 676 576. The BFP estimates that the number of households will grow by 5.8% (on average 0.28% annually) between 2030 and 2050, from 1 676 576 to 1 773 502 Walloon households.

Therefore annual variations of 0.68% in 2016-2030 and of 0.28% in 2030-2050 have been considered when trying to understand the trend in the number of Walloon households. They will be applied to the number of dwellings occupied in 2016 (1 496 955) and will provide an idea of the trend. On the basis of this, Wallonia is expected to have 1 612 292 dwellings in 2030 and1 705 502 dwellings in 2050.

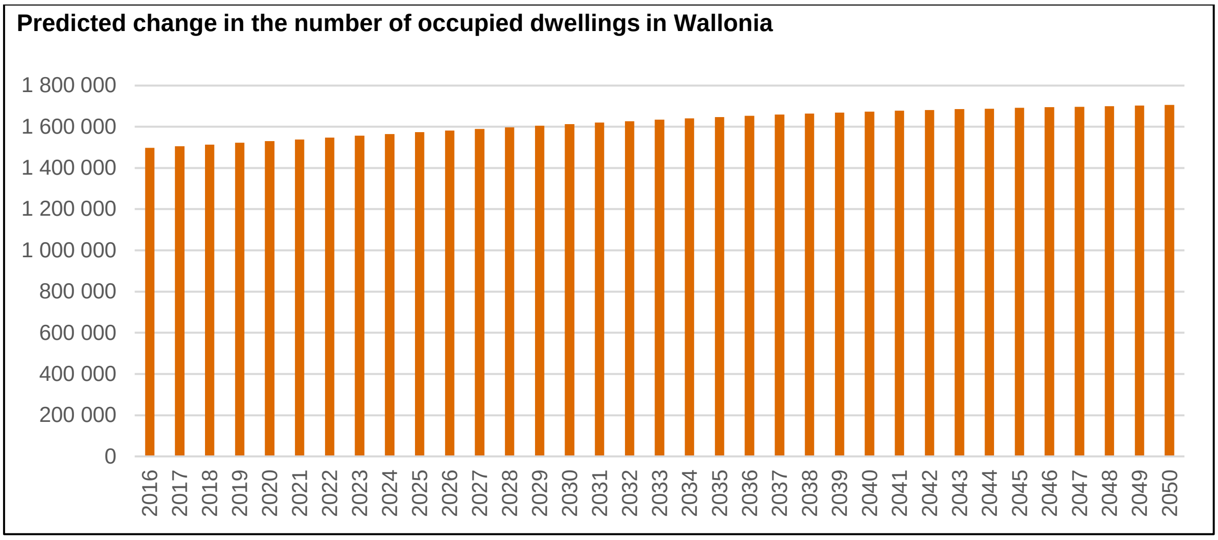

Figure 96: Changes in the number of occupied dwellings in Wallonia

119 Federal Planning Bureau (2019), 'Perspectives de ménages 2019-2070' ('Prospects of Households 2019-2070').

XIII. Methodology for cooling consumption projections in the residential sector

1. Sources and methods

Cooling consumption is divided between air conditioning and refrigeration. In 2016 this consumption was 116.5 GWh and 881 GWh, respectively.

The development of refrigeration consumption depends on changes in the number of dwellings. The development of air conditioning consumption depends on changes in the number of dwellings, energy efficiency (air-conditioning equipment and insulation of the building) and the share of equipped dwellings. Therefore, in order to be able to estimate cooling consumption up to 2030 and 2050, it is necessary to have an estimate of the annual variations in the number of dwellings, of the energy efficiency of air-conditioning equipment and buildings and of the share of equipped dwellings.

Estimated change in air conditioning consumption

The development of air conditioning consumption depends on changes in the number of dwellings, the energy efficiency of air-conditioning equipment and the share of equipped dwellings.

Estimated change in energy efficiency

This parameter is estimated according to the assumption that energy efficiency follows changes in the energy efficiency of heating consumption. The latter takes into account improvements in equipment performance and building insulation. More efficient insulation makes it possible to lessen cooling consumption for an equivalent outdoor temperature.

Estimated change in the share of equipped dwellings

Wallonia's energy balance for 2016 shows the penetration rate of various household appliances in Walloon households. In 2016, 5% of households had a portable air conditioner and 2% had integrated air conditioning.

According to the International Energy Agency (IEA), the number of air-conditioning units will increase from 97 million in 2016 to 275 million in 2050 in the European Union[120], or by 183.5% over the period under consideration. Assuming that Wallonia will follow this trend, this growth rate is applied to the 2016 penetration rate. It is consequently expected that by 2050 **14.2% of Walloon households will be equipped with a portable air conditioner** and that **5.7% of households will have integrated air conditioning**.

[120] https://www.iea.org/reports/the-future-of-cooling

Estimated change

By applying the penetration rate of portable air conditioners and integrated air conditioning to the expected number of dwellings in 2050, this would mean that 338 463 dwellings are equipped with air conditioning in Wallonia in 2050, i.e. 19.8% of the dwellings existing in 2050. In 2050 the energy consumption of air conditioning would amount to **185.9 GWh.**

Cooling consumption 2050 - Air conditioning				
Equipment	**Number of equipped households**	**Penetration rate**	**Annual consumption (kWh/year)**	**Overall consumption**
Portable air conditioner	241.759	14.2%	330	79.688.155
Integrated air conditioning	96.704	5.7%	1.099	106.250.873
				185.939.028

Estimated change in refrigeration consumption

The development of refrigeration consumption depends on changes in the number of dwellings. The development of refrigeration consumption follows changes in the number of dwellings when the energy consumption of each item of equipment is considered constant. On the basis of this, **refrigeration consumption is estimated to be 1 004 GWh** in 2050, meaning an increase of **13.9% between 2016 and 2050.**

XIV. Methodology for heat consumption projections in the service sector

Methodology

Changes in heat consumption in the service sector up to 2050 have been estimated on the basis of projections of the annual development of heat consumption in the service sector in 2016 (i.e. 'g' in the equation below).

Equation 2: Projection of the heat consumption growth rate in the service sector

$$CC_{t2}^{T} = CC_{t1}^{T} * (1 + g) \rightarrow g = \frac{CC_{t2}^{T}}{CC_{t1}^{T}} - 1$$

With CC = $\frac{CC}{VA} * VA$:

$$g = \frac{\left(\frac{CC_{t2}}{VA_{t2}}\right) * VA_{t2}}{\left(\frac{CC_{t1}}{VA_{t1}}\right) * VA_{t1}} - 1 = \frac{\left[\left(\frac{CC_{t1}}{VA_{t1}}\right) * \left(1 + \Delta\frac{CC}{VA}\right)\right] * \left[(VA_{t1}) * (1 + \Delta\, VA)\right]}{\left(\frac{CC_{t1}}{VA_{t1}}\right) * VA_{t1}} - 1 = \{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\} - 1$$

$$CC_{t2}^{T} = CC_{t1}^{T} * (1 + [\{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\} - 1]) = CC_{t1}^{T} * \{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\}$$

Equation 1: Projection of the heat consumption growth rate in the service sector

This equation shows[121] that the development of heat consumption in the service sector depends on changes in heat consumption per unit of added value (energy intensity) and on changes in added value. Therefore, in order to be able to estimate heat consumption up to 2050, it is necessary to have an estimate of the annual variations in heat consumption per unit of added value and in added value up to 2050.

Estimated change in heat consumption per unit of added value:

In order to understand changes in heat consumption per unit of added value in the service sector, the projections of the development of energy intensity in the service sector (ratio of energy consumption to added value) made by the Federal Planning Bureau (BFP, October 2017)[122] are used. According to the Federal Planning Bureau, energy intensity in the service sector will improve by 1.3% per year in Belgium.

[121] Energy Efficiency Directive 2012/27 – Art. 14 – Strategy for district heating and cooling powered by cogeneration and waste energy (PwC, ICEDD, Deplasse & Associés, 2015), p. 33
[122] Federal Planning Bureau, *Le paysage énergétique belge à l'horizon 2050*, p.38.

Estimated change in added value:

The changes in added value have been estimated on the basis of the figures published by the Federal Planning Bureau[123]. These projections have been made up to 2024 for each of the service sectors (transport and communication, commerce and hospitality, credit and insurance, health and social services, other market services, public administration and education). As there are no projections for the period 2025-2050, it was decided to use the average of the estimated projections for 2018-2024.

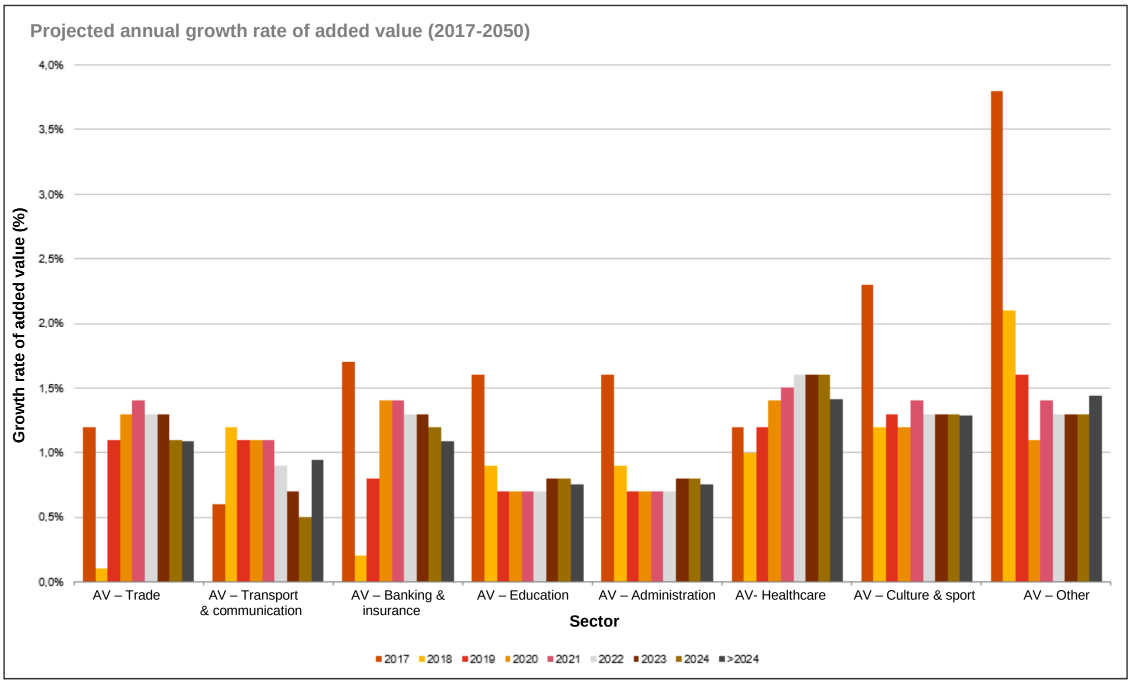

Figure 97: Projected annual growth rate of added value (2017-2050)

[123] Federal Planning Bureau, *Perspectives économiques régionales 2019-2024*.

XV. Methodology for cooling consumption projections in the service sector

Sources and methodology

As confirmed in the report of the JRC[124] assessing national notifications in relation to Article 14 of the Energy Efficiency Directive, it is difficult to make projections of cooling consumption in the service sector, because data are scarcer and assumptions uncertain.

It would seem consistent to use the same methodology and assumptions (energy intensity and changes in added value) as for the projection of heat consumption, because the principles of energy efficiency should also affect cooling consumption.

However, a number of studies appear to show opposite results [125]. The results of projections made by other EU Member States mainly indicate an upward trend.

Keeping this in mind, the results below present two scenarios:

An ‘optimistic’ scenario, which applies the same method used in the projection of heat consumption;
A ‘realistic’ scenario based on changes in cooling consumption calculated in the residential sector. Depending on the scenario chosen, the annual increase in cooling needs is estimated to be between 1.04% and 2.23%.

[124] JRC Science for Policy Report, Synthesis report on the evaluation of national notifications related to Article 14 of the Energy Efficiency Directive, 2018, p.15.
[125] Heat Roadmap Belgium, Quantifying the Impact of Low-carbon Heating and Cooling Roadmaps, 2018, p.18.

XVI. Methodology for heat consumption projections in the industrial sector

Sources and methods

Heat consumption in Walloon industry up to 2050 has been estimated on the basis of the projected annual changes in heat consumption in the industrial sector in 2016 (i.e. ‘g’ in the equation below).

Equation 3: Projection of the heat consumption growth rate in the industrial sector

$$CC_{t2}^{I} = CC_{t1}^{I} * (1 + g) \rightarrow g = \frac{CC_{t2}^{I}}{CC_{t1}^{I}} - 1$$

With CC = $\frac{CC}{VA} * VA$*:*

$$g = \frac{\left(\frac{CC_{t2}}{VA_{t2}}\right) * VA_{t2}}{\left(\frac{CC_{t1}}{VA_{t1}}\right) * VA_{t1}} - 1 = \frac{\left[\left(\frac{CC_{t1}}{VA_{t1}}\right) * \left(1+\Delta\frac{CC}{VA}\right)\right] * [(VA_{t1}) * (1+\Delta\, VA)]}{\left(\frac{CC_{t1}}{VA_{t1}}\right) * VA_{t1}} - 1 = \{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\} - 1$$

$$CC_{t2}^{I} = CC_{t1}^{I} * (1 + [\{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\} - 1]) = CC_{t1}^{T} * \{(1 + \Delta\frac{CC}{VA}) * (1 + \Delta\, VA)\}$$

Key: CC = heat consumption; g = annual change in heat consumption; VA = added value

Equation 2: Projection of the heat consumption growth rate in the industrial sector

This equation shows[126] that the development of heat consumption in industry depends on changes in heat consumption per unit of added value (energy intensity) and on changes in added value. Therefore, in order to be able to estimate heat consumption up to 2050, it is necessary to have an estimate of the annual variations in heat consumption per unit of added value and in added value up to 2050.

[126] Energy Efficiency Directive 2012/27 – Art. 14 – Strategy for district heating and cooling powered by cogeneration and waste energy (PwC, ICEDD, Deplasse & Associés, 2015), p.35

Estimated change in heat consumption per unit of added value:

In order to understand changes in heat consumption per unit of added value in industry, the projections of the development of energy intensity in the different industrial sectors made by the Federal Planning Bureau [127] are used.

Industrial sectors	2015–2030	2030-2050
IRON AND STEEL	0.71%	0.71%
NON-FERROUS	0.71%	0.71%
CHEMICHALS	1.07%	1.61%
NON-METALLIC MINERALS	0.79%	1.25%
FOOD	1.18%	1.79%
TEXTILES	1.43%	1.43%
PAPER	1.43%	1.96%[128]
METAL MANUFACTURING[129]	1.43%	1.43 %
OTHER INDUSTRIES	1.43 %	1.43 %

Table 70: Projected development of the energy efficiency of Belgian industry as applied to Wallonia (average annual growth rate)

[127] Federal Planning Bureau, *Le paysage énergétique belge à l'horizon 2050 – Perspectives à politique inchangée* , October 2017, p.30.

[129] The 'Metal manufacturing' category is not included in the report published by the BFP. The percentages refer to the 'Other' category.

Estimated change in added value

The changes in added value by sub-sector have been estimated on the basis of the figures published by the Federal Planning Bureau[130]. These projections concern the periods 2015-2030 and 2030-2050

Industrial sectors	2015–2030	2030-2050
IRON AND STEEL	0.1 %	0.1 %
NON-FERROUS	0.7 %	0.5 %
CHEMICHALS	0.8 %	0.8 %
NON-METALLIC MINERALS	1.4 %	1.1 %
FOOD	1.2 %	1.4 %
TEXTILES	-1.1 %	-1.1 %
PAPER	1.3 %	1.3 %
METAL MANUFACTURING	1.7 %	1.9 %
OTHER INDUSTRIES	0.7 %	1.2 %

Table 71: Projection of the development of added value of Belgian industry as applied to Wallonia

[130] Federal Planning Bureau, *Le paysage énergétique belge à l'horizon 2050 – Perspectives à politique inchangée*, October 2017, p.16.

XVII. Methodology for cold consumption projections in the industrial sector

Sources & methodology

As confirmed in the report of the JRC[131] assessing national notifications in relation to Article 14 of the Energy Efficiency Directive, it is difficult to make projections of cooling consumption in the industrial sector, because data are scarcer and assumptions uncertain.

It would seem consistent to use the same methodology and assumptions (energy intensity and changes in added value) as for the projection of heat consumption as energy efficiency, supported by Sector Agreements, targets energy consumption as a whole, regardless of whether it is used for heating or cooling.

However, a number of studies appear to show opposite results [132]. The results of projections made by other EU Member States mainly indicate an upward trend. In this case, the results below present two scenarios:

An ‘optimistic’ scenario, which applies the same method used in the projection of heat consumption;
A ‘realistic’ scenario based on the figures in the study carried out by *Heat Roadmap Europe*[133] in 2017. That study predicts that cooling consumption for industrial processes will increase by 42% between 2015 and 2050. It estimates that cooling consumption for space cooling will grow by 79% between 2015 and 2050.

[131] JRC Science for Policy Report, Synthesis report on the evaluation of national notifications related to Article 14 of the energy Efficiency Directive, 2018, p.15.
[132] Heat Roadmap Belgium, Quantifying the Impact of Low-carbon Heating and Cooling Roadmaps, 2018, p.18.
[133] [133] Heat Roadmap Europe, Baseline scenario of the heating and cooling demand in buildings and industry in the 14 MSs until 2050, 2018, p.18.

Annex to Chapter 9

XVIII. Calculation of the cogeneration potential

In order to assess the potential of heating needs which can be supplied by cogeneration, standard consumption profiles have been identified that correspond to sectors referred to in the Walloon Region's energy balance. For each of these standard profiles, sizing was carried out to maximise the coverage rate of heating needs by means of a cogeneration unit [134].

For each of these profiles, this sizing corresponds to the optimal technical percentage of cogeneration for the sub-sector. Multiplying that percentage by the heating need of the sub-sector gives the cogeneration potential of that sub-sector. Wallonia's cogeneration potential corresponds to the sum of the potential of each sub-sector[135].

The standard profiles identified come from the computer transcription of the guide on installing cogeneration, 'Installer une cogénération dans votre établissement'(Cogencalc), edited by the Walloon and Brussels regions:

A: Daytime profile 5d/7 (offices, schools, services to individuals)

B: Daytime profile 6d/7 (shops, culture)

C: Daytime profile 7d/7 (sports centres)

D: Continuous profile 7d/7 (hospitals and other care, Horeca)

E: Daytime profile 5d/7 (SMEs, laundry and dry cleaning services, very regular consumption)

F: Daytime profile 7d/7 (collective housing)

G: Specific profile of Brussels hotels.

It should be noted that the cumulative tapping profile of single-family houses is considered similar to profile F in proportion to the potential of the district heating networks.

Profiles	Heating needs (GWh)[136]	Potential which can be supplied by cogeneration (%)	Equivalent hours	Cogeneration potential (GWh)
Collective housing	2.916	49%	4000	1.429
Individual dwellings	23.591	49%	4000	4 277[137]
Health	840	49 %	4000	411
Education and research	1.161	43%	3000	500
Sport and recreation	402	52%	4000	209
Shops	2.812	44%	4000	1.237

[134] Analysis of the national potential for applying high-efficiency co-generation (Ministry of Ecology, Energy, Sustainable Development and Maritime Affairs, France)
[135] The industrial sector is currently excluded from the analysis, as there is insufficient information on the heating demand profiles of the various industries.
[136] *Bilan énergétique de la Wallonie 2016 – Réseaux de chaleur et de froid*, ICEDD (2019), p.10
[137] It should be noted that the cumulative tapping profile of single-family houses is considered similar to profile F in proportion to the potential of the district heating networks. The factor used (0.37) comes from Heat Roadmap Belgium.

Cafes, hotels, restaurants	88	49%	4000	43
Offices	943	22%	4000	207
			Total	**8.314**

Annex to Chapter 10

XIX. Technical and economic assumptions for the scenarios

Technical assumptions

The model makes the following technical assumptions:

- The model identifies three different types of energy load: Heating needs and electricity needs. Needs are annualised and simulations are performed at static capacity (no transitional ranges; see below).
- Two complementary means of energy production are considered in the calculation: the primary source covering basic needs and the secondary source, which supports supplementary heating. Different technologies may be used in each case.
- The evaluation is based on consumer heating and electricity needs. The primary source and, in general, the additional supply from supplementary heating should be sufficient to independently cover about 100% of thermal demand. In the case of electricity demand, a number of specific cases need to be considered, depending on whether:
  - demand for electricity is met by cogeneration (in theory);
  - cogeneration exceeds the demand for electricity: in this case, the surplus is purchased by and fed into the network.
  - cogeneration falls below the demand for electricity: in this case the surplus is sold back to the network;
  - the production system does not include cogeneration and all the customer's energy demands are satisfied by separate withdrawals from the network This is the case for compression refrigeration cycles. It is also the default situation in the baseline scenarios based on the use of standard boilers.
- The savings made from self-consumption and the potential production sold on the network are deducted from the costs/cash flows for the applicable scenario (profit).
- The sizing of the facility derives from practical cases that may be generalised at the level of the Walloon Region.
- Collective self-consumption is considered non-existent. This is why, in electricity generation scenarios, all electricity generated is resold on the network and all electricity needs are purchased on the network. Energy communities are set to develop. How sensitive the different scenarios are to the establishment of such a system is analysed. In this case, the following assumption is made: all electricity generated is self-consumed and the surplus/shortage is sold/purchased on the network.
- The electricity required for heat production equipment is considered equivalent to that which would be used by individual boilers in the baseline scenario. That assumption is not applied to HPs.

Economic assumptions:

The model makes the following economic assumptions:

- The benefits of the alternative options are determined on the basis of cost. Each option is then compared to the baseline scenario using the annualised present value of the net costs (VAACN). The costs considered are the net balances resulting from the cumulative total costs of production[138] on the one hand, after any deduction of income generated by the sale of the electricity produced in the case of cogeneration (see above)[139]. Any subsidies granted are also deducted from production and operating costs. The amounts granted for green certificates are calculated using a tool developed by the Walloon Region. The factors taken into account when granting green certificates are similar to those currently in place.

- Since cogeneration units produce both heat and electricity, the bases for comparison include consumer demand expressed in both forms and valued in monetary units (see above).

- The operating life is set at 30 years (see *below*). Since the physical depreciation period for each category of technology varies, the model takes into account the recovery of the residual value of the technologies. In other words, in the case of district heating networks, the model takes into account a positive cash flow in the thirtieth year to incorporate the residual value of the network, or 20/50 of the value of the network. If the technology in question has a lifetime of less than 30 years, a replacement of that technology is considered (e.g. investment in three gas cogeneration units is considered).

- The actuarial calculations are based on monetary data expressed in EUR at current prices, i.e. accounting for inflation. Consequently the results reflect the speculative effect of price slippage[140].

- Cost cash flows include both CAPEX and OPEX:
    - CAPEX, or capital expenditure, encompasses the cost of equipment and installation (infrastructure). Investment aid is also taken into account for eligible technology (cogeneration, district heating network, etc.).
    - OPEX, or operating expenditure, covers servicing and maintenance. Fuel expenses are covered separately in the model.

- Fuels prices vary according to the consumption profiles (small vs large consumer). Scenarios with centralised and collective technologies generally benefit from fuel prices for large consumers. In contrast, individual technologies generally benefit from fuel prices for small consumers.

- The model does not include disinvestment costs[141].

- Cash flows are defined before taxes. The reason for this is that tax arrangements differ substantially depending on the consumer's status and circumstances. For example, the deduction possibilities for natural persons are influenced by their level of income. Different scales apply in respect of commercial and/or industrial uses. An approximation of the effect of VAT will be quantifiable through sensitivity analyses on fuel costs and CAPEX costs.

- Given the heterogeneity of the production methods envisaged, gains/losses from the implementation of new technology have little meaning in themselves when expressed in terms of kWh. This creates methodological difficulties: should the gains/losses be attributed to the production of heat or electricity? Consequently, these variables will not be calculated. However, comparisons between the baseline scenario and the proposed alternatives are analysed in terms of the contribution of each component, or group of variables, to the final updated result.

- The costs of establishing a gas distribution network are not taken into account. This element creates a bias in favour of scenarios based on gas-fired technologies. However, it represents a true regional specificity. An exception is made in profile 5. As ecodistrict projects are usually built on greenfield land, the costs of building infrastructure ensuring a connection to the main network and the distribution on the site are considered.

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[138] i.e. CAPEX, OPEX for maintenance and OPEX linked to the purchase of fuels.
[139] In this analysis, all of the heat is self-consumed. Therefore it is not income from the sale of heat but rather a saving (reduction) on the energy bill.
[140] The assumptions relating to these variables are presented in section **Error! Reference source not found.**
[141] According to this assumption, disinvestment costs are similar for all technologies. However, it is worth reflecting on the disinvestment costs (pollution) for fuel oil technologies.

Environmental assumptions

An environmental analysis is made for each profile studied. It only takes account of CO_2 emissions linked to fuel consumption (gas[142] and electricity). The emission factors used are[143]:

- Natural gas: 0.201 kg CO_2/kWh
- Fuel oil: 0.264 kg CO_2/kWh
- Electricity: 0.502 kg CO_2/kWh

In addition to CO_2 emissions, each technology has environmental advantages and disadvantages of its own. They include:

- In a decentralised system, acid condensates are unlikely to be treated. However, if production is centralised, this is relatively common, and the necessary investment is reduced as there is only one machine to treat.
- **Biomass boilers** generate fine particles. Old biomass boilers were not always equipped with a flue-gas treatment system, because such systems are expensive. Nowadays these systems are standardised (cyclone-type, etc.) and the cost is moderate. It is important to highlight the environmental impact of transporting solid materials and therefore to favour materials from short and local circuits (ideally less than 100 km).
- **Fuel oil** produces more fine particles than gas. Besides, there is the risk of fuel oil leaks and, ultimately, of soil pollution. The transport of fuel oil causes in itself local and international environmental impacts.

[142] Note that to simplify things, a distinction was made between (1) electricity, (2) carbonaceous fuels, i.e. fuel oil and natural gas, and (3) decarbonised fuels (i.e. biomass). The emission factor used for carbonaceous fuels is that of gas, as the analysis mainly looks at alternative scenarios based on gas technologies in the case of carbonaceous fuels. This may lead to bias in some of the results of the analysis, which considers both fuel oil and gas technologies.

[143] SPW TLPE (2019), Calculation software for green certificates: https://energie.wallonie.be/fr/estimation-du-nombre-de-certificats-verts-en-fonction-du-coefficient-keco.html?IDC=9787&IDD=135639

XX. Background information

Generally, and for all scenarios, data input is grouped as follows:

1. *Economic and financial* data: These include variables such as interest rates, the rates applicable to energy purchases and sales on the network, the cost of fuel, inflation, subsidies, etc.
2. *Information on consumers' heating and electricity needs (or those of groups of consumers):* Such information is treated as net, i.e. before any additional charges that may be necessary to activate heating or cooling production equipment (such as heat pumps).
3. *Data outlining the solutions proposed for the baseline production*: the amounts for equipment investments (CAPEX), other installation costs such as set-up costs, the installation of chimneys for condensing boilers (expressed as a percentage of CAPEX), costs for the servicing and maintenance of equipment, service life, amounts used for end-of-service-life dismantling purposes, thermal efficiency (in the case of boilers, cogeneration) and electrical efficiency (in the case of cogeneration), performance coefficients (compression and absorption cycles), annual production and installed capacity. The baseline production may be centralised or decentralised, e.g. for an apartment building or an office building. Network usage is optional (see below) and only concerns the transport of heat-transfer fluids outside - or between - buildings.

4. *Comparable data on back-up production* : The latter concern both heating needs and domestic hot water. The back-up production may cover a significant part of consumer needs if the primary source is limited by constraints on the load curve.

5. *Data on network transmission:* The latter mainly include capital expenditure, maintenance costs and losses. The network is defined as a system for transmitting energy between buildings. Internal networks, such as those used within the same building to transmit heating and cooling to be fed into induction units, are not considered to be part of the network at this stage.

Data on capital and operational expenditure are converted into physical units: the capacity of the installation. Specific consumption is therefore processed separately from OPEX. It depends on the efficiency or the performance coefficient. The underlying assumption is that there is no economy of scale. This is acceptable in practice if the power ranges are sufficiently narrow.

The simulations are based on common core economic and financial data. These are described below.

Economic and financial data	Value	Sources and assumptions
Actuarial rate	1.7%	According to the Federal Planning Bureau, the rate is the average for 2018-2024[144].
Lifetime of the project	30 years	Assumption
Price of natural gas for individual consumers (excl. VAT)	EUR 0.041/kWh	On the basis of the study carried out by PwC comparing gas and electricity prices in Europe145 – price for a household consumer.
Price of natural gas for collective consumers (excl. VAT)	EUR 0.022/kWh	On the basis of the study carried out by PwC comparing gas and electricity prices in Europe – price for a small professional consumer (G0 profile)[146] . This choice reflects the possibility for a centralised technology to negotiate prices.
Inflation of natural gas	2%	On the basis of the development of energy prices in Belgium as published by CREG each quarter [147] – changes between December 2015 and December 2019.
Price of biomass (excl. VAT)	EUR 0.027/kWh	PwC's assumption: on the basis of the ValBiom report on the price of biomass[148] and on the basis of APERe data[149]
Price for waste heat produced by the energy recovery unit (excl. VAT)	EUR 0.012/kWh	Assumption by Deplasse et Associés[150].
Price of electricity for small consumers (excl. VAT)	EUR 0.21/kWh	On the basis of the study carried out by PwC comparing gas and electricity prices in Europe[151].
Price of electricity for large consumers (excl. VAT)	EUR 0.125/kWh	On the basis of the study carried out by PwC comparing gas and electricity prices in Europe[152].

[144] Federal Planning Bureau, **Perspectives économiques 2019-2024**, p.39
[145] PwC, **A European comparison of electricity and natural gas prices for residential, small professional and large industrial consumers**, May 2020, p.22
[146] PwC, **A European comparison of electricity and natural gas prices for residential, small professional and large industrial consumers**, May 2020, p.23
[147] https://www.creg.be/fr/professionnels/fonctionnement-et-monitoring-du-marche/evolution-prix-de-lenergie-belgique-et-pays, consulted on 20/06/2020
[148] Valbiom, **biomass boilers**, material for a presentation given on 6 December 2018.
[149] APERe (2020), Observatoire des prix de l'énergie: https://www.apere.org/fr/observatoire-prix. The prices are considered lower than those for households, as the purchase profile is of the G0 type.
[150] The extraction of steam weakens electrical efficiency. The purchase price covers this loss as well as the risk related to the obligation to supply heat. Value from actual consultancy projects, in particular the case of the Pont-de-Loup incinerator.
[151] PwC, **A European comparison of electricity and natural gas prices for residential, small professional and large industrial consumers**, May 2020, p.17
[152] PwC, A European comparison of electricity and natural gas prices for residential, small professional and large industrial consumers, May 2020, p.18

Electricity price inflation	4%	On the basis of the development of energy prices in Belgium as published by CREG each quarter [153] – changes between December 2015 and December 2019.
Electricity resale tariff	EUR 0.025/kWh	PwC assumption: on the basis of the figures for service projects in Wallonia.
Belpex electricity resale tariff	EUR 0.047/kWh	PwC assumption: on the basis of the observed electricity prices[154]
Price of fuel oil (excl. VAT)	EUR 0.035/kWh	Maximum price of fuel oil on the basis of the publication of FPS Economy[155].
Price of green certificates	EUR 65/GC	Guaranteed price at regional level[156]
Inflation of OPEX	1.8%/year	Total average increase in inflation over the period 2021– 2024[157]
Inflation of CAPEX	1.8%/year	See above

Table72: Economic and financial data

[153] https://www.creg.be/fr/professionnels/fonctionnement-et-monitoring-du-marche/evolution-prix-de-lenergie-belgique-et-pays, consulted on 20/06/2020

[154] https://my.elexys.be/MarketInformation/IceEndexAverage.aspx, consulted on 22 July 2020.

[155] https://economie.fgov.be/fr/themes/energie/prix-de-lenergie/prix-maximum-des-produits/tarif-officiel-des-produits, consulted on 26 June 2020.

[156] SPW TLPE (2020), A qui vendre mes certificats verts: https://energie.wallonie.be/fr/a-qui-vendre-mes-certificats-verts.html?IDC=9788&IDD=135557#:~:text=Ces%20certificats%20verts%2C%20une%20fois,d%C3%A9lais%20de%20paiement%2C%20etc.)

[157] Federal Planning Bureau, Perspectives économiques 2019-2024, p.2

DIRECTIVE 2012/27/EU (ENERGY EFFICIENCY DIRECTIVE) – ARTICLE 14

POTENTIAL FOR EFFICIENCY IN HEATING AND COOLING

Strategy for district heating and cooling networks supplied by cogeneration, waste heat or renewable energy sources

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