WALLOON LONG-TERM BUILDING RENOVATION STRATEGY

– ANNEXES –

NOVEMBER 2020 UPDATE

Wallonie service public	Walloon Public Service
SPW	SPW

planning housing heritage energy

Department for Energy and Sustainable Building

Office for Sustainable Buildings

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Annexe 1. Public consultation

The methodology used to develop Wallonia's long-term building renovation strategy since 2017, and its update in 2020, is based on involving the various stakeholders: academics, various professionals in the construction and renovation sector, the finance industry and users of the various buildings were consulted and involved throughout.

This broad involvement is a prerequisite for the success of the Walloon energy renovation strategy, as there are numerous complex aspects and challenges, which differ depending on the perspective – the Walloon strategy touches on many subjects and links to several other government plans.

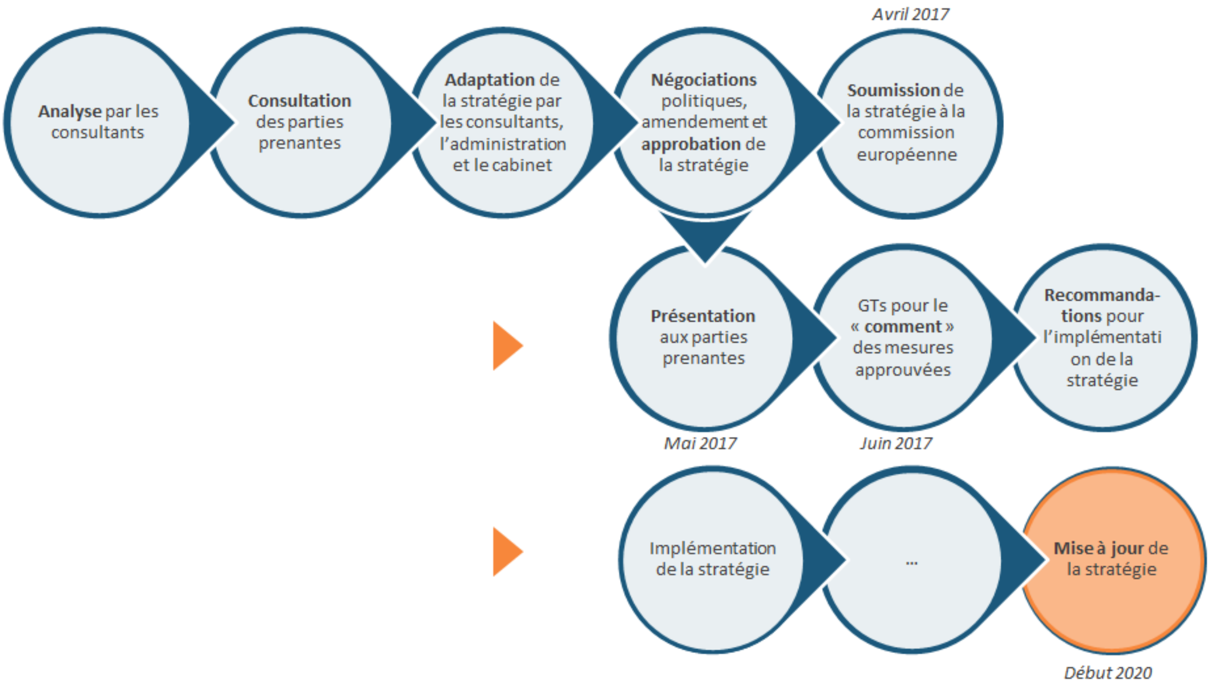
Several working groups (WGs) have been set up to address specific issues. These working groups are overseen by the Department for Energy and Sustainable Building within the Operational Directorate for Spatial Planning, Housing, Heritage and Energy (DG04) and by the team at the Office of the Minister for Climate, Energy and Mobility. The WGs helped, firstly, to gather all the latest analyses and expert assessments and, secondly, to facilitate ownership and buy-in by the various stakeholders.

The WGs were designed to optimise the balance between diversity of viewpoints and quality and depth of the various contributions.

There were several stages in Climact's role in facilitating these WGs: (i) preparing the WGs on the content and identifying questions, proposed preliminary responses and points of convergence and divergence; (ii) facilitating the WGs by focusing on convergences and mitigating divergences; (iii) collecting feedback; and (iv) pulling the work together and producing an objective summary.

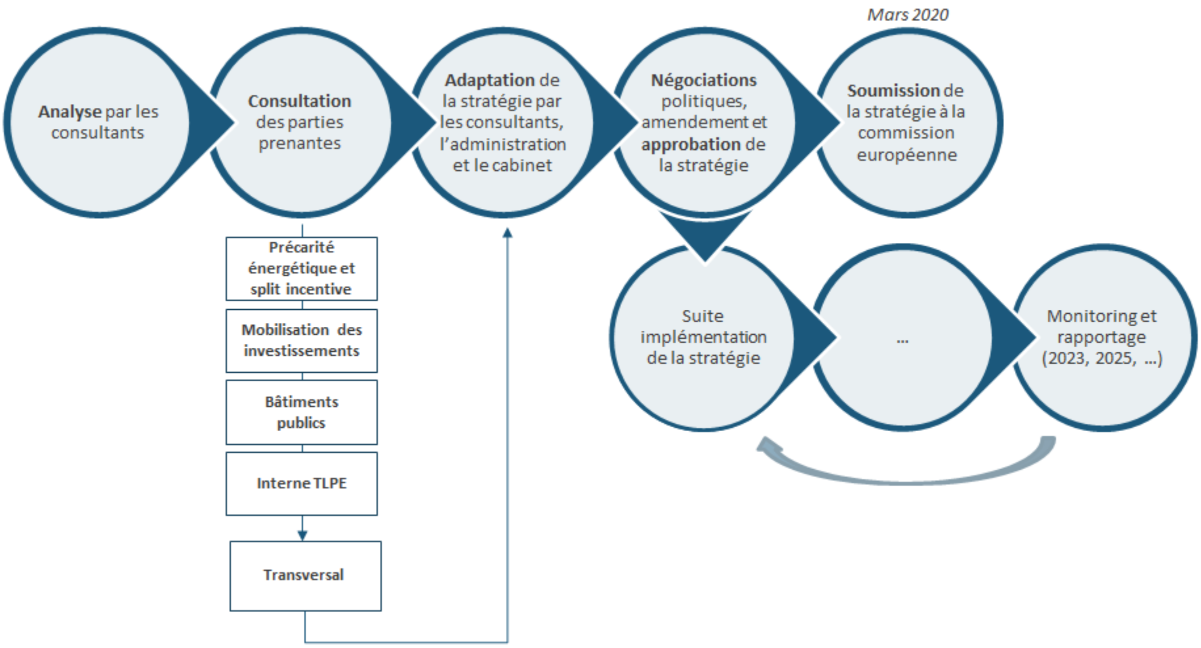
This strategy is the result of analysis, consultation, synopsis and arbitration.

The following process was followed in developing the 2017 version of the renovation strategy:



Avril 2017	April 2017
Analyse par les consultants	Analysis by consultants
Consultation des parties prenantes	Stakeholder consultation
Adaptation dela stratégie par ► les consultants, l'administration et le cabinet	Strategy revised by consultants, government and Minister's office
Négociationspolitiques, amendement et approbation de la stratégie	Policy negotiations, amendment and approval of the strategy
Soumission dela stratégie à la commission européenne	Strategy submitted to European Commission
Présentationaux parties prenantes	Presentation to stakeholders
GTs pour le «comment» desmesures approuvées	WGs to address the 'how' for measures approved
Recommandations pour l'implémentation de la stratégie	Recommendations for implementation of the strategy
Mai 2017	May 2017
Juin 2017	June 2017
Implementation de la stratégie	Implementation of the strategy
...	...
Mise à jour de la stratégie	Updating of the strategy
Début 2020	Early 2020

The following process was followed in developing the 2020 version of the renovation strategy:



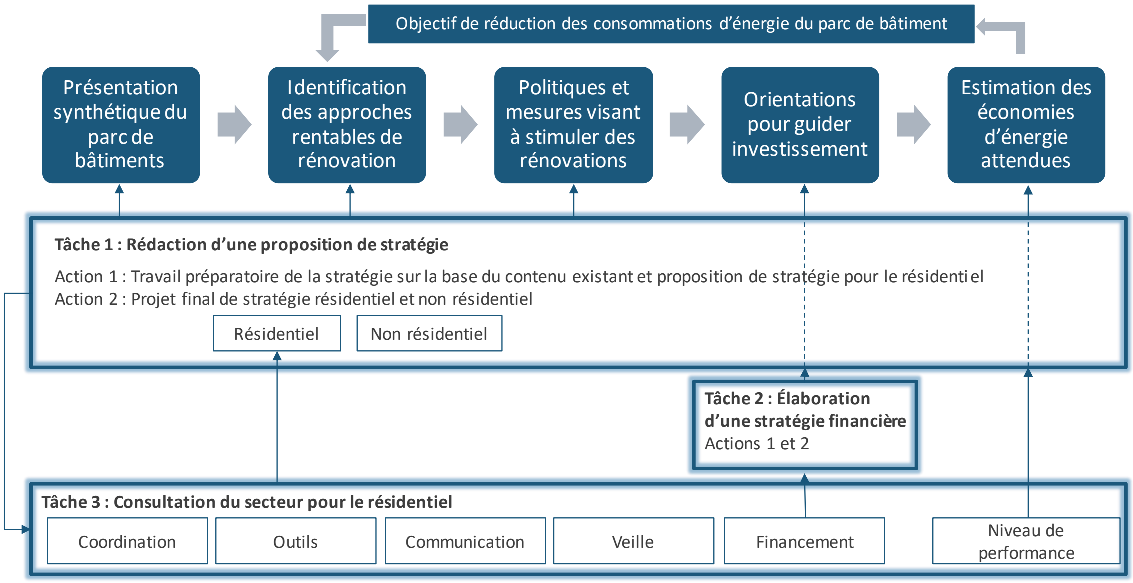
Mars 2020	March 2020
Analyse par lesconsultants	Analysis by consultants
Consultation des parties prenantes	Stakeholder consultation
Adaptation de la stratégie par les consultants, l'administration et le cabinet	Strategy revised by consultants, government and Minister's office
Négociations politiques, amendement et approbation de la stratégie	Policy negotiations, amendment and approval of the strategy
Soumission de la stratégie à la commission européenne	Strategy submitted to European Commission
Précarité énergétique et split incentive	Energy poverty and split incentive
Mobilisation des investissements	Mobilising investment
Bâtiments publics	Public buildings
Interne TLPE	DGO4 internal
Transversal	Cross-cutting
Suite implémentation de la stratégie	Continued implementation of the strategy
...	...
Monitoring et rapportage (2023, 2025, ...)	Monitoring and reporting (2023, 2025, etc.)

A. DEVELOPMENT OF THE VERSION OF THE STRATEGY SUBMITTED IN APRIL 2017

1) METHODOLOGY

LINKAGES

The methodology is structured around the five main components of the strategy, as prescribed by Article 4 of Directive 2012/27/EU on energy efficiency. It is illustrated in Figure 1.



Objectif de réduction des consommations d'énergie du parc de bâtiment	Energy consumption reduction target for the building stock
Présentation synthétique du parc de bâtiments	Overview of building stock
Identification des approches rentables de rénovation	Identification of cost-effective renovation approaches
Politiques et mesures visant à stimuler des rénovations	Policies and measures to encourage renovation
Orientations pour guider investissement	Guidelines for investment
Estimation des économies d'énergie attendues	Estimation of energy savings expected
Tâche 1 : Rédaction d'une proposition de stratégie	Task 1: Drafting a strategy proposal
Action 1 : Travail préparatoire de la stratégie sur la base du contenu existant et proposition de stratégie pour le résidentiel	Action 1: Preparatory work on strategy based on existing content and strategy proposal for residential sector
Action 2 : Projet final de stratégie résidentiel et non résidentiel	Action 2: Final draft strategy for residential and non-residential
Résidentiel	Residential
Non résidentiel	Non-residential
Tâche 2 : Élaboration d'une stratégie financière	Task 2: Develop a financial strategy
Actions 1 et 2	Actions 1 and 2
Tâche 3 : Consultation du secteur pour le résidentiel	Task 3: Sector consultation for residential
Coordination	Coordination
Outils	Tools
Communication	Communication
Veille	Monitoring
Financement	Finance
Niveau de performance	Performance level

Figure 1. Linkages in the methodology.

The methodology was developed with the involvement of stakeholders, through working groups with sectors and actors and through numerous discussions. The methodology covers the main components of the strategy:

- overview of the national/regional building stock;
- identification of cost-effective approaches to renovations relevant to the building type and climatic zone;

- policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;
- a forward-looking perspective to guide investment decisions by individuals, the construction industry and financial institutions;
- an evidence-based estimate of expected energy savings and wider benefits.

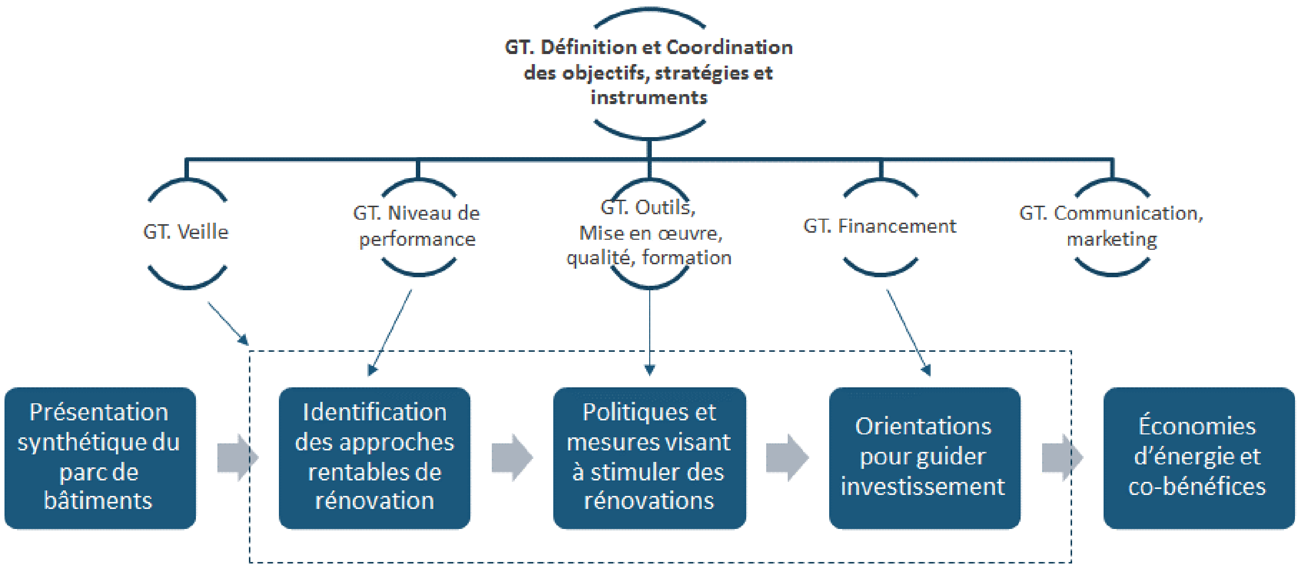
Firstly, consultation with stakeholders ensures the development of a strategy that is relevant to the realities of Wallonia and, secondly, the involvement of actors to maximise the chances of effective implementation and ownership by all stakeholders. Wallonia is aware that the stakeholders have a lot of experience to share, and that many are willing to support the government to ensure its renovation strategy is effective, so it has taken care to listen to them and to take their views into account as far as possible.

From September to December 2016, work was carried out on structuring and analysis, to which the various categories of stakeholders were invited. This work resulted in the following:

- the definition of ambitious long-term energy performance targets, for both residential and commercial sectors;
- phasing of the renovation of housing in the Region, in conjunction with the identification of renovation approaches;
- a series of measures to stimulate and finance the deep energy renovation of buildings in Wallonia.

WORKING GROUPS

Working groups (WGs) were set up to feed into the various sections of the residential component of the strategy, as illustrated in Figure 2.



GT. Définition el Coordination des objectifs, stratégies et instruments	WG - Definition and coordination of objectives, strategies and instruments
GT. Veille	WG - Monitoring
GT. Niveau de performance	WG - Performance level
GT. Outils, Mise en œuvre, qualité, formation	WG - Tools, implementation, quality, training
GT. Financement	WG - Finance
GT. Communication, marketing	WG - Communication, marketing
Présentation synthétique du parc de bâtiments	Overview of building stock
Identification des approches rentables de rénovation	Identification of cost-effective renovation approaches
Politiques et mesures visant à stimuler des rénovations	Policies and measures to encourage renovation
Orientations pour guider investissement	Guidelines for investment
Économies d'énergie et co-bénéfices	Energy savings and wider benefits

Figure 2. Linkage between working groups and components developed in the renovation strategy.

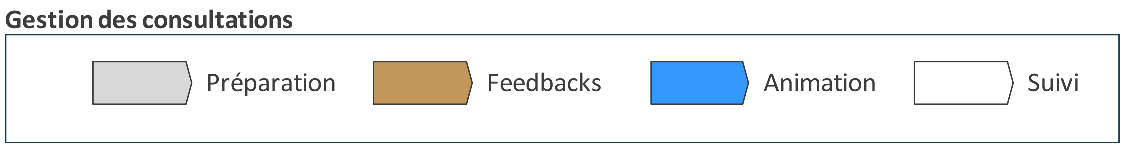
The objectives of each of these working groups are as follows:

- **WG – Definition and coordination of objectives, strategies and instruments**
  The objectives of this WG are to:
    - prioritise issues to be addressed in the other WGs;
    - coordinate the outcomes of the other WGs.

  This WG discussed the issues that were to be debated in each of the groups, as well as the objectives for the sectoral consultation and their distribution among the working groups.
- **WG – Performance level**
  The objective of this WG is to propose acceptable performance levels for renovation, in conjunction with the nearly zero-energy buildings (NZEB) objectives, the findings of the COZEB cost-optimal study and the findings of the COZEB extension study.
- **WG – Financing**
  The objectives of this WG are to:
    - assess available financing mechanisms;
    - reflect on new innovative mechanisms to be created, to guarantee access to housing and the capacity to finance renovation works.
- **WG – Tools, implementation, quality, training**
  The objectives of this WG are to:
    - assess existing tools in relation to renovation;
    - reflect on the development of new tools;
    - consider the actions necessary to ensure quality implementation of the measures and training for professionals and stakeholders in the renovation sector.
- **WG – Communication, marketing**
  The objective of this WG is to develop a solid communication and marketing plan to reach as many people as possible and ensure the actions have an impact on the various target audiences.
- **WG – Monitoring**
  The objectives of this WG are to assess best practices in energy renovation in other Member States and to implement those projects in Wallonia. A selection of inspiring initiatives was presented and the value of and requirements for transposing them to Wallonia were discussed by a sub-group of stakeholders. The following projects were presented by their respective project leaders or some of their key stakeholders:
    - *woningpas* [building passport] scheme and related *renovatieadvies* [renovation advice] (Flanders),
    - ENERGIESPRONG (NL),
    - ENERGIES POSIT'IF (FR),
    - Picardie Pass Rénovation (FR),
    - renovation classes devised in Denmark,
    - French legislative framework, including the law on Energy Transition for Green Growth,
    - the first building passport initiatives (Baden-Wuerttemberg).

  The summary of actions or instruments that could be applicable to the Walloon strategy was then used to feed into this strategy.

Each of the consultations was carried out in four stages.



Gestion des consultations	Management of consultations
Préparation	Preparation
Feedbacks	Feedback
Animation	Facilitation
Suivi	Monitoring

Preparation and feedback. The preparation phase allowed stakeholders, ahead of the meetings, to clearly understand the objectives of the strategy, the working group and the specific meeting, and also the data and assumptions used. To make the discussions as in-depth as possible, all participants were sent a draft list of responses to the working questions to generate maximum reaction during the consultations. Stakeholders provided a range of feedback, which was incorporated into the draft responses to be discussed.

Facilitation. To ensure that everyone could contribute to the discussions and share their point of view, the sessions sometimes took place in the form of roundtables and sometimes in sub-groups of five to ten people. All contributions were systematically summarised to ensure a good shared understanding.

Follow-up. A summary of the discussions was sent out after each meeting. The objections and suggestions received in response were considered in developing the content of the strategy.

TEAM

The analyses were carried out from September to December 2016, by the consortium led by Climact and made up of the consulting firm 3E and the Buildings Performance Institute Europe (BPIE). Several experts were invited to support the work and share lessons learned from pilot projects. These included the Belgian Building Research Institute (BBRI), Architecture et Climat, the Centre for Economic and Social Studies of the Environment (CEESE), the Economic Redeployment Group of Liège (GRE-Liège), the Institute for Climate Economics (I4CE), the négaWatt Institute and CAP 2020 (a group of Walloon enterprises active in the building industry).

The work was supervised by the Office for Sustainable Buildings of the Regional Energy Administration, and by the team at the Office of the Minister for Local Government, Cities, Housing, Energy and Infrastructure.

2) LIST OF STAKEHOLDERS CONSULTED

WG – Performance level

Academic

University of Louvain (UCL) – Architecture et Climat
University of Louvain (UCL) – Observatoire de l'Habitat
University of Mons (UMons)

Other experts

Centre d'Etudes en Habitat Durable (sustainable housing research centre – CEHD)

Financial

INCLUSIO [sustainable property fund]

Organisation

Passive House Platform

Building professionals

- CAP 2020
- CIR
- Cluster Eco-Construction
- Confédération Construction Wallonne
- BBRI
- Ordre des architectes
- PMC-BMP (Belgian Producers of Construction Materials)
- Union Wallonne des Architectes
- UPSI (Professional Union of the Real Estate Sector)
- VELUX

Associated sector professionals

- Agoria
- Essencia

Public sector

- Office of the Minister for Energy
- DGO4 – Energy and Sustainable Building
- DGO4 – Housing
- Environment and Energy Agency of the Brussels-Capital Region (IBGE)
- Union of Cities and Municipalities of Wallonia (UVCW)
- Vlaams Energieagentschap (Flemish Energy Agency)
- Public Service of Wallonia (SPW), sustainable development
- Walloon Air and Climate Agency (AwAC)

WG – Monitoring

Academic

- University of Mons (UMons)

Support

- IFAPME

Other experts

- Vesta Conseil&Finance

Social rental

- SWL [Walloon housing company]

Organisation

- Passive House Platform
- Walloon Network for Sustainable Access to Energy (RWADE)

Building professionals

- CAP 2020
- CIR
- Cluster Eco-Construction
- Confédération Construction Wallonne

Ordre des architectes
Union Wallonne des Architectes
UPSI (Professional Union of the Real Estate Sector)
VELUX
Renovate Europe

Associated sector professionals

Agoria
Essencia

Public sector

Office of the Minister for Energy
DGO4 – Energy and Sustainable Building
Environment and Energy Agency of the Brussels-Capital Region (IBGE)
Union of Cities and Municipalities of Wallonia (UVCW)
Vlaams Energieagentschap (Flemish Energy Agency)

WG – Financing

Academic

University of Liège (ULG)

Other experts

CEESE

Financial

BELESCO [Belgian association of energy service companies]
Belfius Bank and Insurance
INCLUSIO [sustainable property fund]
Triodos Bank
Financité [ethical finance network]

Social rental

SWL [Walloon housing company]

Organisation

Passive House Platform
Walloon Network for Sustainable Access to Energy (RWADE)

Building professionals

Cluster Eco-Construction
Confédération Construction Wallonne
Ordre des architectes
PMC-BMP (Belgian Producers of Construction Materials)
Union Wallonne des Architectes
UPSI (Professional Union of the Real Estate Sector)

Owners

SNPC [National union of owners and co-owners]

Public sector

Office of the Minister for Energy
DGO4 – Energy and Sustainable Building

Environment and Energy Agency of the Brussels-Capital Region (IBGE)

Union of Cities and Municipalities of Wallonia (UVCW)

WG – Implementation and tools

Support

Forem

IFAPME

Energy Audit Procedure (PAE) Auditor

Knowenergy/Confédération Construction Wallonne (CCW)

Other experts

CEESE

Centre d'Etudes en Habitat Durable (sustainable housing research centre – CEHD)

GRE-Liège

Consumers

Test-Achats

Organisation

Passive House Platform

Walloon Network for Sustainable Access to Energy (RWADE)

Building professionals

CAP 2020

Cluster Eco-Construction

Confédération Construction Wallonne

BBRI

Ordre des architectes

PMC-BMP (Belgian Producers of Construction Materials)

Union Wallonne des Architectes

UPSI (Professional Union of the Real Estate Sector)

Associated sector professionals

Essencia

Owners

SNPC [National union of owners and co-owners]

Public sector

Office of the Minister for Energy

DGO4 – Energy and Sustainable Building

DGO4 – Housing

Environment and Energy Agency of the Brussels-Capital Region (IBGE)

Union of Cities and Municipalities of Wallonia (UVCW)

Vlaams Energieagentschap (Flemish Energy Agency)

Public Service of Wallonia (SPW), sustainable development

Walloon Air and Climate Agency (AwAC)

B. UPDATED STRATEGY SUBMITTED IN 2020

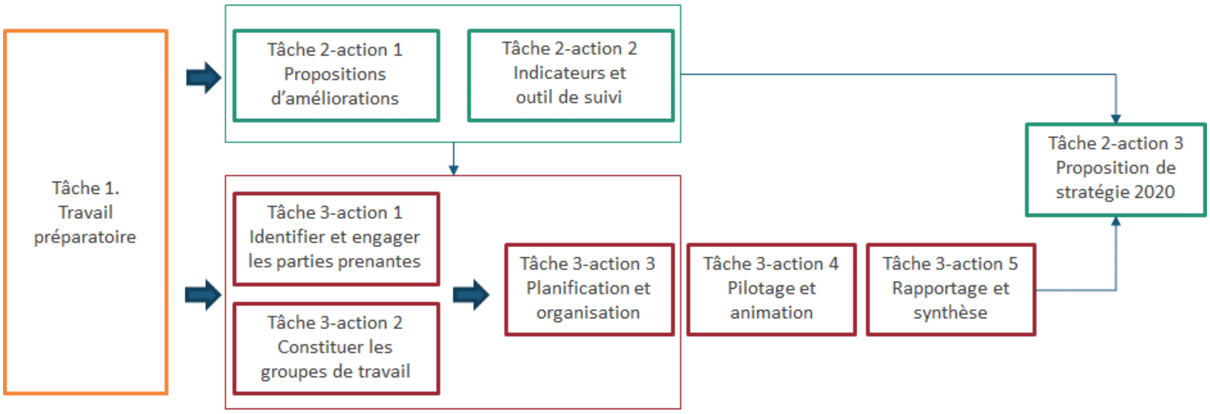
1) METHODOLOGY

LINKAGES

The Government has identified three main tasks in updating the strategy:

- Task 1 – preparatory work involved gathering the resources necessary to complete the exercise and identifying aspects where improvements or additions could or should be made. These aspects were prioritised in order to address some of them in more depth through in-house work and consultation with stakeholders;
- Task 2 – proposals were then drafted for improvement for the content of the strategy (Action 1) and in the indicators and monitoring tools (Action 2). These proposals will be integrated into the 2020 renovation strategy (Action 3) following sectoral consultation;
- Task 3 – the proposals drafted under Task 2 were discussed, challenged and developed in consultation with the stakeholders.

The figure below illustrates the sequencing of actions to enable interactions. For each of these tasks and actions, a specific methodology was developed to maximise the effectiveness and efficiency of the activities.



Tâche 1. Travail préparatoire	Task 1. Preparatory work
Tâche 2-action 1	Task 2 – Action 1
Propositions d'améliorations	Proposed improvements
Tâche 2-action 2	Task 2 – Action 2
Indicateurs et outil de suivi	Indicators and monitoring tool
Tâche 3-action 1	Task 3 – Action 1
Identifier et engager les parties prenantes	Identify and engage stakeholders
Tâche 3-action 2	Task 3 – Action 2
Constituer les groupes de travail	Establish working groups
Tâche 3-action 3	Task 3 – Action 3
Planification et organisation	Planning and organisation
Tâche 3-action 4	Task 3 – Action 4
Pilotage et animation	Steering and facilitation
Tâche 3-action 5	Task 3 – Action 5
Rapportage et synthèse	Reporting and synopsis
Tâche 2-action 3	Task 2 – Action 3
Proposition de stratégie 2020	2020 strategy proposal

WORKING GROUPS

Working groups were set up to deal with the aspects prioritised for improvement, with a view to 1) transpose Directive (EU) 2018/844 (EPBD) of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, and 2) ensuring effective implementation of this strategy.

The issues addressed in these working groups are presented below, and the stakeholders who participated are specified in the next section. Summaries of these discussions are available on the SPW TLPE (Public Service of Wallonia: Planning, Housing, Heritage and Energy) website, on the renovation strategy page.

The working groups discussed the following issues.

WG for split incentive and energy poverty (5/11/2019)

- Harnessing critical points in the landlord and rental housing process.
- How to combine improving the energy efficiency of private rental stock with accessibility to housing for vulnerable groups.

WG for public buildings (19/11/2019)

- Formulating an action plan to accelerate the energy renovation of public buildings in Wallonia.
- What mechanisms could be embedded in one-stop shop services to help mobilise investments?
- How do we best build on existing initiatives? How can they be strengthened, replicated or transposed to the scale of the Region in order to achieve 3% annual renovation and meet the energy performance objectives?
- What are the necessary conditions to ensure the success of measures to support the renovation of public buildings?

WG for investment mobilisation (3/12/2019)

- Developing one-stop shops: defining the role of one-stop shops, financial support, third-party financing and project aggregation.
    - What would be the role of a one-stop shop providing financial support and what would be the role of the Region?
    - Can we develop third-party investment in the renovation of private housing?
    - How can we enable project aggregation in the private residential buildings sector? Do the one-stop shops have a role to play here?
- Reducing the perceived risks of energy efficiency measures for investors, with a view to mobilising investments in renovation.
    - How can we improve and standardise the translation of energy efficiency aspects into risk indicators?
    - How can we offer more guarantees in order to reduce the technical risk associated with energy efficiency measures?
    - Mortgages and home loans – what mechanisms could we develop to reflect the positive impact of the energy efficiency project on the value of the asset and on the risk of default?
- Using public funds to leverage additional private sector investment / address market failures.
    - How can we promote access to credit for deep renovation for as many people as possible?
    - What mechanisms could we promote to mobilise citizens' savings / private investors and maximise the leverage effect of public funds?

WG for cross-cutting in government actions (20/1/2020)

- Identifying measures and actions to improve coherence between the various TLPE policies and achievement of the objectives pursued.

- **In terms of objectives and links between them**
    - Which objectives in the policies you are developing may impact or be impacted by the energy renovation of buildings?
    - What is the framework formalising these objectives? (Housing Code, regional development plan, Fast 2030, regional mobility strategy, etc.)
- **In terms of current measures and actions**
    - Which key measures may impact or be impacted by the energy renovation of buildings? How can we improve cross-cutting between these measures to seize the opportunity for synergies?
    - What tools are being implemented at regional or local level to put these measures into operation?
    - What are potential or observed deviations in the use of these tools with regard to the different objectives? How can we better define the use of tools in line with the objectives?
- **In terms of improving cross-cutting**
    - How can we improve cross-cutting at the different levels of power?
    - What can we put in place to achieve buy-in from local authorities in this process?
    - What model cross-cutting actions would it be helpful to develop?

Cross-cutting WG for the presentation and discussion of update proposals (21/1/2020)

- Presenting the main proposals for updating the renovation strategy.
- Sharing reactions and questions from participants.
- Collecting written summaries on priorities and key measures to remove the remaining barriers to these measures and actions.

2) LIST OF STAKEHOLDERS CONSULTED

WG – Split incentive and energy poverty

Surname	First name	Organisation
Anfrie*	Marie-Noëlle	Centre d'Etudes en Habitat Durable (sustainable housing research centre – CEHD)
Biquet	Véronique	ACE Retrofitting - Liège
Borsus	Alexandre	UWAIS [Walloon union of social housing agencies]
Callewaert*	Philippe	PMC-BMP (Belgian Producers of Construction Materials)
Chamcham	Salim	Confédération Construction Wallonne
Ciuti*	Aurélie	Réseau Wallon de Lutte Contre la Pauvreté (Walloon Anti-Poverty Network)
Collignon	Arnaud	IEW (Inter-Environnement Wallonie)
Coumanne	Fabienne	ACE Retrofitting - Liège
Crèvecoeur	Natacha	SPW - CST [Public Service of Wallonia cross-cutting strategy unit]
Delpierre	Frédéric	Fonds du logement de Wallonie (Walloon Housing Fund)
Deproost	Magali	SPW - Sustainable development
Duquesne	Marianne	Union of Cities and Municipalities of Wallonia (UVCW)
Galerin	Julien	Guichet Énergie Wallonie [Walloon energy information desk]
Glineur	Monique	SPW - TLPE - Energy and Sustainable Building
Gustin	Pierre	ING
Jandrain	Luc	SPW - TLPE - Housing
Jossen	Quentin	Climact
Joukovsky	Anastasia	Université Libre de Bruxelles (ULB) - CEESE
Meyer	Sandrine	Université Libre de Bruxelles (ULB) - CEESE
Minjauw	Elisabeth	BNP PARIBAS FORTIS
Motte	Sébastien	Union Wallonne des Architectes
Piccirilli	Sara	SPW - TLPE - Energy and Sustainable Building
Piron	Bernard	UPSI (Professional Union of the Real Estate Sector)
Poskin	Hervé-Jacques	Cluster Eco-Construction
Praile	David	RWDH [Walloon assembly for the right to housing]
Renard	Céline	SPW - TLPE - Energy and Sustainable Building
Stevens	Joël	Walloon Social Credit Association (SWCS)
Van Ermen	Yves	FEDERIA
Van Rillaer	Lionel	INCLUSIO [sustainable property fund]
Van Cauwenberghe	Thierry	Office of the Minister for Energy
Vignisse	Christelle	Guichet Énergie Wallonie [Walloon energy information desk]
Vos	Laurent	CBC Bank & Insurance

*** Absent**

WG – Public buildings

Allard	Christian-Marie	SPW - Mobility and infrastructure
Baron	Michaela	SPW - Taxation
Bataille	Gwennaël	SPW - TLPE - Sustainable buildings
Botton	Caroline	Province du Hainaut
Capart	Raphael	Energy facilitator for non-residential
Cattalini	Nathalie	IGRETEC
De Meulemeester	Hugues	Climact
Declerck	Joost	Belfius Bank and Insurance
Delhaye	Quentin	Association des provinces wallonnes [association of Walloon provinces]
Deproost	Magali	SPW - Sustainable Development
Doneux	Julien	Bruxelles Environnement
Dupont	Ornella	SPW - TLPE - Energy and Sustainable Building
Duquesne	Marianne	Union of Cities and Municipalities of Wallonia (UVCW)
Giuliana	Samuel	SPW - TLPE - Sustainable Buildings
Glineur	Monique	SPW - TLPE - Energy and Sustainable Building
Hofer	Benoit	CAP Construction
Jossen	Quentin	Climact
Lasri	Salma	Renowatt
Lattenist	Guy	SeGEC (General Secretariat of Catholic Education)
Madam	Christophe	FWB (French Community)
Mahaux	Nancy	BEP [responsible for the economic, social and environmental development of the province of Namur]
Mariage	Alain	SPW - Directorate-General for Public Buildings
Motte	Sébastien	Union Wallonne des Architectes
Pevenage	Valérie	SPW - TLPE - EPB (energy performance of buildings)
Piron	Bernard	UPSI (Professional Union of the Real Estate Sector)
Poskin	Hervé-Jacques	Cluster Eco-Construction
Renard	Céline	SPW - TLPE - Energy and Sustainable Building
Spies	Nicolas	Confédération Construction Wallonne
Van Moeseke	Geoffrey	University of Louvain (UCL) – Architecture et Climat
Vancauwenberghe	Thierry	Office of the Minister for Energy
Vanstraelen	Lieven	BELESCO [Belgian association of energy service companies]

WG: Investment Mobilisation

Anfrie	Marie-Noëlle	Centre d'Etudes en Habitat Durable (sustainable housing research centre – CEHD)
Baron	Michaela	SPW - Taxation
Bayot	Bernard	Financité [ethical finance network]
Bogaert	Gérald	Europabank
Chamcham	Salim	Confédération Construction Wallonne
Collignon*	Arnaud	IEW (Inter-Environnement Wallonie)
Comblin	Daniel	Corenove
Delpierre	Frédéric	Fonds du logement de Wallonie (Walloon Housing Fund)
Dineur	Lise	Financité [ethical finance network]
Duquesne	Marianne	Union of Cities and Municipalities of Wallonia (UVCW)
Franck	Pierre-Alain	UPSI (Professional Union of the Real Estate Sector)
Glineur	Monique	SPW - TLPE - Energy and Sustainable Building
Gouthière	Isabelle	SPW - TLPE - Housing
Gun	Gedik	Liège Energie
Hallet	Geneviève	Credal
Hofer*	Benoit	CAP Construction
Jossen	Quentin	Climact
Joukovsky*	Anastasia	Université Libre de Bruxelles (ULB) - CEESE
Laureys	Thierry	Energie & Développement Local
Sylvie	Magali	Public Service of Wallonia (SPW), sustainable development
Meyer	Sandrine	Université Libre de Bruxelles (ULB) - CEESE
Monfort	Nathalie	Gaume Energie
Moric	Kim	BeeBonds
Motte	Sébastien	Union Wallonne des Architectes
Persy	Davy	CBC Bank & Insurance
Romnée	Ambroise	Bruxelles Environnement
Stevens	Isabelle	Triodos Bank
Stevens	Joël	Walloon Social Credit Association (SWCS)
Van Bulck	Ivo	Febelfin - UPC - BVK
Vancauwenberghe	Thierry	Office of the Minister for Energy

WG – Cross-cutting between government actions

Department	Name
Heritage (AWaP)	Thomas DERUYVER Pascal DELHAYE
Planning (DATU)	Thierry BERTHET Claire VANSCHEPDAEL Sylvie LJUBICIC
Housing	Philippe CARLIER Laurence LAMBERT
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Delhaye	Quentin	APW [Association of Walloon provinces]
Delhaye	Pascal	AWAP (Walloon Heritage Agency) - DZO
Delpierre	Frédéric	FLW (Walloon Housing Fund)
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Dion	Laurent	SWL [Walloon housing company]
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Doison	Denis	Province de Hainaut
Doquire	Gaëtan	UWA (Union Wallonne des Architectes)
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Dupont	Ornella	SPW - Energy
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Francois	Nathalie	Credal
Galet	Sandrine	FEDERIA
Gedik	Gun	LIEGE-ENERGIE ASBL
Genin	Céline	FedNot

Gouthière	Isabelle	SPW
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Graff	Véronique	GreenWin
Heijmans	Nicolas	BBRI
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Jossen	Quentin	Climact
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Lambert	Carine	essenscia wallonie
Lathiers	Marion	Climact
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Ombelets	Nathalie	SWCS (Walloon Social Credit Association)
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Praile	David	Rassemblement Wallon pour le Droit à l'Habitat [Walloon assembly for the right to housing]
Renard	Céline	SPW
Schlitz	Marc	City of Liège
Simon	Julien	Office of Minister Alain Maron
Spies	Nicolas	CCW (Confédération Construction Wallonne)
Stevens	Joel	SWCS (Walloon Social Credit Association)
Thomas	Yasmine	Belfius Bank
Van Cauwenberg	Thierry	Cabinet of Walloon Minister Henry
van Goethem	Carole	TLPE - Sustainable Building
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Van Rillaer	Lionel	Inclusio
Vanderzeypen	Bénédicte	SPW

Vanstraelen	Lieven	Energinvest
Vermeiren	Roel	Vlaams Energieagentschap (Flemish Energy Agency)
Vermeulen	Pascal	Climact
Watillon	Nicolas	Federia
Zuinen	Natacha	SPW
Spies	Benoit	Cabinet of Minister Henry

Annexe 2. Additional description of the building stock

This chapter describes the current situation of the building stock: constitution (type of buildings, year of construction), type of occupation, consumption and energy performance.

The chapter is divided into two sections: the first describing the housing stock, the second the commercial building stock.

Wallonia has a single climatic zone; in fact there are no different climatic zones in Belgium given all the local weather data (temperature, sunshine, wind, humidity, etc.). On this basis, no distinction is therefore made in the following paragraphs.

The main documents considered in preparing this chapter were the following:

- literature reviews and selected typologies representative of the building stock from the COZEB[1] extension study. This study is briefly presented in Chapter II (Section A.1);
- Walloon energy balances.

A. ADDITIONAL DESCRIPTION OF THE HOUSING STOCK

Since the 1980s, urbanisation has continued to increase in Wallonia: in less than 20 years, the total area of Walloon buildings increased by 18%. Previously limited to land close to existing towns and villages, it now affects the entire territory, down to the most remote rural areas[2].

In reaction to the increasing and diffuse urbanisation of the Walloon territory, the sparing use of land and improved structuring of the territory are enshrined in the legislation (SDT (Regional Development Plan)[3], CoDT (Territorial Development Code)[4]) that provides the main guidelines for spatial planning in Wallonia. The renovation of existing buildings and the reuse of brownfield sites and already urbanised areas are important tools for curbing this diffuse growth[5].

The most frequent problems[6] with housing quality are found in urban centres and homogeneous built-up areas (social housing districts).

[1] COZEB: Cost-Optimal Zero-Energy Buildings.
[2] Solen-energie.be.
[3] Regional Development Plan
[4] Territorial Development Code.
[5] Sustainable energy renovation of Walloon housing. Analysis of existing buildings and identification of priority housing typologies. Architecture et Climat, 2008.
[6] Humidity, sound insulation, lack of central heating, lack of thermal insulation, etc.

1) CONSTRUCTION PERIOD AND LINK WITH ENERGY PERFORMANCE OF BUILDINGS[7]

The date of construction is a key element in determining performance. Table 1 below breaks down the types of buildings by construction period; the data are from the Walloon Region Housing Quality Survey (2006-2007).

Table 1. Construction dates for housing stock in Wallonia.

Building type	Construction period					
	Pre-1919	1919-1945	1946-1970	1971-1990	Post-1990	Total
Single-family home	27.6%	19.8%	22.6%	19.2%	10.8%	100%
Apartment building	12.3%	10.8%	35.2%	18.9%	22.7%	100%
Multi-dwelling building	31.3%	24.7%	24.3%	11.3%	8.4%	100%

- Before 1921, it was mainly workers' houses that were built in or near towns, while vernacular architecture dominated in rural areas.
- From 1922 to 1945, we saw the appearance of village houses, of fairly simple and large structure, built with industrial materials (concrete, bricks). Towns also saw the appearance of *maisons de maître* ('masters' houses').
- From 1946 to 1970, the towns expanded and housing developed on the outskirts. It was a time of intense real estate activity due to the emergence of new financing systems and construction techniques, and the development of private cars. Villas were built in the first urban expansions.
- From 1971 to 1984, increasing numbers of the Walloon population left the towns. Development could be observed in particular in the Walloon Brabant province, and more generally in the suburbs, where detached villas were starting to appear.
- In 1985, the first Walloon thermal regulations stipulated an insulation rating of K70[8]. Any housing built from this date must comply with this requirement, which stipulates the insertion of several centimetres of insulation in the roof, walls and floor, and also double glazing. In the suburbs, the developments comprising detached houses dominate.
- In 1996, the second Walloon thermal regulation stipulated an insulation rating of K55. Thicker insulation needed to be inserted in the various heat loss surfaces. The ventilation regulations (NBN D50-001 standard) further stipulated that homes must be equipped with all the necessary features for efficient ventilation of the building.
- From 2004 to 2011, the *Construire Avec L'Energie* ('Building With Energy' – CALE) initiative encouraged building to be more efficient than the regulations in force. CALE motivated and rewarded efforts made during construction by granting bonuses. The most efficient CALE houses achieved a performance level of **K35, EW70**and specific primary energy consumption not exceeding **120 kWh/m²/yr.**
- From 2008, the European Energy Performance of Buildings Directive was transposed into Walloon law and set the requirements at a level applicable in Wallonia. It stipulated a performance level of K45, an EW level of less than 100 and specific primary energy consumption not exceeding

[7] *Ibid.*
[8] The coefficient K has no unit. It represents a value that should not be exceeded. This value reflects the compactness of the building and the average insulation of the building envelope.

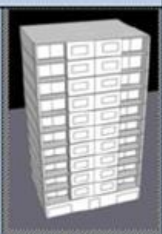
170 kWh/m²/yr. (Source: COZEB extension study. Overview of existing residential building stock in Wallonia, UMons, ULg, February 2015).

The COZEB extension study categorised 15 types of single-family homes and 10 types of apartment buildings. This typology is illustrated in the figures below. Details of the technical specifications for each of these typologies are available in the study reports.

	Maison 4 façades	Maison 3 façades	Maison mitoyenne
< 1945	Maison de type vernaculaire (1) 	Maison de type ouvrière, avec passage latéral (2) 	Maison de type ouvrière (3) 
	6%	4%	15%
45%	Maison villageoise, entre deux guerres (4) 		Maison urbaine moyenne (5) 
	4%		16%
De 1946 à 1970 20%	Villa des premières extensions urbaines (6) 		Maison de type bel-étage (8) 
	10%		4%
	Villa de plain-pied, en périphérie de la ville (7) 		
	6%		
De 1971 à 1984	Villa 4 façades, de type lotissement (9) 		Maison «sociale», barre de logements (10) 
15%	12%		3%
De 1985 à 1995	Villa 4 façades, de type lotissement, K70 (11) 	Maison 3 façades avec garage latéral, K70 (12) 	Maison type bel-étage, K70  (13)
10%	6%	2%	2%
De 1996 à 2008	Villa 4 façades, de type lotissement, K55 (14) 		Maison ossature bois, type éco-quartier, K55 (15) 
10%	7%		3%

	Detached house	Semi-detached house	Terraced house
Pre-1945 45%	Vernacular style house (1)	Worker's house, with side passage (2)	Worker's house (3)
	6%	4%	15%
	Village house, inter-war period (4)		Average town house (5)
	4%		16%
1946 to 1970 20%	Detached house from first urban expansions (6)		Town house (8)
	10%		4%
	Single storey detached, on outskirts of town (?)		
	6%		
1971 to 1984 15%	Detached, housing development style (9)		'Social' housing, residential block (10)
	12%		3%
1985 to 1995 10%	Detached, housing development style, K70 (11)	Semi-detached house with side garage, K70 (12)	Town house, K70 (13)
	6%	2%	2%
1996 to 2008 10%	Detached, housing development style, K55 (14)		Wooden frame house, eco-district style, K55 (15)
	7%		

Figure 3. 15 types of existing single-family homes were examined in the COZEB II study.

	Immeuble à appartements	Dans une maison ou sur un commerce
< 1919	7,7% [1] 	11,7% [2] [3] 
De 1919 à 1945	6,8%	9,3% [4] 
De 1946 à 1970	  22,0% [5] … …[6]	9,1% [7] 
De 1971 à 1990	11,8% [8] 	4,2%
Après 1990	14,2% [9] [10]  	3,2%
TOTAL	62,5%	37,5%

	Apartment building		Within a house or over a shop
Pre-1919	7.7% [1]		11.7% [2] [3]
1919 to 1945	6.8%		9.3% [4]
1946 to 1970	22.0% [5]	[6]	9.1% [7]
1971 to 1990	11.8% [8]		4.2%
Post-1990	14.2% [9] [10]		3.2%
TOTAL	62.5%		37.5%

Figure 4. 10 types of apartment buildings were examined in the COZEB II study.

2) ENERGY PERFORMANCE

The breakdown of housing by EPB rating is presented in Section IA of the main strategy report.

The EPB rating reflects consumption for heating, domestic hot water production, auxiliary devices and, if applicable, cooling. The Espec indicator assessed in the certificate represents the primary energy consumption of buildings, per square metre, under standardised conditions. This is different to the actual energy consumption of buildings for heating. In fact, the ‘actual’ consumption of the least efficient buildings can be seen to be virtually half their theoretical consumption.[9] The explanation is that the theoretical consumption is calculated assuming that the entire premises is heated to a constant temperature and it does not reflect the behaviour of the occupants (who do not occupy – or do not heat – the entire premises). Conversely, the actual consumption of the most efficient homes can sometimes be slightly higher than the theoretical consumption, mainly due to improper use of the building’s features and/or increased user comfort requirements (rebound effect linked to lower energy bills).

3) SPATIAL DISTRIBUTION – URBAN CENTRES, SUBURBS AND COUNTRYSIDE

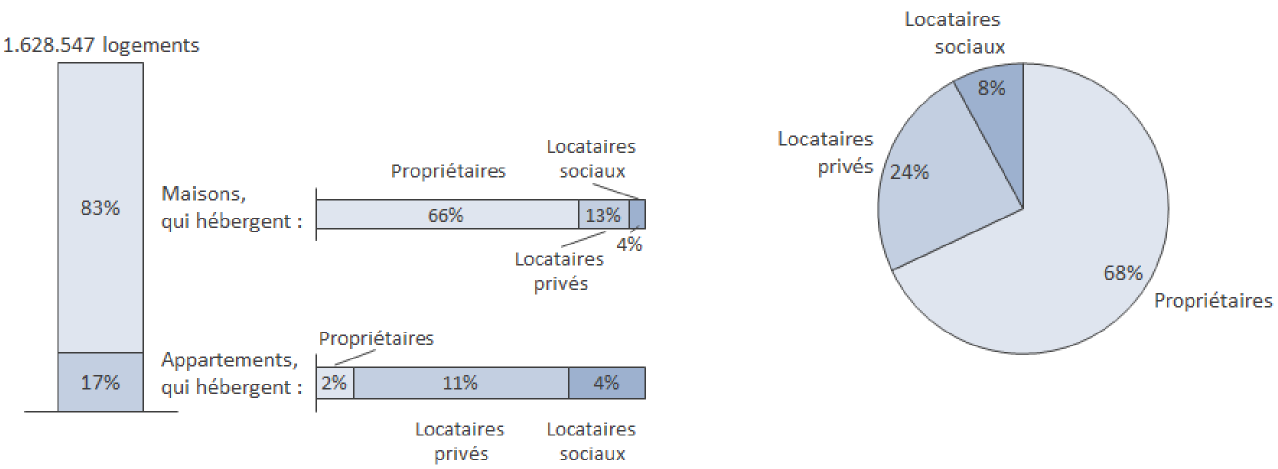
Today, each inhabitant uses five to ten times more space for their home, work and leisure than in 1900. As a result, the urban fringes are expanding by encroaching on rural areas, while at the same time we are witnessing a reduction in population density in the urban centres.

In Wallonia, the average population density is approximately 205 inhabitants/km² and there are almost 90 houses/km². However, this distribution is not homogeneous throughout the region. Analysis of the various maps produced for the 2001 socio-economic survey[10] clearly highlights the high concentration of urbanisation and housing along the Sambre-et-Meuse valley and in the north of the German-speaking Region. The provinces of Hainaut and Liège are the most populated: they account for more than 70% of housing in Wallonia. Half of the Walloon territory is covered by agricultural land and one third by woodland. The remaining area (approximately 14%) is urbanised: buildings, gardens, roads. These urbanised areas are mainly located at an altitude <200 m (less harsh climate), on land with moderate relief (gradient <7%).

4) OWNERSHIP AND OCCUPANCY PROFILE

68% of Walloons own their homes, 24% live in private rental housing and 8% live in public rental properties. It should be noted that most of the rented accommodation is located in town or on the outskirts.

[9] COZEB extension study, Department of Energy and Sustainable Building, SPW-DGO4, 2016. Task 1 report – Comparison of actual consumption with theoretical consumption.
[10] DGSIE, FPS Economy.



1.628.547 logements	1 628 547 homes
83%	83%
17%	17%
Maisons, qui hébergent :	Houses, occupied by:
Propriétaires	Owners
66%	66%
Locataires sociaux	Social tenants
4%	4%
Locataires privés	Private tenants
13%	13%
Appartements, qui hébergent :	Apartments, occupied by:
Propriétaires	Owners
2%	2%
Locataires privés	Private tenants
11%	11%
Locataires sociaux	Social tenants
4%	4%
Locataires sociaux	Social tenants
8%	8%
Locataires privés	Private tenants
24%	24%
Propriétaires	Owners
68%	68%

Figure 5. Type of housing occupancy [Walloon housing, UCL].

5) RENOVATION

Each year, around 1% of housing is subject to a planning application for conversion work (either privately or with a view to availability on the rental market). About 20% of homes built before 1921 have been converted in the past 15 years.

As illustrated in the figures below, the energy renovations cover the following aspects[11].

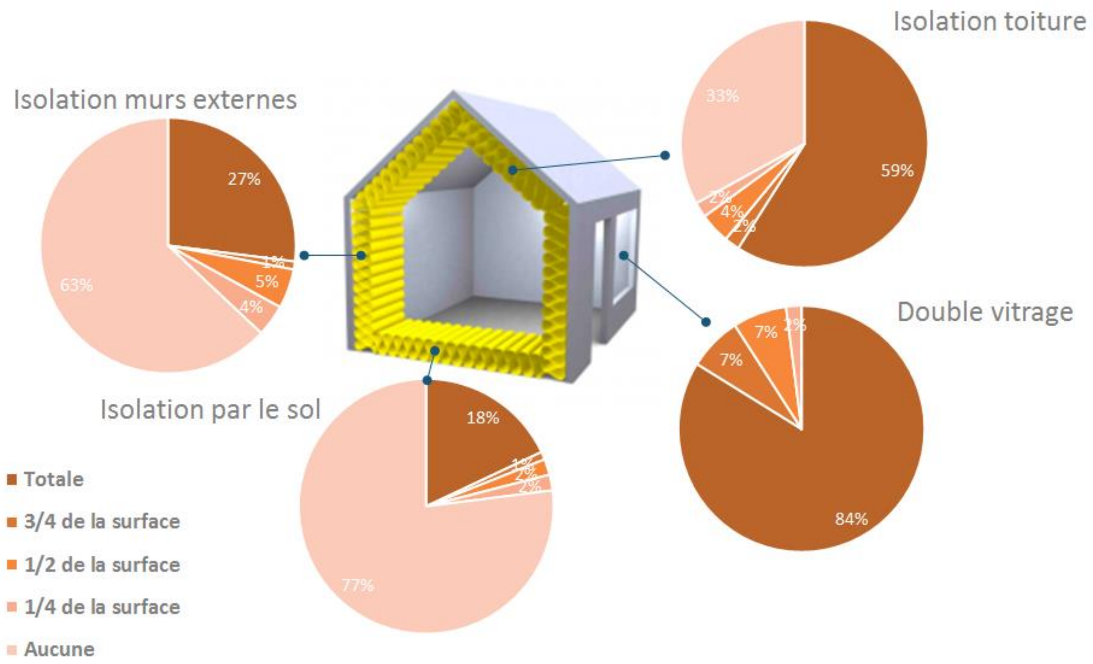
- Floors **Floors are very poorly insulated in Walloon housing**. 18% of homes have entire floor slab insulation, compared with 77% with no insulation and 5% with partial floor insulation. The floor is a heat loss surface that is very rarely retrofitted with insulation (in particular due to the difficulty in execution and cost of the work).

[11] Source: Energy Consumption Survey 2012

- Walls **27% of homes have full wall insulation** (internal, external or cavity), 63% have no insulation and 10% have partial wall insulation. Since 2001, there has been an increase of around 4% in homes with wall insulation.

- Windows and doors **83% of houses have double glazing** (69% of which is efficient double glazing). Single-glazed windows are the first elements of the building to be subject to energy renovation work. Over 12% of additional homes were fitted with double glazing between 2001 and 2010.

- Roofs **59% of Walloon homes have full roof insulation** and 33% of homes have no roof insulation. The proportion of insulated roofs increased by around 15% between 2001 and 2010.



Isolation murs externes	External wall insulation
63%	63%
27%	27%
1%	1%
5%	5%
4%	4%
Isolation par le sol	Floor insulation
77%	77%
18%	18%
1%	1%
2%	2%
2%	2%
Isolation toiture	Roof insulation
59%	59%
33%	33%
2%	2%
4%	4%
2%	2%
Double vitrage	Double glazing
84%	84%
7%	7%
7%	7%
2%	2%
Totale	Total
3/4 de la surface	3/4 of surface area
1/2 de la surface	1/2 of surface area
1/4 de la surface	1/4 of surface area

Aucune	None

Figure 6. Insulation of Walloon homes (data from the Energy Consumption Survey 2012)

In terms of energy performance, apartments present certain specificities:

- Co-ownership makes it difficult to undertake an overall renovation of the building. In most cases, energy retrofits are undertaken separately by each owner and are limited to replacing windows and systems where these are separate.
- Most apartments are occupied by tenants. Although this does not affect the geometry or type of home, it has implications for energy performance. This is because owners are less inclined to invest in renovation since they do not directly benefit from the effects of energy improvement.

Even if all the apartments in the same building have the same envelope and system characteristics, they do not all offer the same performance: for example, a top-floor corner apartment in a large building has a greater heat loss surface than an 'embedded' apartment in the centre of the same building, where most of its walls are party walls.

6) ENERGY CONSUMPTION AND PERFORMANCE OF BUILDINGS REPRESENTATIVE OF THE STOCK

For detailed and up-to-date information on the consumption and energy performance of buildings representative of the Walloon residential real estate stock, please refer to the descriptive sheets for existing residential buildings, produced in 2016 to define the cost-optimal energy performance level (COZEB II). In particular:

- the description of existing single-family homes: https://www.dropbox.com/s/pomytl2iji5n8u8/COZEB3-fiches-habitation.pdf?dl=0,
- the description of existing apartment buildings: https://www.dropbox.com/s/wm4e2wqpp0r3w0j/COZEB3-fiches-immeubleapp.pdf?dl=0.

CONSTRUCTION TYPE AND TYPICAL U-VALUE OF MAIN CONSTRUCTION ELEMENTS

The typical composition and thermal characteristics of the main construction elements are presented in Table 2, by year of construction of the buildings.

Table 2. Thermal characteristics of wall surfaces by date of construction in Belgium [TABULA study].

Wall surface composition				
Year of construction	Roofs	Walls	Floor slab	Windows
<1945	Timber frame roof (tiles or slates), no interior finish, adjacent to an EANC[12]1.7 W/m²K	Solid brick walls (30 cm thick)2.2 W/m²K	Stone or concrete floor, without insulation0.85 W/m²K	Single glazing, wooden frame5 W/m²K
1946-1970	Timber frame roof (tiles or slates), with interior finish1.9 W/m²K	Bricks, 5 cm air gap, no insulation, load-bearing blocks1.7 W/m²K	Stone or concrete floor, without insulation0.85 W/m²K	Single glazing, wooden frame5 W/m²K
1971-1990	Timber frame roof (tiles or slates), 4 cm	Bricks, ventilated air gap with 2 cm of	Stone or concrete, without	Double glazing, metal frame

[12] *Espace Adjacent Non Chauffé* (adjacent unheated space).

	insulation between rafters, with interior finish0.85 W/m²K	insulation, load-bearing blocks1.0 W/m²K	insulation0.85 W/m²K	4.3 W/m²K
1991-2005	Timber frame roof (tiles or slates), 8 cm insulation between rafters, with interior finish0.60 W/m²K	Bricks, ventilated air gap with 6 cm of insulation, load-bearing blocks0.6 W/m²K	Concrete and screed, without insulation0.70 W/m²K	Double glazing, aluminium frame, thermal break 3.5 W/m²K
> 2006	Timber frame roof (tiles or slates), 12 cm insulation between rafters, with interior finish0.3 W/m²K	Bricks, ventilated air gap with 8 cm of insulation, load-bearing blocks0.4 W/m²K	Concrete, 5 cm insulation (or insulating screed)0.40 W/m²K	Double glazing, aluminium frame, thermal break 2 W/m²K

AIR TIGHTNESS

For existing buildings, the loss per unit area used for the reference building is taken from the TABULA study[13]. This value depends on the typology studied (see Table 3 below).

Different values are thus used for infiltration and exfiltration.

Table 3. Infiltration/exfiltration values.

Infiltration/exfiltration at 50Pa [$m^3/h.m^2$]					
	Detached	**Semi-detached**	**Terraced**	**Enclosed apartment**	**Exposed apartment**
Pre-1971	18	18	14.9	14.9	14.9
1971-1990	17.1	16.3	14.1	14.1	14.1
1991-2005	12	12	10	10	10
Post-2005	6.1	6.3	6	6	6
EPB 2010 upgrade scenario	6	6	6	6	6
Low Energy upgrade scenario	2.5	2.5	2.5	2.5	2.5

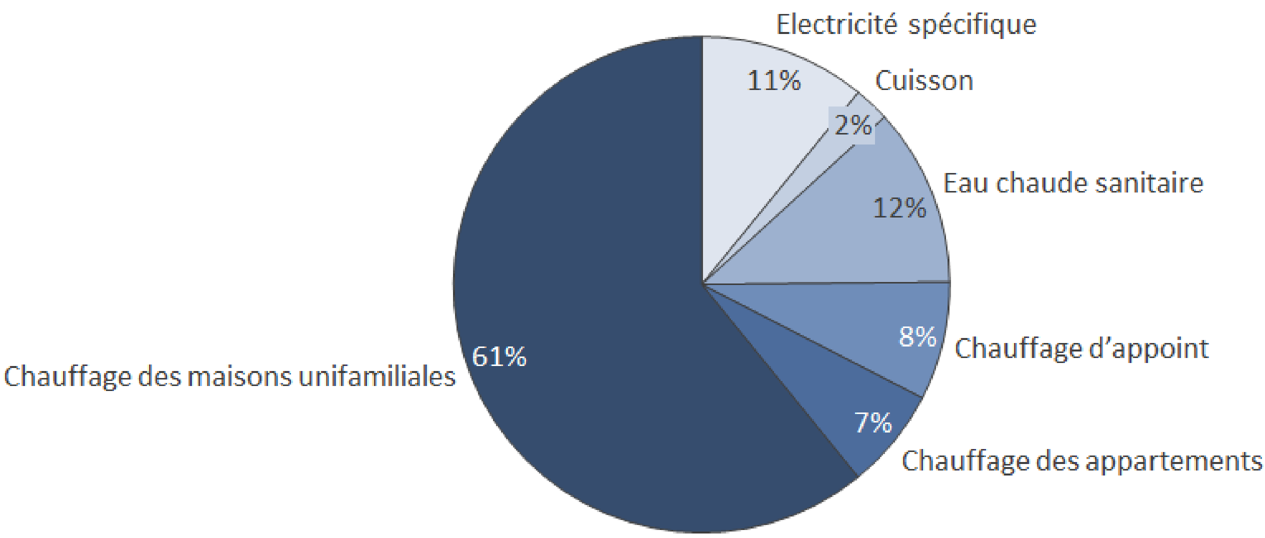
Replacing windows, or carefully insulating the roof and/or walls, can significantly improve the air tightness of the building. The COZEB extension study considers that in renovating existing housing, the general aim is to achieve air tightness of around 4.5 m^3/hm^2. As long as particular care is taken with connections and joints, and there is an emphasis on quality work, the estimated improvement in air tightness compared to the reference building in the TABULA study is as follows:

- **replacing windows**: 20% to 35% improvement in air tightness;
- **Insulating roofs:** 5% to 20% improvement in air tightness;
- **replacing windows and insulating roofs**: 25% to 55% improvement in air tightness;
- **replacing windows, insulating roofs and insulating walls**: 30% to 70% improvement in air tightness;
- **replacing windows, insulating roofs, insulating walls and insulating floors:** 55%-75% improvement in air tightness;
- **complete insulation of home to passive house standards**: a maximum target value of 2.5 m^3/hm^2 can be achieved, or an overall improvement of around 85% compared to the baseline air tightness of the building.

ENERGY CONSUMPTION BY USE

In Walloon housing, more than 75% of energy consumption relates to heating (Source: Walloon energy balance 2017). A breakdown of final energy consumption in the residential sector in 2017, by main use, house type, heating type and energy carrier, is given in Figure 7 and Figure 8.

[13] http://www.building-typology.eu/.



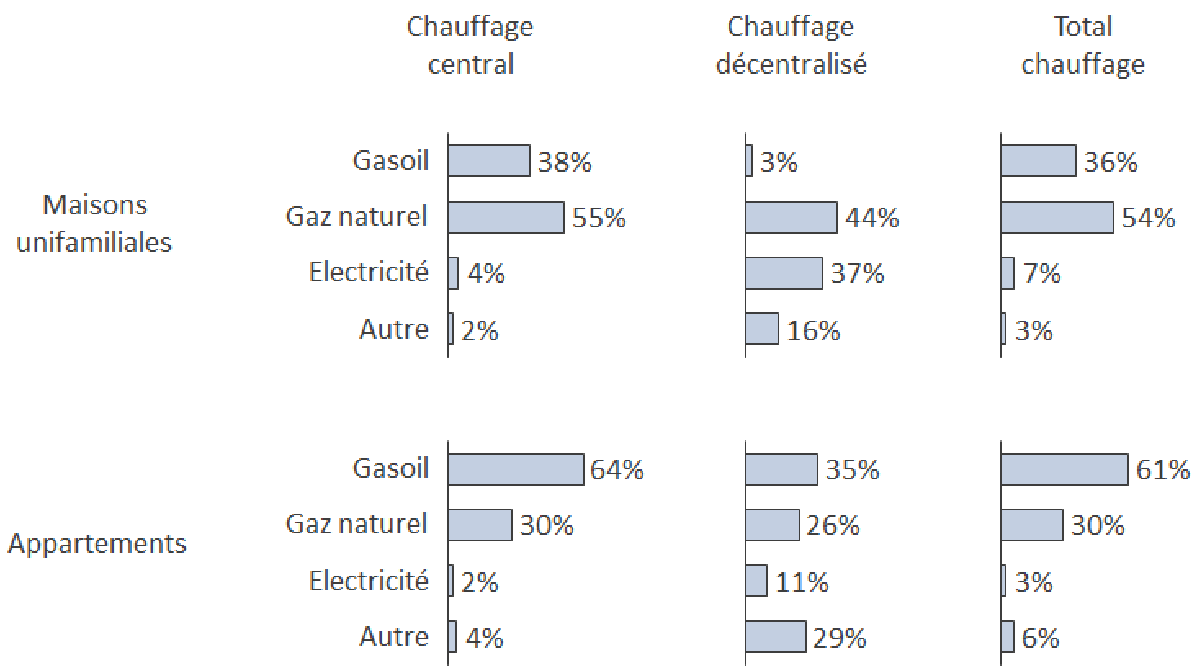
Chauffage des maisons unifamiliales	Heating of single-family houses
61%	61%
Electricité spécifique	Specific electricity
11%	11%
Cuisson	Cooking
2%	2%
Eau chaude sanitaire	Domestic hot water
12%	12%
Chauffage d'appoint	Auxiliary heating
8%	8%
Chauffage des appartements	Apartment heating
7%	7%

Figure 7. Breakdown of corrected final energy consumption, by housing type and by use

ENERGY CONSUMPTION BY CARRIER

In 2017, in the residential sector in Wallonia, the most widely used energy carrier for heating was fuel oil (59%), followed by natural gas (32%). The following are other sources of energy used for heating: electricity (3%), wood (3%), propane/butane (1%) and coal (1%). The use of renewable energy sources and heat pumps is still negligible (less than 1%).

70% of homes are equipped with central heating, 20% are supplied by a local heat source and 10% are heated by a common installation (e.g. in apartment buildings or certain housing clusters).



Maisons unifamiliales	Single-family houses
Chauffage central	Central heating
Gasoil	Oil
38%	38%
Gaz naturel	Natural gas
55%	55%
Electricité	Electricity
4%	4%
Autre	Other
2%	2%
Chauffage décentralisé	Decentralised heating
3%	3%
44%	44%
37%	37%
16%	16%
Total chauffage	Total heating
36%	36%
54%	54%
7%	7%
3%	3%
Appartements	Apartments
Gasoil	Oil
64%	64%
Gaz naturel	Natural gas
30%	30%
Electricité	Electricity
2%	2%
Autre	Other
4%	4%
35%	35%
26%	26%
11%	11%
29%	29%
61%	61%
30%	30%
3%	3%
6%	6%

Figure 8. Breakdown of corrected final energy consumption in the residential sector, by main use, in 2017

[Walloon energy balance]

HVAC SYSTEMS: TYPE, PERFORMANCE LEVEL AND CONTROL

The heating systems installed respectively in the reference single-family residential dwellings and in the reference apartment buildings considered in the COZEB studies are described in the reports for which links are given on page 32. The different systems identified are detailed below.

<table>
<tr><th></th><th>CNC gas 70%</th><th>CNC gas 72%</th><th>CNC gas 76%</th><th>CH gas 107%</th><th>CNC oil 70%</th><th>CNC oil 76%</th><th>CNC oil 90%</th></tr>
<tr><td>Efficiency at 30% load</td><td>70%</td><td>72%</td><td>76%</td><td>107%</td><td>70%</td><td>76%</td><td>90%</td></tr>
<tr><td>Above protected volume</td><td colspan="3">Yes/No (case by case)</td><td>No</td><td>Yes/No (case by case)</td><td></td><td>No</td></tr>
<tr><td>Return temp. at 30% load</td><td></td><td></td><td></td><td>30°C</td><td></td><td></td><td></td></tr>
<tr><td>Boiler at constant temp.</td><td>Yes</td><td colspan="3">No</td><td>Yes</td><td colspan="2">No</td></tr>
<tr><td>Default value for return temp.</td><td></td><td></td><td></td><td>Yes</td><td></td><td></td><td></td></tr>
<tr><td>Pilot</td><td colspan="2">Yes</td><td colspan="2">No</td><td></td><td></td><td></td></tr>
<tr><td>Fan</td><td colspan="3">No</td><td>Yes</td><td></td><td></td><td></td></tr>
<tr><td>Electronic regulation</td><td colspan="2">No</td><td colspan="2">Yes</td><td>No</td><td>Yes</td><td></td></tr>
<tr><td>Storage system</td><td colspan="7">Absent</td></tr>
<tr><td>Auxiliary circulator</td><td colspan="2">Per unit without regulation</td><td colspan="2">Per unit with regulation</td><td>Per unit without regulation</td><td colspan="2">Per unit with regulation</td></tr>
<tr><td>Supply</td><td colspan="7">Simplified calculation + pipes above/within protected volume (case by case)</td></tr>
<tr><td>Emission</td><td colspan="7">Simplified calculation + radiators</td></tr>
<tr><td>Emitters in front of glass</td><td colspan="7">No</td></tr>
<tr><td>Ambient temp. regulation by premises</td><td>No</td><td colspan="3">Yes</td><td>No</td><td colspan="2">Yes</td></tr>
</table>

Constant water/air start temp.	Yes	No	Yes	No

Table 1 – Characteristics of heating systems in existing residential dwellings

	CH gas 75%	CH gas 82%	CH gas 102%	CH gas 108%	CH Oil73%	CH Oil82%
Efficiency at 30% load	75%	82%	102%	108%	73%	82%
Above protected volume	Yes	Yes/No (case by case)	No	Yes		
Return temp. at 30% load			40°C	30°C		
Boiler at constant temp.	Yes		No		Yes/No (case by case)	No
Default value for return temp.			Yes			
Pilot	Yes		No			
Fan	No		Yes			No
Electronic regulation	No		Yes		No	
Storage system	Absent	Absent/present in protected volume (case by case)	Absent			
Auxiliary circulator	Per unit without regulation	Per unit without/ with regulation (case by case)	Per unit with regulation		Per unit without regulation	
Supply	Simplified calculation + pipes above/within protected volume (case by case)		Simplified calculation + pipes within protected volume		Simplified calculation + pipes above/within protected volume (case by	Simplified calculation + pipes above protected volume

			case)	
Emission	Simplified calculation + radiators			
Emitters in front of glass	No		Yes/No (case by case)	No
Ambient temp. regulation by premises	Yes			
Constant water/air start temp.	Yes	No	Yes/No (case by case)	No

Table 2 – Characteristics of heating systems in existing apartment buildings

DOMESTIC HOT WATER

Table 4 and Table 5 show the domestic hot water (DHW) production systems considered during renovation, installed respectively in the reference single-family residential dwellings and in the reference apartment buildings for the COZEB studies. The main configurations of DHW production systems are included.

Table 4. Characteristics of DHW systems in existing residential dwellings.

	Gas instant water heater	Electric boiler with storage	Combi boiler Gas	Combi boiler Oil
System	Gas-fired appliance	Electric boiler	Boiler	Boiler
Presence of storage tank	No	Yes	Yes/No (case by case)	Yes/No (case by case)
Pilot	Yes		Yes/No (case by case)	Yes/No (case by case)
Circulation loop	No	No	No	No

Table 5. Characteristics of DHW systems in existing apartment buildings.

	Gas instant water heater	Electric boiler with storage	Combi boiler Gas	Combi boiler Oil
System	Individual gas-fired appliance (per dwelling unit)	Individual electric boiler (per dwelling unit)	Individual or shared boiler (case by case)	Shared boiler
Presence of storage tank	No	Yes	Yes/No (case by case)	Yes/No (case by case)
Pilot	Yes		Yes/No (case by case)	Yes/No (case by case)
Circulation loop	No	No	No	Yes/No (case by case)

7) CONSUMPTION TABLE FOR RESIDENTIAL BUILDINGS

	Oil	Natural gas	Coal	Butane propane	Wood	Cogen. steam	Geothermal	Heat pumps	Solar thermal	Electricity	Total
Specific electricity										3 860.8	3 860.8
Cooking	0.0	175.6	0.4	74.9	5.6	0.0	0.0	0.0	0.0	565.2	821.7
Domestic hot water	1 337.2	1 356.3	0.7	272.9	33.8	1.7	0.0	46.3	87.1	997.3	4 133.4
Auxiliary heating	0.0	0.0	10.0	0.0	2 143.2	0.0	0.0	0.0	0.0	447.3	2 601.1
Central heating	800.4	1 145.7	0.6	9.6	3.4	3.3	2.1	20.5	0.0	93.5	2 079.1
Decentral. heating	5.2	71.3	8.5	9.3	7.3	0.0	0.0		0.0	59.3	161.4
Total	**805.6**	**1 217.0**	**9.0**	**18.9**	**11.2**	**3.3**	**2.1**	**20.5**	**0.0**	**152.8**	**2 240.5**
Central heating	12 042.0	5 663.7	10.6	226.2	389.4	0.5	0.3	128.8	0.0	359.5	18 821.1
Decentral. heating	650.6	479.9	211.9	26.8	301.5	0.0	0.0	0.0	0.0	199.0	1 869.8
Total	**12 692.6**	**6 143.6**	**222.5**	**253.0**	**690.9**	**0.5**	**0.3**	**128.8**	**0.0**	**558.6**	**20 690.9**
Central heating	12 842.4	6 809.4	11.2	235.8	392.8	3.8	2.4	149.3	0.0	453.1	20 900.2
Decentral. heating	655.3	551.2	220.4	36.1	309.3	0.0	0.0	0.0	0.0	258.3	2 031.2
Total	**13 498.3**	**7 360.7**	**231.5**	**272.0**	**702.1**	**3.3**	**2.4**	**149.3**	**0.0**	**711.4**	**22 931.4**
Total excluding heating	1 337.2	1 531.9	11.1	347.8	2 132.7	1.7	0.0	46.3	87.1	5 871.2	11 417.0
Total heating	13 498.3	7 360.7	231.5	272.0	702.1	3.8	2.4	149.3	0.0	711.4	22 931.4
Total	**14 835.4**	**8 392.6**	**242.7**	**619.7**	**2 884.8**	**5.5**	**2.4**	**195.6**	**87.1**	**6 582.6**	**34 348.3**

Table 6. Actual final energy consumption in the residential sector in 2017, by main use, housing type, heating type and energy carrier (source: Walloon energy balance)

	Oil	Natural gas	Coal	Butane propane	Wood	Cogen. steam	Geothermal	Heat pumps	Solar thermal	Electricity	Total
Specific electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3 860.8	3 860.8
Cooking	0.0	175.6	0.4	74.9	5.6	0.0	0.0	0.0	0.0	565.2	821.7
Domestic hot water	1 337.2	1 356.3	0.7	272.9	33.8	1.7	0.0	46.3	87.1	997.3	4 133.4
Auxiliary heating	0.0	0.0	10.0	0.0	2 280.0	0.0	0.0	0.0	0.0	447.3	2 737.8
Central heating	835.4	1 195.3	0.6	10.0	3.6	3.5	2.2	21.4	0.0	97.6	2 170.1
Decentral. heating	5.4	74.5	8.8	9.8	8.1	0.0	0.0	0.0	0.0	61.9	168.5
Total	**840.8**	**1 270.3**	**9.4**	**19.8**	**11.7**	**3.5**	**2.2**	**21.4**	**0.0**	**159.5**	**2 338.5**
Central heating	12 568.8	5 911.5	11.1	236.1	406.4	0.5	0.3	134.4	0.0	375.3	19 644.5
Decentral. heating	679.1	500.9	221.2	28.0	314.3	0.0	0.0	0.0	0.0	207.7	1 951.6.
Total	**13 247.9**	**6 412.4**	**232.3**	**264.1**	**721.2**	**0.5**	**0.3**	**134.4**	**0.0**	**583.0**	**21 596.1**
Central heating	13 404.3	7 107.3	11.7	246.1	410.0	4.0	2.5	155.8	0.0	472.9	21814.6
Decentral. heating	684.5	575.3	230.0	37.7	322.9	0.0	0.0	0.0	0.0	269.6	2 120.1
Total	**14 088.8**	**7 632.7**	**241.7**	**283.8**	**732.9**	**4.0**	**2.5**	**155.8**	**0.0**	**742.5**	**23 934.6**
Total excluding heating	1 337.2	1 531.9	11.1	347.8	2 319.5	1.7	0.0	46.3	87.1	5 371.2	11 553.7
Total heating	14 088.8	7 632.7	241.7	233.3	732.9	4.0	2.5	155.3	0.0	742.5	23 934.6
Total	**15 426.0**	**9 214.6**	**252.8**	**631.6**	**3 052.3**	**5.7**	**2.5**	**202.1**	**87.1**	**6 613.7**	**35 488.4**

Table 7. Corrected final climate energy consumption in the residential sector in 2017, by main use, housing type, heating type and energy carrier (source: Walloon energy balance)

B. ADDITIONAL DETAILS OF THE COMMERCIAL BUILDING STOCK

1) SIZE OF COMMERCIAL BUILDINGS

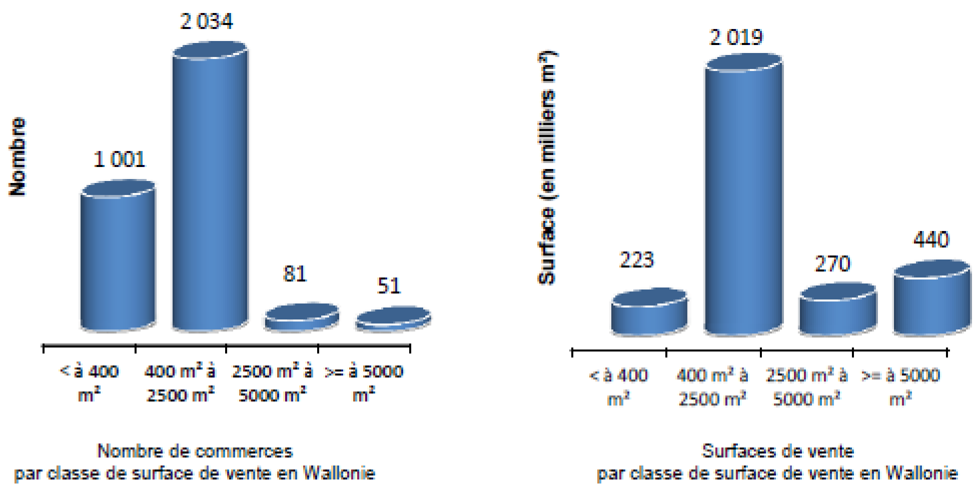
The description of the commercial building stock for the Walloon energy balance 2013 is based on limited samples.

SHOPS

In terms of the number of units or total area, the stock of shops mainly comprises buildings with retail space between 400 m² and 2,500 m², as shown in Figure 9. This latter category, as well as shops with over 5,000 m² of retail space, are therefore priority targets for the renovation strategy in this sector, which accounted for more than 40% of total consumption (electricity and fossil fuels) by the commercial sector in 2013.

These businesses include:

- wholesalers, trade intermediaries and retail businesses other than supermarkets,
- supermarkets and hypermarkets.



Nombre	Number
1001	1001
< à 400 m²	<400 m²
2034	2 034
400 m2 à 2500 m²	400 m² to 2 500 m²
81	81
2500 m2 à 5000 m²	2 500 m² to 5 000 m²
51	51
>= à 5000 m²	> 5 000 m²
Nombre de commences par classe de surlace de vente en Wallon	Number of shops by bracket of retail space in Wallonia
Surface (en milliers m²)	Area (in thousands m²)
223	223
< à 400 m²	<400 m²
2019	2019
400 m2 à 2500 m²	400 m² to 2 500 m²
270	270
2500 m2 à 5000 m²	2 500 m² to 5 000 m²
440	440
>= à 5000 m²	> 5 000 m²
Surfaces de vente par classe de surface de vente en Wallonie	Retail space by bracket of retail space in Wallonia

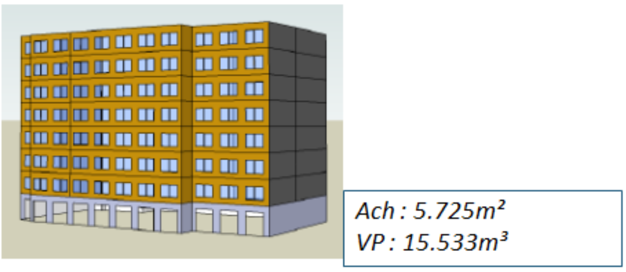
Figure 9. Source: *FPS Economy, SMEs, Self-employed and Energy* as of 31/12/2013, according to the Walloon Energy Balance 2013, p. 81.

OFFICES

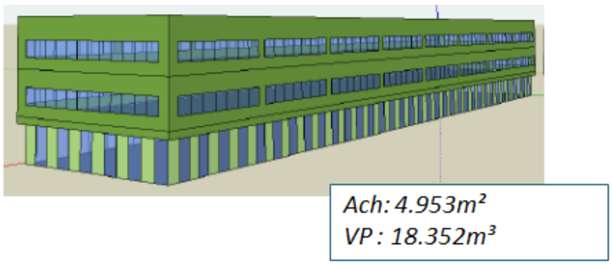
The first COZEB study identified two typologies of existing offices based on their geometry and energy performance (types A and B below). In the COZEB extension study, two additional office buildings to the reference buildings above were defined (types C and D below). These are smaller units with a more recent construction date than the first two reference buildings. Five typologies representative of Walloon office stock are therefore considered in the COZEB II study. They are illustrated in Figure 10.

A. A large building with seven floors in total, representative of large office buildings from pre-1945, with the street level occupied by a car park.
B. A 'small' three-storey office, representative of the large footprint but low-rise office buildings built in the 1970s.
C. A small office occupying the ground floor of an apartment building, designed for a micro-business or a freelance professional. Located in the city, it was built during the period 1984-1996, when the first thermal regulations appeared in Wallonia (K70). Its usable area is 94 m².
D. An office with a footprint of approximately 574 m² and four levels (usable area of 2,051 m²). It is located in an industrial zone or suburban area and is detached. It was built between 1996 and 2008, during the implementation of the second thermal regulation in Wallonia (K65, U_{max}), including requirements on the healthy ventilation of offices.
E. An 18th century town house transformed into offices in the early 1990s. It is a terraced building with uninsulated solid walls and floors, and a lightly insulated roof. With double glazing and gas central heating.

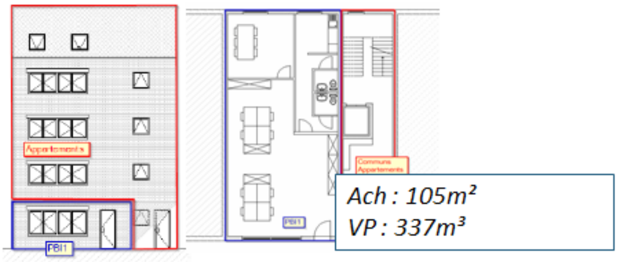
A. Grand bâtiment de bureaux



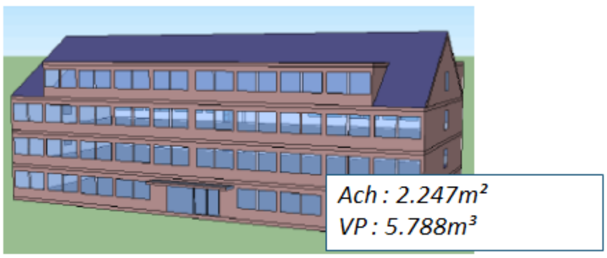
B. Petit bâtiment de bureaux



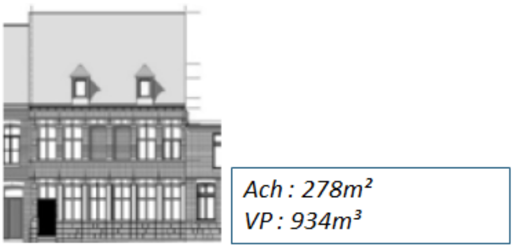
C. Petit bureau indépendant



D. Bureau compact



E. Maison de maître transformée en bureaux



A. Grand bâtiment de bureaux	A. Large office building
Ach : 5.725m²	Area: 5 725 m²
VP : 15.533m³	Volume: 15 533 m³
B. Petit bâtiment de bureaux	B. Small office building
Ach : 4.953m²	Area: 4 953 m²
VP : 18.352m³	Volume: 18 352 m³
C. Petit bureau indépendant	C. Small independent office
Ach : 105m²	Area: 105 m²
VP : 337m³	Volume: 337 m³
D. Bureau compact	D. Compact office
Ach : 2.247m²	Area: 2 247 m²
VP : 5.788m³	Volume: 5 788 m³
E. Maison de maître transformée en bureaux	E. Large town house converted to offices
Ach : 278m²	Area: 278 m²
VP : 934m³	Volume: 934 m³

Figure 10. Reference office and service buildings (Source: COZEB II)

EDUCATION

The number of establishments, based on data from the ONSS (Belgian National Social Security Office (NSSO)), is shown in Table 8 below.

Table 8. Number of establishments by NACE code.

NACE 3	NACE category of economic activity	Number of establishments
721	Research and experimental development on natural sciences and engineering	124
722	Research and experimental development on social sciences and humanities	11
854	Tertiary education and post-secondary non-tertiary education	175
851	Pre-primary education	60
852	Primary education	2 096
853	Secondary education	1 126
855	Other education	867
856	Educational support activities	170

The number of universities is estimated as the sum of the top three categories (in red), totalling 310 establishments.

In terms of surface area, the cumulative responses from the three networks questioned by the ICEDD for its Walloon energy balance 2008 (community education, provincial and municipal education and free and private education), showed the following:

1. 94% of schools (178/189) are smaller than 20,000 m²;
2. 87% of schools (164/189) are smaller than 15,000 m²;
3. 76% of schools (143/189) are smaller than 10,000 m²;
4. 54% of schools (102/189) are smaller than 5,000 m².

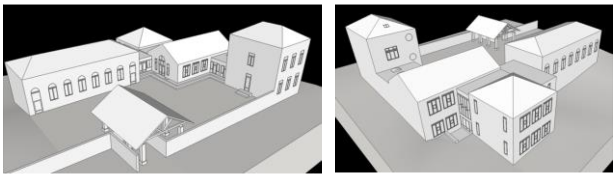
In view of these statistics, the COZEB II study considered as a reference: two buildings of less than 5,000 m² (nursery/primary school), one between 5,000 m² and 10,000 m² (secondary school), and one larger than 10,000 m² (higher education)

A. Pre-1945 nursery/primary school with a surface area <5,000 m²
A school built in the early 20th century and extended in 1994. The school is made up of several buildings. The first buildings constructed are not insulated but the extension is.
B. Nursery/primary school from 1950 with a surface area of <5,000 m²
Built in 1950, the school consists of a main building with front façade facing south, and a secondary building attached perpendicularly to the rear façade of the main building.
C. Post-1970 secondary school with a surface area between 5,000 m² and 10,000 m²

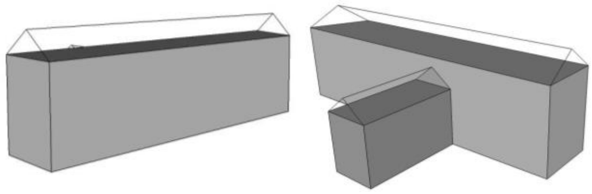
It is an ‘Athénée’ style school, comprising a central block and two side wings. The main façade faces SE and the rear façade faces NW. There are no adjacent buildings.

D. University building from 1968 with a surface area of approximately 10,000 m^2
The building dates from 1968 and has a monolithic appearance, while ensuring integration into the site thanks to limited height and many bay windows

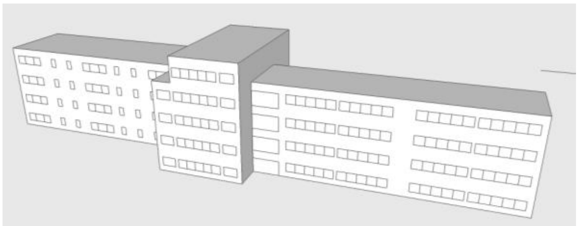
A. Ecole maternelle/primaire d’avant 1945
Surface < 5000 m^2



B. Ecole maternelle primaire de 1950
Surface < 5000 m^2



C. Ecole secondaire d’après 1970
surface comprise entre 5000 m^2 et 10000 m^2



D. Bâtiment universitaire de 1968
surface d’environ 10000 m^2

A. Ecole maternelle/primaire d'avant 1945	A. Pre-primary/primary school pre-1945
Surface < 5000 m^2	Area <5 000 m^2
B. Ecole maternelle primaire de 1950	B. Pre-primary/primary school from 1950
Surface < 5000 m^2	Area <5 000 m^2
C. Ecole secondaire d'après 1970	C. Secondary school post-1970
surface comprise entre 5000 m^2 et 10000 m^2	Area between 5 000 m^2 and 10 000 m^2
D. Bâtiment universitaire de 1968	D. University building from 1968
surface d'environ 10000m^2	Area approximately 10 000 m^2

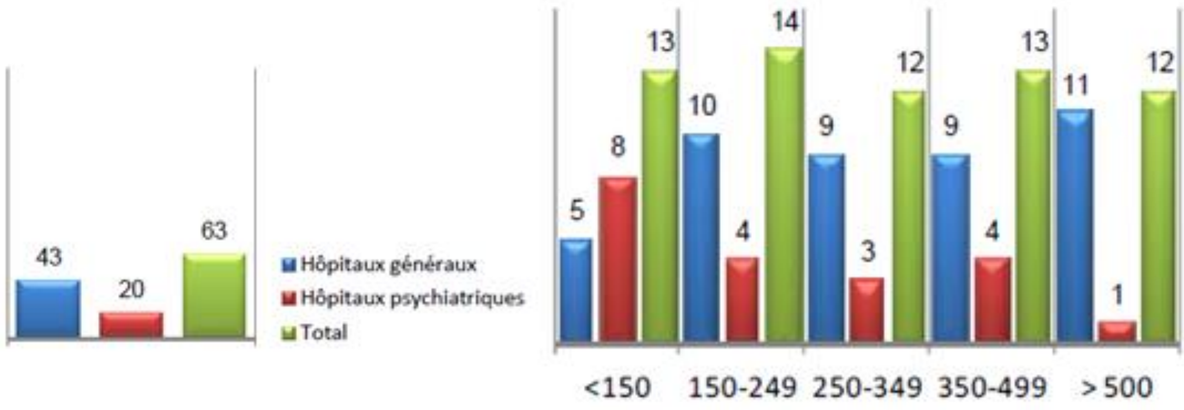
Figure 11. School building typologies (Source: COZEB extension).

HEALTH

Based on data from the NSSO, there are 149 establishments in the hospital sector. As of 1 January 2013, there were 614 nursing and care homes accredited by INAMI (National Institute for Health and Disability Insurance).

The size of hospitals is expressed in number of beds. The different categories of hospitals and their breakdown according to number of beds are given in Figure 12.

NACE 3	NACE category of economic activity	Number of establishments
861	Hospital activities	149
869	Other human health activities	542
871	Residential nursing care activities	170
872	Residential care activities for persons with mental disabilities, etc.	380
873	Residential care activities for elderly or with physical disabilities	506
879	Social work activities with accommodation	273
881	Social work activities without accommodation for the elderly and disabled	173
889	Other social work activities without accommodation	1 681



43	43
20	20
63	63
Hôpitaux généraux Hôpitaux	General hospitals
psychiatrique!	Psychiatric hospitals
Total	Total
5	5
8	8
13	13
< 150	<150
10	10
4	4
14	14
150-249	150-249
9	9
3	3
12	12
250-349	250-349
9	9
4	4
13	13
350-499	350-499
11	11
1	1
12	12
> 500	> 500

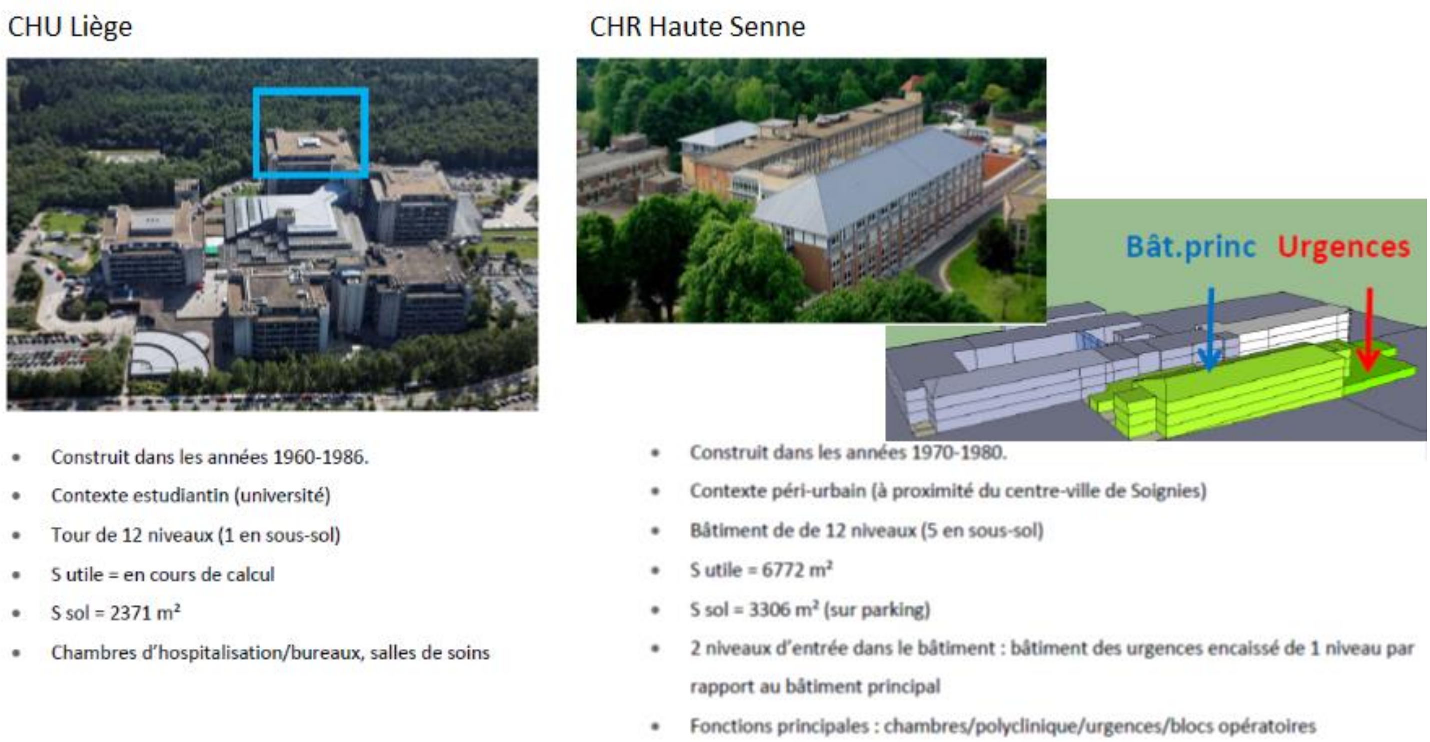
Figure 12. Number of accredited general and psychiatric hospitals in Wallonia (left) and breakdown by bed capacity (right) (Source: ISPF Santé Publique (data valid on 1 January 2014), via Walloon Energy Balance 2013).

Two reference buildings were considered in the COZEB extension study[14]:

- A hospital tower at the University Hospital of Liège (Sart Tilman site): highly compact infrastructure, all buildings close together and interconnected;
- a wing of the Regional Hospital of Haute Senne, Soignies (Tilleriau site): a pavilion structure comprising several buildings.

The main characteristics of the healthcare buildings considered in the study are shown in Figure 13.

[14] COZEB extension. Task 1 report – Summary analysis of existing stock of office, service and healthcare buildings in Wallonia.



CHU Liège	University Hospital of Liège
• Construit dans les années 1960-1986.	• Built 1960-1986.
• Contexte estudiantin (université)	• Student environment (university)
• Tour de 12 niveaux (1 en sous-sol)	• Tower with 12 floors (1 below ground)
• S utile = en cours de calcul	• Usable area: being calculated
• S sol = 2371 m²	• Footprint: 2 371 m²
• Chambres d'hospitalisation/bureaux, salles de soins	• In-patient wards/offices, treatment rooms
CHR Haute Senne	Regional Hospital of Haute Senne
Bât.princ	Main building
Urgences	Emergency department
• Construit dans les années 1970-1980	• Built 1970-1980
• Contexte péri-urbain (à proximité du centre-ville de Soignies)	• Suburban setting (near Soignies town centre)
• Bâtiment de 12 niveaux (S en sous-sol)	• Building with 12 floors (5 below ground)
• S utile = 6772 m²	• Usable area: 6 772 m²
• S sol = 3306 m² (sur parking)	• Footprint: 3 306 m² (above car park)
• 2 niveaux d'entrée dans le bâtiment : bâtiment des urgences encaissé de 1 niveau par rapport au bâtiment principal	• Two entry levels into building: one level lower for emergency department than for main building
• Fonctions principales : chambres/poiydlnique/urgences/blocs opératoires	• Main functions: in-patient wards/outpatient clinics/emergency/operating theatres

Figure 13. Main characteristics of the healthcare buildings considered in the COZEB extension study.

SPORTS INFRASTRUCTURE

The COZEB extension study selected two categories of building representative of sports infrastructure[15]:

- A public swimming pool, heated all year round, covered by an old building (dating from pre-1945), often poorly insulated and with a large glazed surface. As well as the necessary additional facilities

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[15] COZEB extension. Task 1 report – Summary analysis of stock of buildings for education, hospitality and sports.

(such as changing rooms and showers), this building may accommodate other services such as a cafeteria, a gym or a children's paddling pool).

- A larger 'multisport' hall (between 2,000 and 3,000 m²) that can accommodate ball sports. This kind of structure usually includes:
    - one or more courts, providing opportunities for competitive sport (amateur or professional) and training,
    - possibly one or more multipurpose halls,
    - changing rooms for players and referees,
    - a cafeteria.

  In addition to these four main features, there may even be utility and reception facilities: offices, caretaker’s room, first aid room, equipment store, utility areas, meeting room, viewing area, etc.

The characteristics of the buildings considered are provided in the study report.

2) ENERGY CONSUMPTION AND PERFORMANCE OF BUILDINGS REPRESENTATIVE OF THE STOCK

The specific consumption of the different sub-sectors is given in Section 4) below, to allow for a potential comparison with other regions carrying out this exercise.

In the COZEB extension study, in order to refine and support the typologies of reference commercial buildings used to calculate the cost-optimal level in different scenarios for improving their energy performance, and to guide the energy renovation strategy accordingly, each reference building was defined in terms of the following:

- zones in which standardised activities take place (internal conditions),
- climatic zone (external conditions),
- geometry of each zone (surface, volume),
- thermal characteristics of each of the elements,
- characteristics of each system.

For detailed and up-to-date information on the consumption and energy performance of buildings representative of the Walloon commercial real estate stock, please refer to the descriptive sheets for existing commercial buildings, produced in 2016 to define the cost-optimal energy performance level (COZEB II). In particular:

- the description of existing office buildings: https://www.dropbox.com/s/p8i9nmiw9hq0xp6/COZEB3-fiches-bureau.pdf?dl=0
- the description of existing educational buildings:https://www.dropbox.com/s/p4i5e7wn4vgmwga/COZEB3-fiches-ecoles.pdf?dl=0

These documents show, for the various reference buildings, the type of construction and the typical U-values of the main construction elements, as illustrated in Table 9. The analyses are extended to systems used for heating and cooling, as well as renewable energy sources, in the 2016 cost-optimal study.

Surfaces	U (W/m²K)	Pre-1945	1946-1970	1971-1990	1991-3108/08
Walls					
Brick (full)	2.13	X			
Concrete, uninsulated	1.71		X		
Concrete, insulated 2	0.95			X	
Concrete, insulated 6	0.55				X
Roof					
Concrete, uninsulated	2.90	X	X		
Concrete, insulated 4	0.81			X	
Concrete, insulated 8	0.43				X
Surfaces	**R (m²K/W)**	**Pre-1945**	**1946-1970**	**1971-1990**	1991-3108/03
Floor slab					
Concrete, uninsulated	0.12	X	X		
Concrete, insulated 2	0.564			X	X
Surfaces	**U_w (W/m²K)**	**Pre-1945**	**1946-1970**	**1971-1990**	1991-3108/08
Windows					
Single glazing, wooden frames	5	X	X		
Double glazing, metal frames	4.3			X	
Double glazing, thermal break					X

Table 9. Illustration of findings available in the COZEB study reports for commercial buildings: wall surface composition of a building depending on its construction period.

3) SEGMENTATION OF COMMERCIAL SECTORS

Table 10 shows the segmentation of the commercial sector proposed in the Walloon Energy Balance 2013.

Table 10. Segmentation of the commercial sector.

Shops	Wholesale trade and intermediaries
	Retail trade (excluding supermarkets)
	Supermarkets
Offices	
Authorities	State and Regional administration
	Municipal and intermunicipal administration
	National defence
	International organisations
	Social security
Transport and communication	Rail
	Public transport excluding SNCB
	Private transportation
	Belgacom, la Poste
Banks, insurance, business services	Banks and insurance
	Estate agents
	Business services
Other services	Laundries
	Other personal services
	Other community services
Various	Water
	Public lighting
	Waste treatment
Education	Community education
	Official education
	Independent education
	Universities and research
Care, health	Hospitals
	Outpatient clinics
	Nurseries, social accommodation
	Retirement homes
Culture and sport	Swimming pools
	Libraries and museums
	Other cultural or sport services
	Tourism

Table 11. Breakdown of actual energy consumption in the commercial sector in 2013, by main use, housing type, heating type and energy carrier (source: Walloon Energy Balance 2013).

Specific consumption		Electricity	Fuel	Sample size	Average
	Activity sector	kWh/m²	kWh/m²		m²
per square metre	Wholesale and retail HT 400 m² to 2 500 m²	82	129	47	1 355
	Wholesale and retail HT > 2 500 m²	65	57	28	8 545
	Trade HT (total area)	73	75	100	3 048
	Supermarket HT	434	158	36	1 286
	Hypermarket HT	285	143	25	10 214
	Restaurant HT	361	408	9	562
	Hotel HT	93	186	17	3 486
	Private office HT	134	102	20	7 944
	Public office HT	61	144	106	3 943
	Community education	24	122	64	6 621
	Official education	26	153	120	5 761
	Independent or private education	24	116	73	8 932
	Hospital (all types)	129	201	55	22 240
	Retirement home	66	195	110	5 013
	Cultural centre	80	170	29	2 450
	Swimming pool (per m² of body of water)	967	2 274	36	436
	Sports complex	51	151	44	2 064
per employee	**Activity sector**	**kWh/employee**	**kWh/employee**		**employees**
	Private office HT	5 552	4 496	21	200
	Public office HT	2 389	5 632	88	95
per student	**Activity sector**	**kWh/student**	**kWh/student**		**students**
	Community education	354	1 911	66	424
	Official subsidised education	401	2 438	75	351
	Independent or private education	212	1 042	78	988
per bed	**Activity sector**	**kWh/bed**	**kWh/bed**		**beds**
	Hospital (all types)	13 636	18 517	52	223
	General hospital	15 423	16 424	36	201
	Psychiatric hospital	4 259	16 591	13	257
	Retirement home	3 301	9 590	106	104

Annexe 3. Additional information on cost-optimal studies

A. KEY DOCUMENTS FOR ANALYSIS OF THE BUILDING STOCK

- The cost-optimal studies, or COZEB studies, comply with Article 5 of Directive 2010/31/EU on the energy performance of buildings. They aim to ensure that the energy performance requirements applicable to new and existing buildings in Wallonia are cost-optimal. By extension, they help to identify energy renovation measures that may prove economically advantageous over a given assessment period (20 years for commercial buildings, 30 years for residential buildings). These studies are updated every 5 years.
- The study *La rénovation énergétique et durable des logements wallons - Analyse du bâti existant et mise en évidence de typologies de logements prioritaires*, carried out in 2008 by Caroline Kints, Architecture et Climat, UCL. This study is specific to the Walloon Region; it identified the priority typologies for energy renovation and demonstrated the low energy quality of existing Walloon housing. Features of the building such as age, size, configuration and location were analysed. The study identified eight priority typologies (Annex 1); these typologies represent approximately 76% of housing built pre-1991.
- TABULA: *Typology Approach for Building Stock Energy Assessment* carried out in 2011 by W. Cyx, N. Renders, M. Van Holm and S. Verbeke, VITO (vision on technology). This study is specific to Belgium (case study 15). This study is very comprehensive and precise in terms of the envelope (wall surface composition, air tightness, etc.). In the TABULA project, buildings are classified on the basis of characteristics that have an impact on energy consumption (Annex 2).
- *Réno 2020 – Etude énergétique et typologie du parc résidentiel wallon en vue d'en dégager des pistes de rénovation prioritaires*, a study carried out in 2009 by Stéphane Monfils and Jean-Marie Hauglustaine, Energy SuD, ULg, is specific to the Walloon Region. It provides a great deal of information on the construction periods of Walloon housing, and demonstrates many links between the age of the building and the characteristics of the heat loss surfaces.
- *Energy Consumption Survey for Belgian Households*, final report produced in 2012 by VITO (K. Jespers, Y. Dams, K. Aernouts), ICEDD (P. Simus, F. Jacquemin, L. Delaite) and FPS Economy, SMEs, Self-employed and Energy – Statistics Belgium (C. Vanderhoeft). This study is specific to Belgium and gives detailed results for each region. The analysis of the findings includes the general characteristics of the dwellings (type, ownership, age, surface area) but also a great deal of information on the thermal characteristics of the surfaces (roof, wall and floor insulation and double glazing). In addition, the study specifies the heating and domestic hot water production systems used in the homes.
- *Plan pluriannuel de la Première Alliance Emploi-Environnement*: the Walloon Marshall Plan 2. Green, second reading, study specific to the Walloon Region (case study 28).
- *Etude sur la réduction des émissions de CO_2 dans le parc immobilier futur*, a study carried out in 2008 by 3E and the Haute Ecole Professionnelle du Limbourg, specific to Belgium. This study draws up a CO_2 assessment for the Belgian residential sector, based on the analysis of reference buildings in the existing housing stock, differentiated according to type, size and age. Each reference building is categorised so as to correctly assess its energy consumption and CO_2 emissions.
- *Enquête sur la qualité de l'habitat en Wallonie – résultats clés* carried out by CEHD in January 2014, study specific to Wallonia. This is carried out in Wallonia every 10 years to monitor the quality of housing. The second part of the survey report describes the physical aspects of the housing: general characteristics, surface area, energy performance, condition of buildings and fittings, etc.

B. OVERVIEW OF COST-OPTIMAL STUDIES

Table 12 summarises the cost-optimal studies carried out to date. They are described in more detail below.

	Target buildings	Scope	Objective
COZEB I (2013)	New buildings	Envelope + systems	Check that the EPB requirements set in Wallonia are not more than 15% lower than the outcome of the cost-optimal calculation
	Existing buildings	Envelope	
COZEB extension (2015)	Existing buildings	Envelope	Address the first aspects of the renovation strategy (overview of this identification of cost-effective renovation approaches)
COZEB II (2018)	New and existing buildings	Envelope + systems	Create a cost-optimal calculation tool and identify cost-optimal packages of measures for the envelope and systems

Table 12. Overview of cost-optimal studies

To date, three cost-optimal studies have been carried out: COZEB I (2013), COZEB II (2018) and a supplement to the first study (COZEB extension, 2015).

- The original study focused on the classic building types subject to EPB: apartment buildings, school buildings and offices. It has two distinct components. One covers the definition of a nearly zero-energy building (NZEB) and the performance levels to be set to achieve this, depending on the building types and uses. The other involves modelling the updated overall cost of different combinations of measures to improve the energy performance of buildings, to ensure that the EPB requirements in Wallonia for 2012 and 2014 were not more than 15% lower than the cost-optimal requirement. This study showed that the EPB requirements imposed by the 2014 EPB regulations for a series of buildings were very close to the cost-optimal performance level.
- The COZEB extension study focuses on existing buildings in order to identify cost-effective approaches and cost-optimal energy renovations for the envelope of the reference buildings analysed.
- The COZEB II study is an update of the first study, with the objective of ensuring that the energy performance requirements set for residential and non-residential buildings for 2017 and 2021 were not more than 15% lower than the cost-optimal requirement. This study covered a very large number of combinations of measures to improve the energy performance of the envelope and systems (including renewable energy systems), thus refining the assumptions of the first study.
- The reference buildings, performance improvement measures (envelope and systems) and costs associated with implementing these measures were validated by representatives from the construction sector during a stakeholder consultation.
- These studies are published on www.energie.wallonie.be

Findings of the COZEB extension study for 'passive' windows, roof, walls and floor

	HE1	HE2	HE3	HE4	HE5	HE8	HE9	HE10	HE11	HE12	HE13	HE14
												
	Avant 1945					1946-1970	1971-1984		1985-1995			1996-2008
Nombre de façades	4	3	2	4	2	2	4	2	4	3	2	4
Espec d'origine	642	580	382	676	556	555	423	499	309	287	157	180
Label d'origine	G	G	E	G	G	G	E	F	D	D	B	C
Label A rentable	oui	oui	non	oui	oui	oui	oui	oui	non	non	oui	non
Meilleure performance avec solutions rentables (Espe	49	71	139	49	52	43	52	58	91	121	80	107
Chassis	Triple vitrage	Triple vitrage	Triple vitrage	Triple vitrage	Triple vitrage	Triple vitrage	Triple vitrage	Triple vitrage	/	/	/	/
Umur	0.15	0.2	/	0.15	0.15	0.15	0.15	0.15	0.15	/	/	/
Utoit	0.15	0.24	0.15	0.15	0.2	0.15	0.15	0.2	/	/	0.2	/
Usol	0.15	0.24	/	0.15	0.15	0.15	0.15	0.24	0.15	0.15	/	0.15
Ventilation	D	D	D	C+	C+	C+	C+	C+	C+	D	D	D
Système chauffage	chaudière condensation	poele gaz	chaudière condensation	chaudière condensation	chaudière condensation	Pompe à chaleur	chaudière condensation	chaudière condensation	chaudière condensation	chaudière condensation	chaudière condensation	chaudière condensation
Panneaux solaires thermiques pour ECS	non	non	non	oui	non	oui	oui	non	non	oui	non	oui
Label A atteignable sans énergie fossile (avec système de chauffage renouvelable)	oui	oui	oui	oui	oui	oui	oui	oui	oui	oui	oui	oui
Label A rentable sans énergie fossile (avec système de chauffage renouvelable)	oui	oui		oui	oui	oui	oui	oui	non	non	non	non
Meilleure performance avec solutions rentables, sans énergie fossile (Espec)	60	84	191	50	53	43	68	63	124	153	106	144
Chassis	Chassis +Triple vitrage 0.6	Chassis + Double vitrage 1.0	Chassis + Double vitrage 1.1	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Double vitrage 1.1	Double vitrage 1.1	Double vitrage 1.1	/
Umur	0.15	0.2	/	0.15	0.15	0.15	0.15	0.15	0.15	/	/	/
Utoit	0.2	0.24	0.24	0.15	0.15	0.15	0.15	0.15	/	/	/	/
Usol	0.15	0.24	/	0.15	0.15	0.15	0.15	0.15	0.15	0.15	/	0.24
Ventilation	D	D	C+	C+	C+	C+	C+	C+	D	D	C+	C+
Système chauffage	PAC air-eau	Poele bois	Poele bois	PAC air-eau	Poele bois	PAC air-eau	Poele bois	Poele bois	Poele bois	Poele bois	Poele bois	Poele bois
Panneaux solaires thermiques pour ECS	non	oui	oui	oui	oui	oui	non	non	non	non	oui	
Cost-optimum Label A (Espec théorique)	80	85	85	85	78	85	85	82	85	84	84	85
Cost-optimum Label A (Espec théorique corrigé)	75.86	79.4	79.4	79.4	74.43	79.4	79.4	77.28	79.4	78.7	78.7	79.4
Chassis	Chassis + Double vitrage 1.1	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Chassis +Triple vitrage 0.6	Chassis + Double vitrage 1.1	Chassis + Double vitrage 1.0	Chassis + Double vitrage 1.1	/	/	remplacement vitrage 1.1	remplacement vitrage 1.1	remplacement vitrage 1.1
Umur	0.20	0.2	0.15	0.2	0.24	0.24	0.2	0.24	0.2	0.15	/	
Utoit	0.20	0.2	0.24	0.2	0.24	0.24	0.24	0.24	0.15	/	/	0.15
Usol	/	0.24	/	/	/	0.24	/	0.24	0.15	0.15	/	0.15
Ventilation	C+	D	D	C+	C+	D	C+	C+	D	D	D	C+
Système chauffage	chaudière condensation gaz	/	/	chaudière condensation gaz	chaudière condensation gaz	Poele bois	chaudière condensation gaz	chaudière condensation gaz	chaudière condensation gaz	chaudière condensation gaz	chaudière condensation gaz	chaudière condensation gaz
Panneaux solaires thermiques pour ECS	non	non	non	oui	non		non	non	non	oui	non	non
Rentable oui/non	oui	non	non	non	non	oui	non	non	non	non	non	non
Meilleure performance rentable (Espec théorique)	71	580	382	96	200	51	141	147	131	287	157	149
Meilleure performance rentable (Espec théorique corrigé)	69.34	337	246	87	151	54	116	120	110	198	126	121
Chassis	Chassis +Triple vitrage 0.6	/	/	Chassis + Double vitrage 1.1	/	/	Chassis + Double vitrage 1.1	remplacement vitrage 1.1	remplacement vitrage 1.1	/	/	/
Umur	0.15	/	/	0.2	/	0.15	/	/	/	/	/	/
Utoit	0.20	/	/	0.24	0.24	0.24	0.2	/	/	/	/	/
Usol	/	/	/	/	0.15	0.15	/	/	0.15	/	/	0.24
Ventilation	D	/	/	C+	C+	D	/	D	C+	/	/	/
Système chauffage	chaudière condensation gaz	/	/	chaudière condensation gaz	chaudière condensation gaz	Poele bois	chaudière condensation gaz	chaudière condensation gaz	chaudière condensation gaz	/	/	/
Panneaux solaires thermiques pour ECS	non	/	/	non	non	oui	non	non	non	/	/	/
Rentable oui/non	oui	/	/	oui	oui	oui	oui	oui	oui	/	/	/

	HE1	HE2	HE3	HE4	HE5	HE8	HE9	HE10	HE11	HE12	HE13	HE14
	Pre-1945					1946-1970	1971-1984		1985-1995			1996-2008
Number of facades	4	3	2	4	2	2	4	2	4	3	2	4
Original E_{spec}	642	580	382	676	556	555	423	499	309	237	157	180
Original rating	G	G	E	G	G	G	E	F	D	D	B	C
A rating cost-effective	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Best performance with cost-effective solutions (E_{spec})	49	71	139	49	52	43	52	58	91	121	80	107
Windows	Triple glazing	Triple glazing	Triple glazing	Triple glazing	Triple glazing	Triple glazing	Triple glazing	Triple glazing	/	/	/	/
U walls	0.15	0.2	/	0.15	0.15	0.15	0.15	0.15	0.15	/	/	/
U roof	0.15	0.24	0.15	0.15	0.2	0.15	0.15	0.2	/	/	0.2	/
U floor	0.15	0.24	/	0.15	0.15	0.15	0.15	0.24	0.15	0.15	/	0.15
Ventilation	D	D	D	C+	C+	C+	C+	C+	C+	D	D	D
Heating system	condensing boiler	gas stove	condensing boiler	condensing boiler	condensing boiler	heat pump	condensing boiler	condensing boiler	condensing boiler	condensing boiler	condensing boiler	condensing boiler
Solar thermal panels for DHW	No	No	No	Yes	No	Yes	Yes	No	No	Yes	No	Yes
Rating A achievable without fossil fuels (with renewable heating system)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating A cost-effective without fossil fuels (with renewable heating system)												
Best performance with cost-effective solutions, without fossil fuels (E_{spec})	60	84	191	50	53	43	68	63	124	153	106	144
Windows	Frames + Triple glazing 0.6	Frames + Double glazing 1.0	Frames + Double glazing 1.1	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Double glazing 1.1	Double glazing 1.1	Double glazing 1.1	/
U walls	0.15	0.2	/	0.15	0.15	0.15	0.15	0.15	0.15	/	/	/
U roof	0.2	0.24	0.24	0.15	0.15	0.15	0.15	0.15	/	/	/	/
U floor	0.15	0.24	/	0.15	0.15	0.15	0.15	0.15	0.15	0.15	/	0.24
Ventilation	D	D	C+	C+	C+	C+	C+	C+	D	D	C+	C+
Heating system	Air-to-water heat pump	Wood stove	Wood stove	Air-to-water heat pump	Wood stove	Air-to-water heat pump	Wood stove	Wood stove	Wood stove	Wood stove	Wood stove	Wood stove
Solar thermal panels for DHW	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	
Cost-optimum A rating (theoretical E_{spec})	80	85	85	85	78	85	85	82	85	84	84	85
Cost-optimum A rating (corrected theoretical E_{spec})	75.86	79.4	79.4	79.4	74.43	79.4	79.4	77.28	79.4	78.7	78.7	79.4
Windows	Frames + Double glazing 1.1	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Frames + Triple glazing 0.6	Frames + Double glazing 1.1	Frames + Double glazing 1.0	Frames + Double glazing 1.1	/	/	Replaced panes 1.1	Replaced panes 1.1	Replaced panes 1.1
U walls	0.20	0.2	0.15	0.2	0.24	0.24	0.2	0.24	0.2	0.15	/	
U roof	0.20	0.2	0.24	0.2	0.24	0.24	0.24	0.24	0.15	/	/	0.15
U floor	/	0.24	/	/	/	0.24	/	0.24	0.15	0.15	/	0.15
Ventilation	C+	D	D	C+	C+	D	C+	C+	D	D	D	C+
Heating system	Gas condensing boiler	/	/	Gas condensing boiler	Gas condensing boiler	Wood stove	Gas condensing boiler	Gas condensing boiler	Gas condensing boiler	Gas condensing boiler	Gas condensing boiler	Gas condensing boiler
Solar thermal panels for DHW	No	No	No	Yes	No		No	No	No	Yes	No	No
Cost-effective yes/no	Yes	No	No	No	No	Yes	No	No	No	No	No	No
Best cost-effective performance (theoretical E_{spec})	71	580	382	96	200	51	141	147	131	287	157	149
Best cost-effective performance (corrected theoretical E_{spec})	69.34	337	246	87	151	54	116	120	110	198	126	121
Windows	Frames + Triple glazing 0.6	/	/	Frames + Double glazing 1.1	/	/	Frames + Double glazing 1.1	Replaced panes 1.1	Replaced panes 1.1	/	/	/
U walls	0.15	/	/	0.2	/	0.15	/	/	/	/	/	/
U roof	0.20	/	/	0.24	0.24	0.24	0.2	/	/	/	/	/
U floor	/	/	/	/	0.15	0.15	/	/	0.15	/	/	0.24
Ventilation	D	/	/	C+	C+	D	/	D	C+	/	/	/
Heating system	Gas condensing boiler	/	/	Gas condensing boiler	Gas condensing boiler	Wood stove	Condensing boiler Gas	Gas condensing boiler	Gas condensing boiler	/	/	/

Solar thermal panels for DHW	No	/	/	No	No	Yes	No	No	No	/	/	/
Cost-effective yes/no	Yes	/	/	Yes	Yes	Yes	Yes	Yes	Yes	/	/	/

Table 13. Table of findings reflecting the most ambitious (Espec) cost-effective solutions for single-family homes (source: Climact analysis of COZEB data)

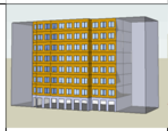
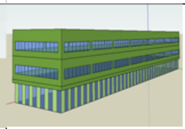
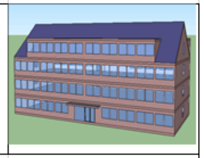
						
	Avant 1919		1919-1945	1946-1970		après 1990
Espec d'origine	524	518	356	310	404	233
Label d'origine	G	G	E	D	E	C
Label A rentable	non	oui	non	oui	non	non
Meilleure performance avec solutions rentables (Espe	88	52	299	73	187	179
Chassis	Chassis + triple vitrage 0.6	Chassis + double vitrage 1.1	/	Chassis + triple vitrage 0.6	Chassis + double vitrage 1.1	double vitrage 1.1
Umur	0.15	0.2	/	0.15	/	/
Utoit	0.15	0.2	/	0.15	0.24	/
Usol	0.15	/	/	/	0.15	/
Ventilation	D	D	D	D	D	D
Système chauffage	/	poele bois	/	/	/	/
Panneaux solaires thermiques pour ECS	oui	oui	non	non	non	/
Label A atteignable	oui	oui	oui	oui	oui	oui
Label A atteignable sans énergie fossile (avec système de chauffage renouvelable)	non*	oui	oui	non*	oui	oui
Label A rentable sans énergie fossile (avec système de chauffage renouvelable)	non*	oui	non*	non*	non*	non*
Meilleure performance avec solutions rentables, sans énergie fossile (Espec)		52				
Chassis		Chassis + double vitrage 1.1				
Umur		0.2				
Utoit		0.2				
Usol		/				
Ventilation		D				
Système chauffage		poele bois				
Panneaux solaires thermiques pour ECS		oui				
Cost-optimum Label A (Espec théorique)	85	75	84	84	84	84
Cost-optimum Label A (Espec théorique corrigé)	79.4	72.26	78.7	78.7	78.7	78.7
Chassis	double vitrage 1.1	Chassis + double vitrage 1.1	Chassis + double vitrage 1.0	double vitrage 1.1	Chassis + double vitrage 1.0	double vitrage 1.1
Umur	0.15	0.24	0.15	0.24	0.15	0.15
Utoit	0.15	0.2	0.2	0.24	0.24	/
Usol	0.15	/	0.15	/	0.15	/
Ventilation		D	D	C+	D	D
Système chauffage	chaudière condensation gaz	poele bois	/	Pompe à chaleur air-eau	/	/
Panneaux solaires thermiques pour ECS	non	non	non	non	oui	oui
Rentable oui/non	non	non	non	non	non	non
Meilleure performance rentable (Espec théorique)	524	429	299	194	404	233
Meilleure performance rentable (Espec théorique corrigé)	312	268	204	147	256	169
Chassis	/	/	/	/	/	/
Umur	/	/	/	/	/	/
Utoit	/	/	/	0.24	/	/
Usol	/	/	/	/	/	/
Ventilation	/	/	D	D	/	/
Système chauffage	/	poele bois	/	/	/	/
Panneaux solaires thermiques pour ECS	/	/	/	/	/	/
Rentable oui/non	/	oui	oui	oui	/	/

* pas atteignable dans les 20% de solutions au dessus du front pareto de solutions optimales

	Pre-1919		1919-1945	1946-1970		Post-1990
Original E_{spec}	524	518	356	310	404	233
Original rating	G	G	E	D	E	C
A rating cost-effective	No	Yes	No	Yes	No	No
Best performance with cost-effective solutions (E_{spec})	88	52	299	73	187	179
Windows	Frames + triple glazing 0.6	Frame + double glazing 1.1	/	Frames + triple glazing 0.6	Frame + double glazing 1.1	Double glazing 1.1
U walls	0.15	0.2	/	0.15	/	/
U roof	0.15	0.2	/	0.15	0.24	/
U floor	0.15	/	/	/	0.15	/
Ventilation	D	D	D	D	D	D
Heating system	/	Wood stove	/	/	/	/
Solar thermal panels for DHW	Yes	Yes	No	No	No	/
Rating A attainable	Yes	Yes	Yes	Yes	Yes	Yes
Rating A achievable without fossil fuels (with renewable heating system)	No*	Yes	Yes	No*	Yes	Yes
Rating A cost-effective without fossil fuels (with renewable heating system)	No*	Yes	No*	No*	No*	No*
Best performance with cost-effective solutions, without fossil fuels (E_{spec})		52				
Windows		Frame + double glazing 1.1				
U walls		0.2				
U roof		0.2				
U floor		/				
Ventilation		D				
Heating system		Wood stove				
Solar thermal panels for DHW		Yes				
Cost-optimum A rating (theoretical E_{spec})	85	75	84	84	84	84
Cost-optimum A rating (corrected theoretical E_{spec})	79.4	72.26	78.7	78.7	78.7	78.7
Windows	Double glazing 1.1	Frame + double glazing 1.1	Frames + double glazing 1.0	Double glazing 1.1	Frames + double glazing 1.0	Double glazing 1.1
U walls	0.15	0.24	0.15	0.24	0.15	0.15
U roof	0.15	0.2	0.2	0.24	0.24	/
U floor	0.15	/	0.15	/	0.15	/
Ventilation		D	D	C+	D	D
Heating system	Gas condensing boiler	wood stove	/	Air-to-water heat pump	/	/
Solar thermal panels for DHW	No	No	No	No	Yes	Yes
Cost-effective yes/no	No	No	No	No	No	No
Best cost-effective performance (theoretical E_{spec})	524	429	299	194	404	233
Best cost-effective performance (corrected theoretical E_{spec})	312	268	204	147	256	169
Windows			/	/		
U walls			/	/		
U roof			/	0.24		
U floor			/	/		
Ventilation			D	D		
Heating system		wood stove	/	/		
Solar thermal panels for DHW		/	/	/		
Cost-effective yes/no		Yes	Yes	Yes		

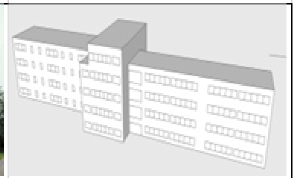
* not attainable in the 20% of solutions above the Pareto front of optimal solutions

Table 14. Table of findings reflecting the most ambitious (Espec) cost-effective solutions for apartment buildings (source: Climact analysis of COZEB data)

	BUE5	BUE1	BUE2	BUE3	BUE4
					
	Avant 1919	1919-1945	1946-1970	1971-1984	1996-2008
Espec d'origine	240	328	339	186	180
Meilleure performance avec solutions rentables (Espe	78	42	103	64	81
Chassis	/	Chassis + double vitrage 1.0	Chassis + triple vitrage 0.6	/	/
Umur	0.15	0.15	0.15	/	0.2
Utoit	/	0.24	0.2	/	0.15
Usol	0.15	0.24	/	0.15	0.15
Ventilation	D	D	D	/	D
Système chauffage	PAC air-air	PAC air-air	Gaz	PAC air-air	/
Système refroidissement	/	/	Clim air-air	/	Clim air-air
Remplacement éclairage	Led	/	Led	Led	Led
ECS	élec ballon	/	/	élec ballon	/
Panneaux solaires thermiques pour ECS	non	non	non	non	non
Meilleure performance avec solutions rentables, sans énergie fossile (Espec)	78	42	108	64	84
Chassis	/	Chassis + double vitrage 1.0	Chassis + double vitrage 1.0	/	/
Umur	0.15	0.15	0.15	/	/
Utoit	/	0.24	0.2	/	/
Usol	0.15	0.24	/	0.15	0.15
Ventilation	D	D	/	/	/
Système chauffage	PAC air-air	PAC air-air	PAC air-air	PAC air-air	PAC air-air
Système refroidissement	/	/	/	/	/
Remplacement éclairage	Led	/	Led	Led	Led
ECS	élec ballon	/	/	élec ballon	PAC air-air
Panneaux solaires thermiques pour ECS	non	non	non	non	non
Cost optimum (Espec théorique)	148	86	228	107	125
Chassis	/	Chassis + double vitrage 1.1	/	/	/
Umur	0.15	0.24	/	/	/
Utoit	/	0.24	/	/	/
Usol	0.15	0.24	/	0.24	0.24
Ventilation	/	/	/	/	/
Système chauffage	/	/	Chaudière cond Gaz	/	/
Système refroidissement	/	Clim air-air	/	/	/
Remplacement éclairage	Led	/	Led	Led	Led
ECS	/	Chauffe eau gaz	Chauffe eau gaz	élec ballon	/
Panneaux solaires thermiques pour ECS	/	/	/	/	/
Rentable oui/non	oui	oui	oui	oui	oui

	BUE5	EUE1	BUE2	BUE3	BUE4
	Pre-1919	1919-1945	1946-1970	1971-1934	1996-2003
Original E_{spec}	240	328	339	136	130
Best performance with cost-effective solutions (E_{spec})	78	42	103	64	81
Windows	/	Frames + double glazing 1.0	Frames + triple glazing 0.6	/	/
U walls	0.15	0.15	0.15	/	0.2
U roof	/	0.24	0.2	/	0.15
U floor	0.15	0.24	/	0.15	0.15
Ventilation	D	El	D	/	El
Heating system	Air-air heat pump	Air-air heat pump	Gas	Air-air heat pump	/
Cooling system	/	/	Air-to-air conditioning	/	Air-to-air conditioning
Lighting replacement	LED	/	LED	LED	LED
DHW	Elec. tank	/	i	Elec. tank	/
Solar thermal panels for DHW	No	No	No	No	No
Best performance with cost-effective solutions, without fossil fuels (E_{spec})	73	42	108	64	84
Windows	/	Frames + double glazing 1.0	Frames + double glazing 1.0	/	/
U walls	0.15	0.15	0.15	/	/
U roof	/	0.24	0.2	/	/
U floor	0.15	0.24	i	0.15	0.15
Ventilation	D	D	/	/	/
Heating system	Air-air heat pump	Air-air heat pump	Air-air heat pump	Air-air heat pump	Air-air heat pump
Cooling system	/	/	i	/	/
Lighting replacement	LED	/	LED	LED	LED
DHW	Elec. tank	/	/	Elec. tank	Air-air heat pump
Solar thermal panels for DHW	No	No	No	No	No
Cost optimum (theoretical E_{spec})	148	86	223	107	125
Windows	/	Frame + double glazing 1.1	/	/	/
U walls	0.15	0.24	i	/	/
U roof	/	0.24	/	/	/
U floor	0.15	0.24	/	0.24	0.24
Ventilation	/	/	i	/	/
Heating system	/	/	Gas cond. boiler	/	/
Cooling system	/	Air-to-air conditioning	/	/	/
Lighting replacement	LED	/	LED	LED	LED
DHW	/	Gas water heater	Gas water heater	Elec. tank	/
Solar thermal panels for DHW	/	i	/	/	/
Cost-effective yes/no	Yes	Yes	Yes	Yes	Yes

Table 15. Table of findings reflecting the most ambitious (Espec) cost-effective solutions for offices (source: Climact analysis of COZEB data)

	EE1	EE2	EE4	EE3
				
	Avant 1919	1946-1970		1971-1995
Espec d'origine	444	460	321	328
Meilleure performance avec solutions rentables (Espe	98	61	139	66
Chassis	Chassis + triple vitrage 0.6	Chassis + triple vitrage 0.6	Chassis + triple vitrage 0.6	Chassis + triple vitrage 0.6
Umur	0.15	0.15	0.15	0.15
Utoit	0.2	0.15	0.15	0.2
Usol	0.15	0.15	0.15	/
Ventilation	/	D	/	D
Système chauffage	/	/	Chaudière gaz condensation	Chaudière gaz condensation
Système refroidissement	Clim air-air	Clim air-air	/	/
Remplacement éclairage	Led	Led	Led	Led
ECS	/	/	Chaudière gaz condensation	Chaudière gaz condensation
Panneaux solaires thermiques pour ECS	/	/	/	/
Cost optimum (Espec théorique)	286	169	191	111
Chassis	/	/		Chassis + double vitrage 1.1
Umur	/	0.24	0.24	0.24
Utoit	/	0.24	0.24	0.2
Usol	/	0.24	/	/
Ventilation	/	/	/	/
Système chauffage	Chaudière gaz condensation	Chaudière biomasse	/	/
Système refroidissement	/	/	/	/
Remplacement éclairage	Led	Led	Led	Led
ECS	Chaudière gaz condensation	/	/	/
Panneaux solaires thermiques pour ECS	non	/	/	/
Rentable oui/non	oui	oui	oui	oui

	EE1	EE2	EE4	EE3
	Pre-1919	1946-1970		1971-1995
Original E_{spec}	444	460	321	323
Best performance with cost-effective solutions (E_{spec})	98	61	139	66
Windows	Frames + triple glazing 0.6	Frames + triple glazing 0.5	Frames + triple glazing 0.6	Frames + triple glazing 0.6
U walls	0.15	0.15	0.15	0.15
U roof	0.2	0.15	0.15	0.2
U floor	0.15	0.15	0.15	/
Ventilation	/	D	/	D
Heating system	/	/	Gas condensing boiler	Gas condensing boiler
Cooling system	Air-to-air conditioning	Air-to-air conditioning	/	/
Lighting replacement	LED	LED	LED	LED
DHW	/	/	Gas condensing boiler	Gas condensing boiler
Solar thermal panels for DHW	/	/	/	/
Cost optimum (theoretical E_{spec})	286	169	191	111
Windows	/	i		Frame + double glazing 1.1
U walls	/	0.24	0.24	0.24
U roof	/	0.24	0.24	0.2
U floor	/	0.24	/	/
Ventilation	/	/	/	/
Heating system	Gas condensing boiler	Biomass boiler	/	/
Cooling system	/	/	/	/
Lighting replacement	LED	LED	LED	LED
DHW	Gas condensing boiler	i	/	/
Solar thermal panels for DHW	No	/	/	/
Cost-effective yes/no	Yes	Yes	Yes	Yes

Table 16. Table of findings reflecting the most ambitious (Espec) cost-effective solutions for schools (source: Climact analysis of COZEB data)

C. RENOVATION MEASURES ANALYSED IN COZEB II

The second cost-optimal study (COZEB II) analysed energy performance improvements applied to 40 reference buildings representative of the Walloon building stock, using the EPB approach.

These reference buildings are broken down as follows:

28 Existing buildings	12 New buildings
• 13 Single-family homes	• 8 Single-family homes
• 6 Apartment buildings	• 1 Apartment building
• 5 Office buildings	• 1 Office building
• 4 Schools	• 2 School buildings

The following were applied to these reference buildings:

- a maximum 60 measures to improve the energy performance of the envelope and ventilation, grouped by wall surface type;
- 70 system replacement measures;
- 44 construction groups at envelope level. These groups represent construction choices at envelope level, making it possible to achieve the improvement (e.g.: U-value of a wall surface) for a fixed cost.

These measures are shown below:

ENVELOPE MEASURES FOR EXISTING BUILDINGS		RES UNIT	RES COLL	NON-RES Off.	NON-RES Sch.
External surfaces					
WALLS	ME0.24	x	x	x	x
	ME0.20	x	x	x	x
	ME0.15	x	x	x	x
FRAME	Ch1.7-DV1.1/0.63	x	x	x	x
	Ch1.7-DV1.0/0.5	x	x	x	x
	Ch0.95-TV0.6/0.5	x	x	x	x
	Ftoit 1	x	x	x	x
	Ftoit 2	x	x	x	x
GLAZING	V1.1/0.63-wood present	x	x		
	V1.1/0.63-pvc present	x	x		
	V1.1/0.63-alu present	x	x		
FLOOR	PlE0.3	x	x	x	x
	PlE0.24	x	x	x	x
	PlE0.15	x	x	x	x
SLOPED ROOF	T0.24	x	x	x	x
	T0.20	x	x	x	x
	T0.15	x	x	x	x
FLAT ROOF	TP0.24	x	x	x	x
	TP0.20	x	x	x	x
	TP0.15	x	x	x	x
DOOR	Pext2	x	x	x	x
	Pext0.8	x	x	x	x
Shared surfaces					
WALLS	MI1.0	x	x	x	x
FLOOR	PlMit1.0	x	x	x	x
CEILING	PfMit1.0	x	x	x	x
Ground surfaces					
WALLS	Ms0.24	x	x	x	x
	Ms0.20	x	x	x	x
	Ms0.15	x	x	x	x
FLOOR	PlSol0.3	x	x	x	x
	PlSol0.24	x	x	x	x
	PlSol0.15	x	x	x	x
Cellar surfaces					
WALLS	Mcave0.24	x	x	x	x
	Mcave0.2	x	x	x	x
	Mcave0.15	x	x	x	x
FLOOR	PlCave0.3	x	x	x	x
	PlCave0.24	x	x	x	x
	PlCave0.15	x	x	x	x
DOOR	Pcave2	x	x	x	x
Adjacent unheated space surfaces					
WALLS	Meanc0.24	x	x	x	x
	Meanc0.2	x	x	x	x
	Meanc0.15	x	x	x	x
CEILING	PfGr0.24	x	x	x	x
	PfGr0.2	x	x	x	x
	PfGr0.15	x	x	x	x
FLOOR	Pleanc0.3	x	x	x	x
	Pleanc0.24	x	x	x	x
	Pleanc0.15	x	x	x	x
DOOR	Peanc2	x	x	x	x
Crawl space surfaces					
WALLS	Mvv0.24	x	x	x	x
	Mvv0.2	x	x	x	x
	Mvv0.15	x	x	x	x
FLOOR	Plvv0.3	x	x	x	x
	Plvv0.24	x	x	x	x
	Plvv0.15	x	x	x	x
Solar protection					
	External solar protection - manual	x	x		x
	External solar protection - automatic	-	-	x	-
Air tightness					
	Air tightness 4	x	x	x	x
	Air tightness 2	x	x	x	x
Inertia					
	Medium	x	x	x	x
	Light	x	x	x	x

Ventilation					
	Ventilation D	x	x	x	x
	Ventilation C + 0.43	x	x		
	Ventilation C + 0.9	x	x		
	Ventilation C	x	x		

SYSTEMS MEASURES FOR EXISTING BUILDINGS		RES UNIT	RES COLL	NON-RES Off.	NON-RES Sch.
Separate supply - Heating only / DHW only					
HEATING	PS (pellet stove)	x	x		
	CH (central heating) gas surface	x			
	CH oil surf	x			
	NCH (non-central heating) bio surf	x			
	CH gas rad	x	x	x	x
	CH oil rad	x		x	x
	NCH bio rad	x	X	x	x
	CH gas CV (centralised ventilation)	x	X	x	x
	CH oil CV	x		x	x
	NCH bio CV	x	x	x	x
	WS (wood stove)	x	x		
	Air-to-water heat pump elec rad surf 3.1	x			
	Air-to-water heat pump elec rad CV 3.1	x	x	x	x
	Ground-to-water heat pump elec rad surf 4.75	x			
	Ground-to-water heat pump elec rad CV 4.75	x		x	x
	Air-to-water heat pump elec rad surf 4	x			
	Air-to-water heat pump elec rad CV 4	x	x	x	x
	Air-to-air heat pump rad no 3.2			x	x
	Air-to-water heat pump + NCH gas exist rad 4	x	x	x	x
	Air-to-water heat pump + NCH oil exist rad 4	x	x	x	x
DHW	Gas water heater - tank	x	x	x	x
	Air-to-water heat pump 4 + elec rad tank	x	x		x
	Elec rad tank	x	x	x	x
	Gas water heater - NO tank	x	x	x	x
Dual supply					
HEATING	CH gas surf (+ DHW) with storage	x			
	CH oil surf (+ DHW) with storage	x			
	CH gas rad (+ DHW) with storage	x	x	x	x
	CH oil rad (+ DHW) with storage	x		x	x
	NCH bio surf (+ DHW) with storage	x			
	NCH bio rad/CV (+ DHW) with storage	x	X	x	x
	CH gas CV (+ DHW) with storage	x		x	
	CH oil CV (+ DHW) with storage	x		x	
	CH gas surf (+ DHW) WITHOUT storage	x			
	CH gas rad (+ DHW) WITHOUT storage	x	X	x	x
	CH gas CV (+ DHW) WITHOUT storage	x	X	x	x
Heat pump	Ground-to-water heat pump 4.75 surf + rad (+ DHW) storage	x			
	Air-to-water heat pump 4 surf + rad (+ DHW) storage	x			
	Ground-to-water heat pump 4.75 CV + rad (+ DHW) storage	x		x	x
	Air-to-water heat pump 4 CV + rad (+ DHW) storage	x		x	x
	Air-to-water heat pump 4 rad + NCH gas exist (+ DHW) storage	x			
	Air-to-water heat pump 4 rad + NCH oil exist (+ DHW) storage	x			
Shared supply					
HEATING	CH gas rad (+ DHW) with storage		x		
	CH oil rad (+ DHW) with storage		x		
	NCH bio rad (+ DHW) storage		x		
	NCH bio CV BT (+ DHW) with storage		x		
	CH gas CV BT (+ DHW) with storage		x		
	CH oil CV BT (+ DHW) with storage		x		
	CH gas rad (+ DHW) WITHOUT storage		x		
	CH gas CV BT (+ DHW) WITHOUT storage		x		
Heat pump	Air-to-water heat pump 4 CV (+ DHW) storage		x		
	Air-water heat pump 3.1 CV (+ DHW) storage		x		
Cooling					
REV. HEAT PUMP	Air-to-water heat pump CV 3.1 (EER 3.0) AIR-WATER			x	x
	Air-water heat pump CV 3.75 (EER 3.6) AIR-WATER			x	x
	Air-water heat pump CV 4 (EER 3.8) AIR-WATER			x	x
	Air-to-air heat pump 3.2 (EER 3.0) AIR-AIR			x	x
Heat pump	Air-to-water heat pump EER 3 central AIR			x	x
COMP MACH	Air-to-air cooling EER 4 central AIR			x	x

Solar thermal					
	ST2	x	x		
	ST4	x	x		
	ST6	x	x		x
Solar photovoltaic					
	PV2 flat	x	x		
	PV5 flat	x		x	x
	PV10 flat			x	x
	PV30 flat			x	x
	PV2 slope	x	x		
	PV5 slope	x		x	x
	PV10 slope			x	x
	PV30 slope			x	x

The **outcomes of the calculations** presented in the report describe or verify for each reference building and building element selected for the study:

- the final and primary energy needs and the adjusted overall cost of the combinations on the Pareto front;
- the adjusted overall cost of cost-optimal combinations over the assessment period (non-residential: 20 years, residential: 30 years);
- the cost-optimal energy performance levels;
- the percentage difference between the optimal energy performance level and the minimum EPB requirements in force in Wallonia in 2017 and 2021 (both for new buildings and for existing buildings).

D. MAIN ASSUMPTIONS OF THE COZEB II STUDY

Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 sets the comparative methodology framework for calculating optimal levels of minimum requirements in terms of the energy performance of buildings.

The regulation also specifies that the calculations must be carried out for both a financial calculation and for a macroeconomic calculation, as well as for two different discount rates. In addition, for each calculation and each discount rate, three scenarios for the development of energy costs must be considered.

1. **The financial calculation** determines the adjusted overall cost by including, in addition to the investments, VAT, taxes, charges and tax incentives and deductions.
2. **The macroeconomic calculation** determines the adjusted overall cost by considering investments exclusive of VAT, taxes and charges, and includes the costs of greenhouse gas emissions.
3. **The discount rate:** The overall cost for buildings and building elements is calculated by summing the different types of costs and applying to these the discount rate by means of a discount factor so as to express them in terms of value in the starting year. The reference discount rates (excluding inflation) used in this study are as follows:

	Financial calculation	Macroeconomic calculation
Residential	FDR: 2%	MDR: 3%
Commercial	FDR: 3%	MDR: 4%

Table 17. Discount rate used in the COZEB II study

4. **Development of energy prices:** The energy prices used in the study are based on national statistics, updated in early October 2017, and differentiated according to the building's consumption brackets. Three scenarios for the development of energy prices are considered in the study: **0%, 1.75% and 3.5%.** The assumptions underlying these three scenarios are detailed in the COZEB I report 'initial investment costs'.

The **optimal cost** is the package of envelope and system improvements for which the adjusted overall cost is minimal. It is expressed in terms of the performance indicators for which Wallonia has set a required level.

The adjusted overall cost for each package is determined by summing the following over the calculation period (30 years for residential buildings and 20 years for non-residential buildings):

- initial investment costs (initial cost in Year 0),
- disposal costs,
- running costs including:
  - annual operating costs (operational costs, maintenance costs, energy costs),
  - periodic replacement (reinvestment) costs,
- annual costs of greenhouse gas emissions (for macroeconomic calculation only).

The global cost includes the cost of the building envelope and systems installed (production, storage, distribution and emissions), as well as the cost of the building's energy consumption over 20 (non-residential) or 30 (residential) years. The total cost of a heat loss surface includes the structure, insulation, interior and exterior finishes. The price of interior partitions and joinery, sanitary facilities, plumbing, electricity, etc., are not included in the global cost.

In calculating the overall cost, the initial investment, the sum of the annual costs (referred to the starting year) and the final value are taken into account.

E. METHODOLOGY FOR ADJUSTING CONSUMPTION AND OVERALL COSTS

As mentioned in point II.B.1 of the body of the renovation strategy, the cost-effectiveness of renovation solutions was assessed using two approaches:

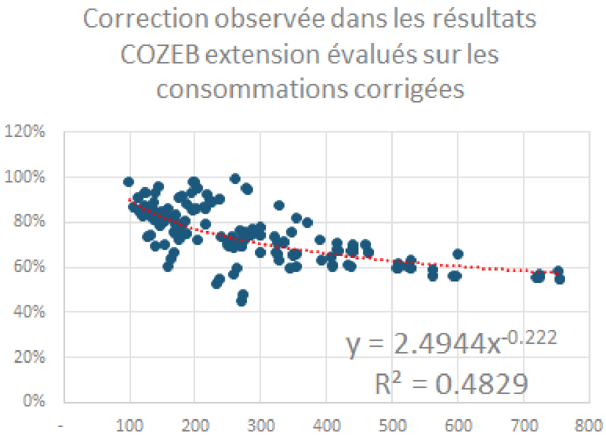
- **a theoretical approach** based on the methodology of the COZEB II study and the EPB calculation method determining theoretical consumption with standard occupancy of the building;
- **a 'corrected theoretical' approach** to better reflect actual building consumption in estimating the cost-effectiveness of investments.

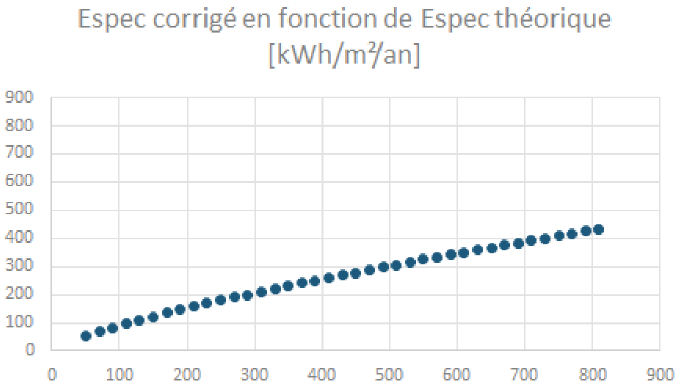
The following paragraphs present the methodology used for this 'corrected theoretical' approach.

The motivation is that the theoretical approach to cost-effective solutions is too optimistic because the energy bill prior to renovation assumes a theoretical consumption that experience shows to be higher than the consumption actually observed. It is therefore appropriate to consider corrected consumption which aims to better reflect actual consumption. Actual and theoretical consumption are closer following renovations.

Two conversion rules are used to correct the COZEB II results.

The first rule involves correcting the primary energy consumption. Work was carried out as part of the COZEB extension study to estimate correction factors for primary energy consumption. These factors lead to the following development of the 'corrected Espec' as a function of 'theoretical Espec'.



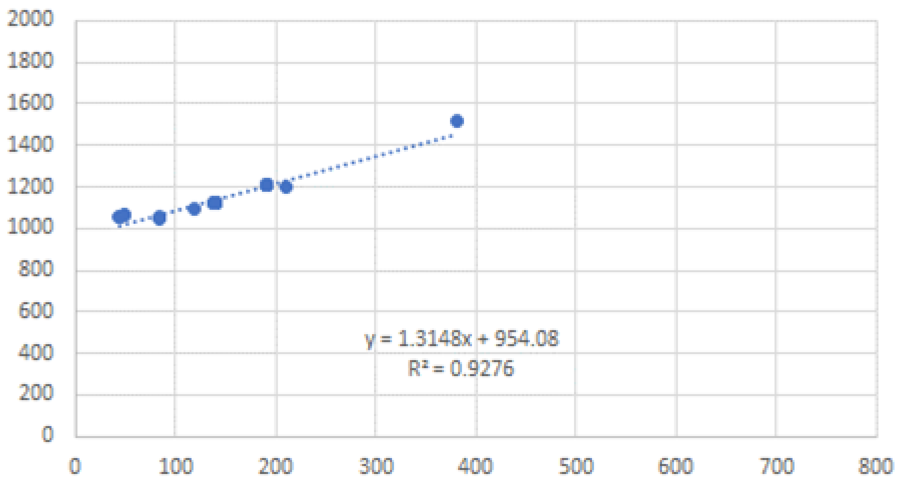


Correction observée dans les résultats COZEB extension évalués sur les consommations corrigées	Correction observed in COZEB extension results evaluated for corrected consumption
120%	120%
100%	100%
80%	80%
60%	60%
40%	40%
20%	20%
0%	0%
$y = 2.4944x^{-0.222}$ $R^2 = 0.4829$	$y = 2.4944x^{-0.222}$ $R^2 = 0.4829$
-	-
100	100
200	200
300	300
400	400
500	500
600	600
700	700
800	800
Espec corrigé en fonction de Especthéorique [kWh/m²/an]	Corrected E_{spec} as a function of theoretical E_{spec} [kWh/m²/year]
900	900
800	800
700	700
600	600
500	500
400	400
300	300
200	200
100	100
0	0
0	0

100	100
200	200
300	300
400	400
500	500
600	600
700	700
800	800
900	900

Figure 14. (Top) Correction factor (%) for specific primary energy consumption as a function of Espec(kWh/m²/yr) identified in COZEB extension study (blue dots) and correction function used in the model (red dotted curve); (Bottom) Specific primary energy consumption (kWh/m²/yr) as a function of Espec (kWh/m²/yr) resulting from the correction function.

The second rule involves amending the adjusted overall cost of the renovation solutions to take into account the corrected Espec and thus lower energy savings than those estimated using the assumptions in the COZEB II study. For this purpose, the relationship between the Espec and the variable component of the adjusted overall cost is extracted for each reference typology. This variable component is obtained by subtracting the investment[16]. The relationship is observed by considering a selection of measures (base, cost-optimal, cost-optimal for A rating, cost-effective maximum and these same solutions conditional on the use of renewable systems). This relationship is illustrated in Figure 15 for the HE3 typology, and the coefficients of the linear function approximating this relationship for each typology are given in Table 18.



2000	2 000
1800	1 800
1600	1 600
1400	1 400
1200	1 200
1000	1 000
800	800
600	600
400	400
200	200
0	0
0	0
100	100
200	200
300	300

[16] Some terms in this component are not proportional to energy consumption (e.g. maintenance costs); they are reflected in the constant term for the linear relationship.

400	400
500	500
600	600
700	700
800	800
y = 1.3148 + 954.08	y = 1.3148 + 954.08
R^2 = 0.9276	R^2 = 0.9276

Figure 15. Variable component of the adjusted overall cost (assessed by deducting the investment from the adjusted overall cost, in adjusted euro) as a function of Espec (kWh/m²/yr); example for the HE3 typology. The linear function reflected by the dotted line is used to calculate the new value of adjusted overall costs using the corrected Espec.

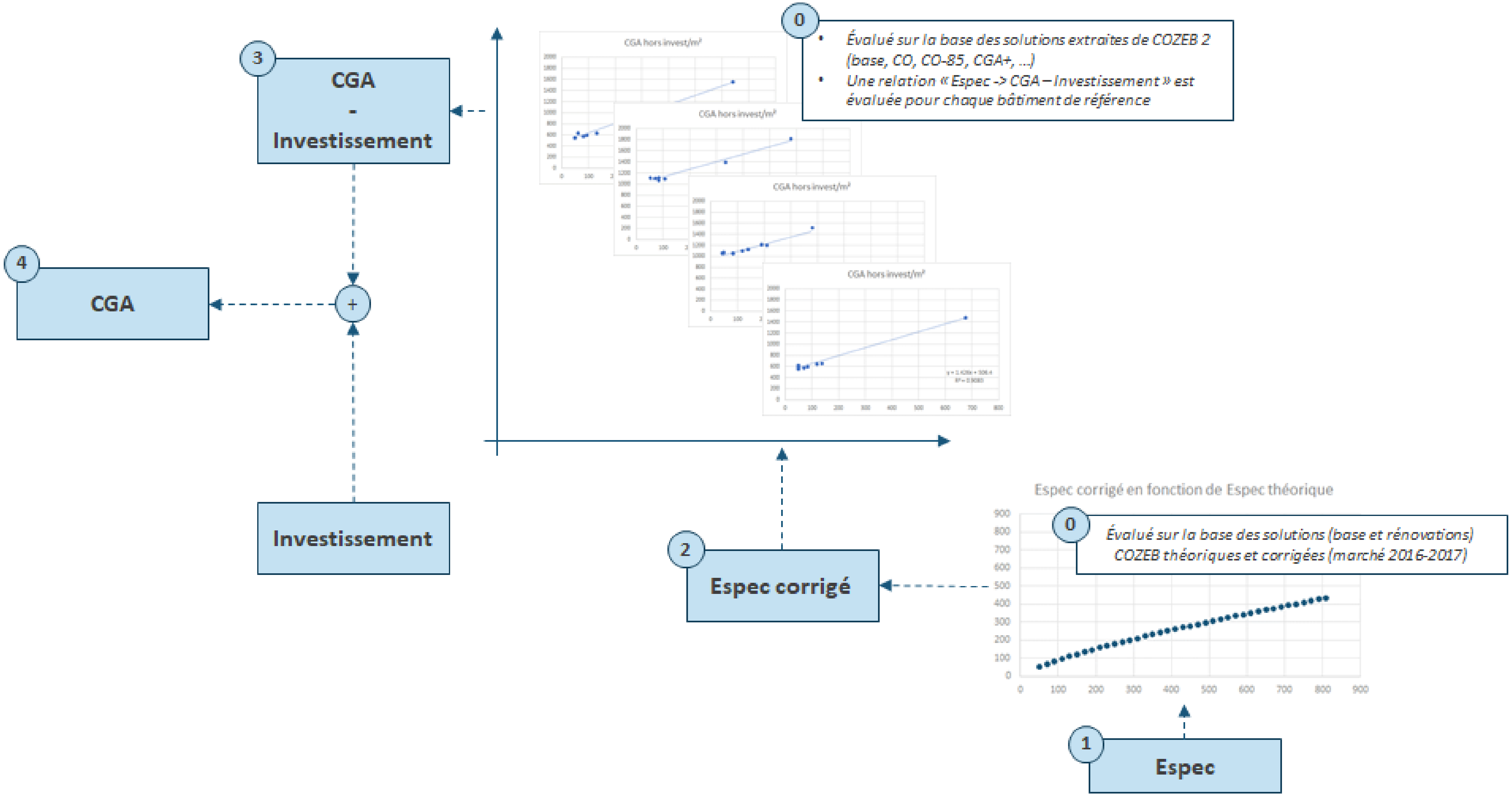
RefBldg	a	b
HE1	1.6789	470.39
HE2	1.365	991.55
HE3	1.3148	954.08
HE4	1.426	506.4
HE5	1.366	407.24
HE8	1.4105	927.56
HE9	1.6542	1,023.2
HE10	1.5237	1,007.6
HE11	1.7637	1,227.2
HE12	1.4126	1,091.1
HE13	1.0747	1,069.1
HE14	1.3295	1,337.8
IAE1	1.6224	663.99
IAE3	0.7751	578.61
IAE4	1.189	794.03
IAE5	1.5854	952.21
IAE7	0.993	996.6
IAE9	1.4967	1,201.3

Table 18. Coefficient for the linear relation between Espec and the variable component of the adjusted overall cost

([Adjusted overall cost – Investment] = (a. Espec + b). m²). Source: Climact analysis

On this basis, the methodology illustrated in Figure 16 is followed to modify the COZEB II results:

1) read Espec after relevant renovation measure;
2) correct this Espec;
3) modify variable component of the adjusted overall cost;
4) calculate modified adjusted overall cost by adding investment for the measure to this new variable component of the adjusted overall cost.



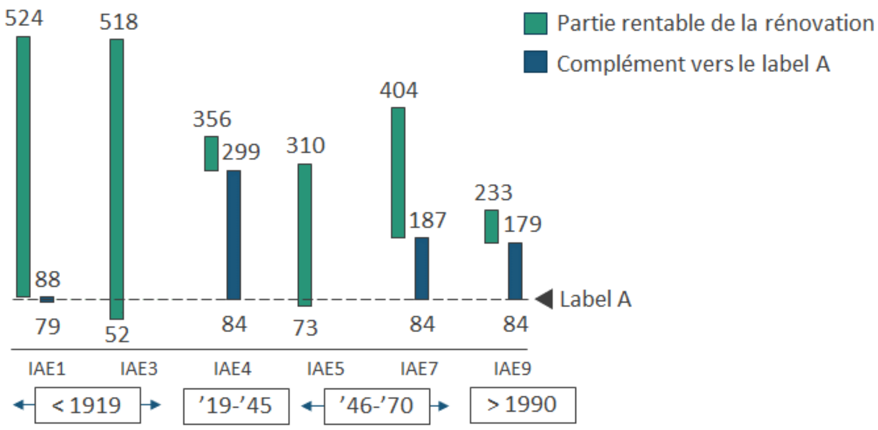
3	3
CGA Investissement	AGC – Investment
4	4
CGA	AGC
+	+
Investissement	Investment
• Évalué sur la base des solutions extraites de COZEB 2 (base, CO, CO-85, CGA+, ...)	• Evaluation based on solutions from COZEB II (base, CO, CO-85, AGC+, etc.)
• Une relation « Espec -> CGA - Investissement» est évaluée pour chaque bâtiment de référence	• Relationship ‘E_{spec} -> CGA – investment’ is evaluated for each reference building

CGA hors invest/m²	AGC excluding invest./m²
CGA hors invest/m²	AGC excluding invest./m²
CGA hors invest/m²	AGC excluding invest./m²
CGA hors invest/m²	AGC excluding invest./m²
2	2
Espec corrigé	Corrected E_{spec}
Espec corrigé en fonction de Espec théorique	Corrected E_{spec} as a function of theoretical E_{spec}
Évalué sur la base des solutions (base et rénovations) COZEB théoriques et corrigées (marché 2016-2017)	Evaluated based on theoretical and corrected COZEB solutions (base and renovations) (2016-2017 market)
Espec	E_{spec}

Figure 16. Methodology followed to correct COZEB II results to better reflect actual building consumption in estimating cost-effectiveness of investments

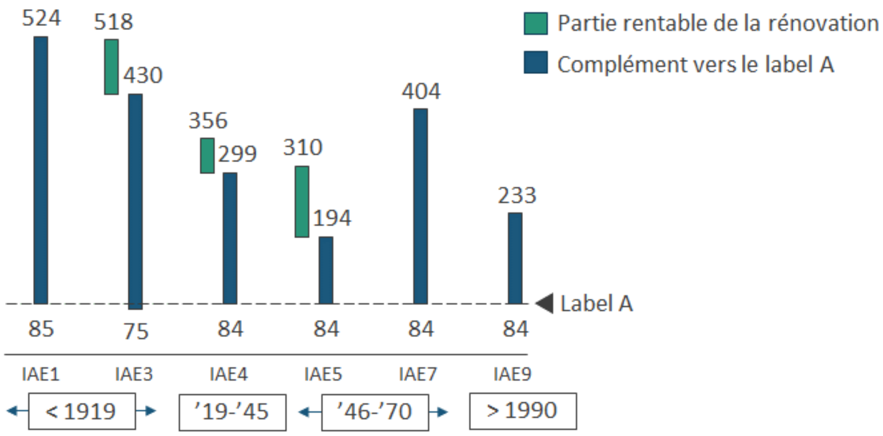
F. COST-EFFECTIVENESS OF RENOVATION MEASURES

1) APARTMENT BUILDINGS



Partie rentable de la rénovation	Cost-effective part of renovation
Complément vers le label A	Supplement to A rating
524	524
88	88
79	79
IAE1	IAE1
518	518
52	52
IAE3	IAE3
356	356
299	299
84	84
IAE4	IAE4
310	310
73	73
IAE5	IAE5
404	404
187	187
84	84
IAE7	IAE7
233	233
179	179
84	84
IAE9	IAE9
Label A	A rating
< 1919	Pre-1919
'19-'45	1919-1945
'46-'70	1946-1970
> 1990	Post-1990

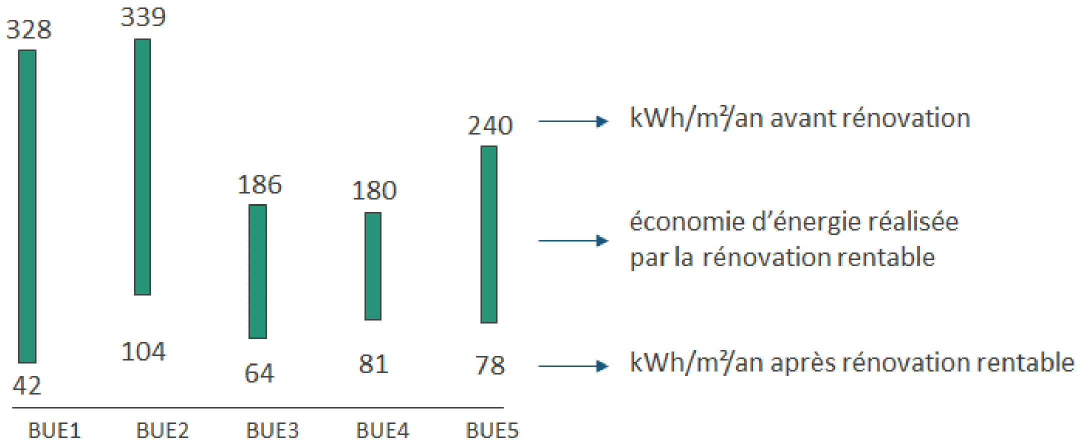
Figure 17. Espec (theoretical, in kWh/m²/yr) pre- and post-renovation, for the reference typologies of apartment buildings, achievable via cost-effective renovation measures (cost-effectiveness in the sense used in the COZEB II study, assessed on the basis of theoretical consumption), and through additional renovations to achieve A rating (Source: Climact analysis based on COZEB II results)



Partie rentable de la rénovation	Cost-effective part of renovation
Complément vers le label A	Supplement to A rating
524	524
85	85
IAE1	IAE1
518	518
430	430
75	75
IAE3	IAE3
356	356
299	299
84	84
IAE4	IAE4
310	310
194	194
84	84
IAE5	IAE5
404	404
84	84
IAE7	IAE7
233	233
84	84
IAE9	IAE9
Label A	A rating
< 1919	Pre-1919
'19-'45	1919-1945
'46-'70	1946-1970
> 1990	Post-1990

Figure 18. Espec (theoretical, in kWh/m²/yr) pre- and post-renovation, for the reference typologies of apartment buildings, achievable via cost-effective renovation measures (cost-effectiveness assessed based on corrected consumption), and through additional renovations to achieve A rating (Source: Climact analysis)

2) OFFICES

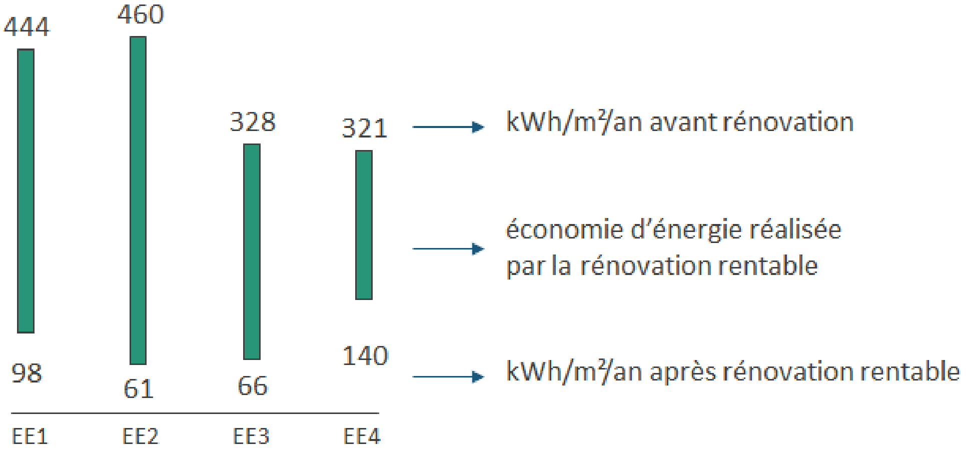


328	328
42	42
BUE1	BUE1
339	339
104	104
BUE2	BUE2
186	186
64	64
BUE3	BUE3
180	180
81	81
BUE4	BUE4
240	240
78	78
BUE5	BUE5
kWh/m²/an avant rénovation	kWh/m²/year before renovation
économie d'énergie réalisée par la rénovation rentable	Energy savings achieved through cost-effective renovation
kWh/m²/an après rénovation rentable	kWh/m²/year after cost-effective renovation

Figure 19. Espec (theoretical, in kWh/m²/yr) pre- and post-renovation, for the reference typologies of office buildings,

achievable through cost-effective renovation measures (cost-effectiveness in the sense used in the COZEB II study)(Source: Climact analysis based on COZEB II results)

3) SCHOOLS



444	444
98	98
EE1	EE1
460	460
61	61
EE2	EE2
328	328
66	66
EE3	EE3
321	321
140	140
EE4	EE4
kWh/m²/an avant rénovation	kWh/m²/year before renovation
économie d'énergie réalisée par la rénovation rentable	Energy savings achieved through cost-effective renovation
kWh/m²/an après rénovation rentable	kWh/m²/year after cost-effective renovation

Figure 20. Espec (theoretical, in kWh/m²/yr) pre- and post-renovation, for the reference typologies of school buildings,

achievable through cost-effective renovation measures (cost-effectiveness in the sense used in the COZEB II study)(Source: Climact analysis based on COZEB II results)

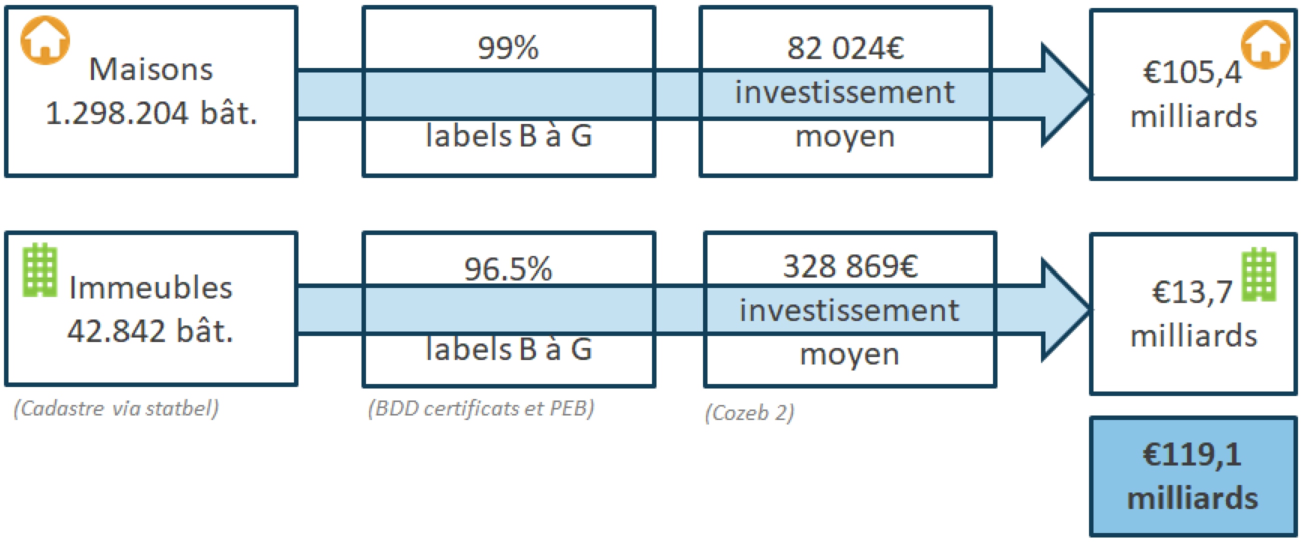
G. COST ANALYSIS FOR RENOVATION TO A-RATED HOUSING AND AMBITIOUS COST-EFFECTIVE RENOVATION OF NON-RESIDENTIAL BUILDINGS

1) RESIDENTIAL BUILDINGS

To estimate the investment costs for average renovation to A-rated housing stock, two approaches were followed. Both result in investment costs of just under €120 billion.

It is the figure resulting from the second approach that is integrated into the scenarios in the model used to develop the phasing for the renovation strategy, with segmentation of the stock by EPB rating. Note that these figures do not include the costs of upgrading from A rating to decarbonised A rating.

1) **Approach based on the cost of renovation to A-rated reference typologies in the COZEB II study (theoretical approach) and representation of these reference typologies.**



Maisons 1.298.204 bât.	Houses 1 298 204 buildings
99% labels B à G	99% ratings B to G
82 024€ investissement moyen	€82 024 average investment
€105,4 milliards	€105.4 billion
Immeubles 42.842 bât.	Apartments 42 842 buildings
96.5% labels B à G	96.5% labels B to G
328 869€ investissement moyen	€328 869 average investment
€13,7 milliards	€13.7 billion
(Cadastre via statbel)	(Land register from Statbel)
(BDD certificats et PEB)	(Certificates and EPB database)
(Cozeb 2)	(COZEB II)
€119,1 milliards	€119.1 billion

Figure 21. Estimated investment costs based on representation of the reference typologies in the COZEB studies

Note: Regardless of the approach (theoretical or corrected theoretical) similar investment is required. Based on the results of the corrected theoretical approach, the total investment is €117 billion.

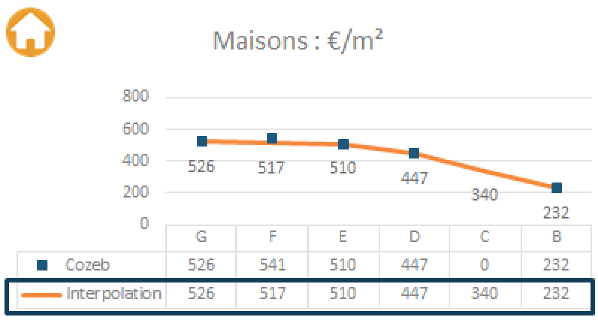
2) **Approach-based on m² to renovate, by EPB rating.**

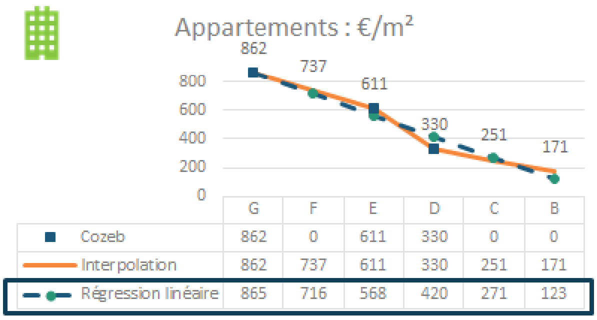
Noting a bias in the EPB rating of the reference buildings compared with the distribution of ratings observed in the certificate database (see Figure 22), the costs of renovation to A rating obtained for the reference typologies (and their EPB rating) were extrapolated to express the cost of renovation for the different EPB ratings levels (see Figure 23).

	BDD certificats et PEB	Cozeb	BDD certificats et PEB	Cozeb
G	36%	34%	15%	14%
F	**17%**	**3%**	9%	0%
E	**17%**	**27%**	12%	18%
D	**14%**	**8%**	17%	29%
C	**9%**	**0%**	**22%**	**0%**
B	**7%**	**19%**	**22%**	**0%**
A	1%	-	4%	-

	Certificates and EPB database	COZEB	Certificates and EPB database	COZEB
G	36%	34%	15%	14%
F	17%	3%	3%	0%
E	17%	27%	12%	18%
D	14%	8%	17%	23%
C	9%	0%	22%	0%
B	7%	19%	22%	0%
A	1%	-	4%	-

Figure 22. Representation of EPB rating in COZEB typologies and in databases of EPB certificates and declarations





Maisons : €/m²	Houses: €/m²
Appartements : €/m²	Apartments: €/m²

	G	F	E	D	C	B
COZEB	526	541	510	447	D	232
Interpolation	526	517	510	447	340	232

COZEB	362	0	611	330	0	0
Interpolation	862	737	611	330	251	171
Linear regression	365	716	568	420	271	123

Figure 23. Cost analysis for renovation to A rating in €/m² for each EPB rating, based on COZEB II results

	Ach moyen m²/logement (house)	Ach moyen m²/logement (building)	# logements (house)	# logements (building)	Coûts réno au label A €/m² (house)	Coûts réno au label A €/m² (building)
G	154	75	484,500	41,340	526	865
F	162	78	225,442	23,513	517	716
E	185	79	224,537	33,385	510	568
D	187	82	189,824	45,470	447	420
C	205	86	126,345	58,964	340	271
B	202	94	93,137	59,028	232	123
A	224	99	13,514	9,548		
			36%	15%		
			17%	9%		
			17%	12%		
			14%	17%		
			9%	22%		
			7%	22%		
			1%	4%		

x x =

Coût total Mrd € (house)	Coût total Mrd € (building)
108.4 milliards €	9.1 milliards €
€117,5 milliards	

Ach moyen	Average Ach
m²/logement	m²/home
# logements	No of homes
Coûts réno au label A	Reno. costs to A rating
€/m²	€/m²
Coût total	Total cost
Mrd €	Billion €

108.4 milliards €	€108.4 billion
9.1 milliards €	€9.1 billion
€117,5 milliards	€117.5 billion

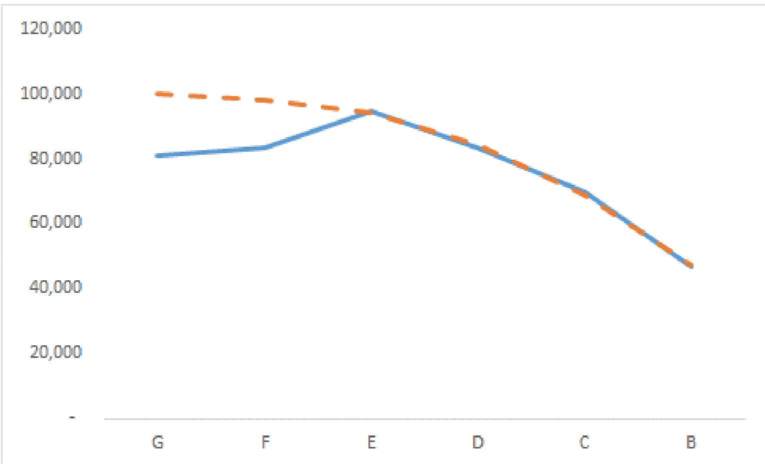
Figure 24. Estimated investment costs for each EPB rating, based on costs from the COZEB II study

The EPB certificate database shows performance increasing with the size of building (heated area). On average and according to the EPB certificates, more efficient buildings are larger than less efficient buildings. Combining the evolution of this area with that of the cost in €/m² results in the evolution of an average cost per single-family house as a function of performance presented in Figure 25 and Figure 26. Figure 26 also presents a potential correction to the average cost per building curve as a function of performance. Applying this correction results in investment costs of €120.8 billion for single-family homes, bringing the total to €130 billion. This correction is not used in the scenarios presented.

	Ach [m²/logement]		Coût [€²/m²]		Coût [€/logement]
G	154		526		81,085
F	162		517		83,607
E	185	x	510	=	94,544
D	187		447		83,608
C	205		340		69,659
B	202		232		46,834

	Ach [m₂/home]		Cost [€2/m²]		Cost [€/home]
G	154		526		81 085
F	162		517		83 607
E	185	x	510	=	94 544
D	187		447		83 608
C	205		340		69 659
B	202		232		46 834

Figure 25. Costs of renovation to A rating according to the EPB rating for single-family homes, extrapolated from the COZEB II results and the certificate database. Source: Climact analysis



120,000	120 000
100,000	100 000
80,000	80 000
60,000	60 000
40,000	40 000
20,000	20 000
-	-
G	G

F	F
E	E
D	D
C	C
B	B

Figure 26. Costs of renovation to A rating according to the EPB rating for single-family homes, extrapolated from the COZEB II results and the certificate database (solid blue line), and potential modification to reflect a more likely evolution (dotted orange line). Source: Climact analysis

2) NON-RESIDENTIAL BUILDINGS

The COZEB study results in an average cost, for cost-effective ambitious renovation, of €190/m² for offices and €442/m² for schools (see Section II.B.2 of the body of the strategy). Weighted by area, this results in an average cost of €288/m².

Feedback from stakeholders suggests we treat these figures with caution, as experience on the ground instead suggests costs ranging from €600/m² to €1,000/m² for renovations resulting in carbon neutrality.

Based on this range and taking into account the surface areas of buildings in each sector, the investment costs amount to between €34 billion and €57 billion, of which public buildings account for between €16 billion and €27 billion.

The highest and lowest values will be considered when presenting the results.

Cost of renovation (€/m²)		300	600	1,000		600	1,000
Sectors	million m²				% public		
Health	8.0	2.4	4.8	8.0	100%	4.8	8.0
Schools	10.3	3.1	6.2	10.3	100%	6.2	10.3
Public offices	5.1	1.5	3.1	5.1	100%	3.1	5.1
Private offices	10.8	3.2	6.5	10.8		0.0	0.0
Shops	14.8	4.4	8.9	14.8		0.0	0.0
Other	8.0	2.4	4.8	8.0	50%	2.4	4.0
Total		17	34	57		16	27

Table 19. Estimated investment costs for renovation of non-residential buildings, based on different cost assumptions

Annexe 4. Additional information on renovation scenarios at Regional level

The Region has a model that lets it analyse the impact of various parameters on annual rates of renovation, which also depend on the Region's decisions on phasing the renovation (schedule for implementation of the strategy), the depth of the planned renovations, etc. This Annex presents the main assumptions made in this tool, along with a sensitivity analysis on the scenarios presented in the body of the strategy.

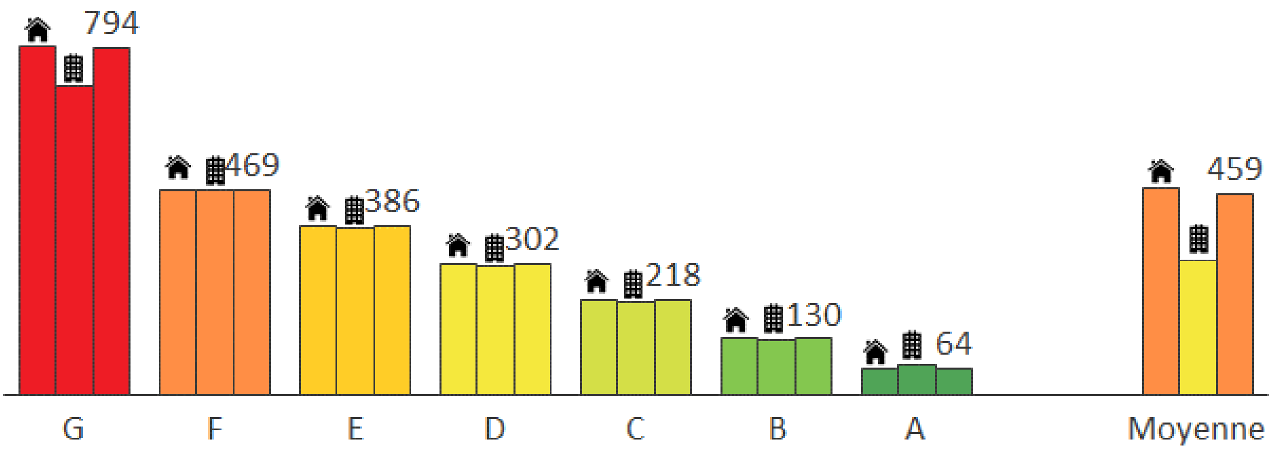
A. SCENARIOS FOR RENOVATION OF RESIDENTIAL BUILDINGS

This section presents a selection of important assumptions made in quantifying the renovation scenarios. Different scenarios were investigated, starting with the renovation schedule communicated in the 2017 version of the strategy, modified to obtain results consistent with the Regional Policy Declaration (DPR) targets of achieving 55% reduction in greenhouse gas (GHG) emissions by 2030 compared to 1990.

1) ASSUMPTIONS

Performance of buildings in the reference year

Based on databases of EPB declarations and certificates, the average energy performance of buildings under each EPB rating is as follows:



Moyenne	Average

Figure 27. Average Espec of residential housing (kWh/m²/yr) by EPB rating

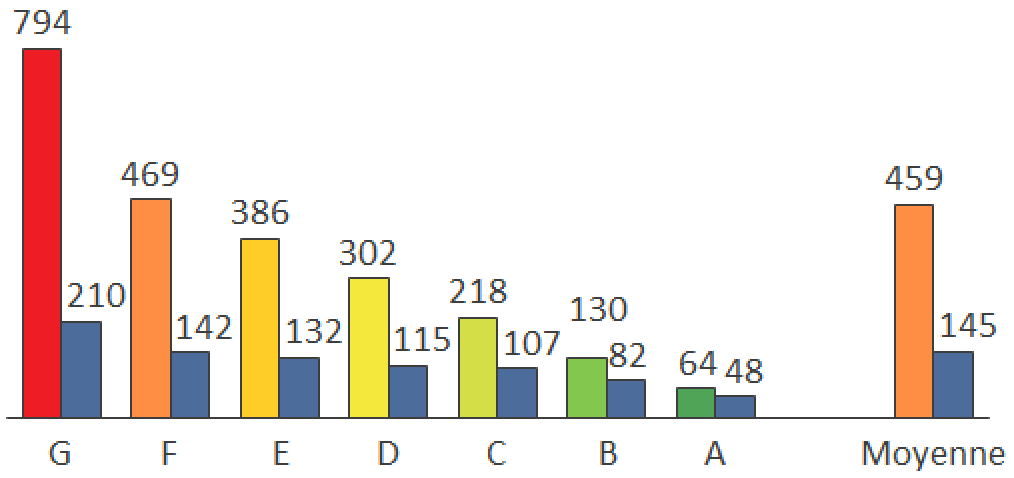
Although this theoretical primary energy consumption reflects the energy performance of buildings, the actual use of buildings differs from the standard conditions considered in the EPB methodology (new or existing). Actual consumption therefore differs from this theoretical consumption.

Actual energy consumption should be taken into account to assess the energy savings resulting from the renovation strategy. This is calculated by calibrating the model with the energy consumption reported in the region's energy balance. This is because the number of dwellings, multiplied by their average surface area and their specific energy consumption, is expected to equal the consumption in the energy balance.

In this calibration exercise, the following assumptions are made:

1. 10% of dwellings are unheated (empty dwellings, second homes), out of the number of dwellings indicated by the land register.
5. The average efficiency of heating systems is 80%.
6. The share of electricity in energy consumption linked to EPB uses is 7.1%.

The corrected specific primary energy consumption (kWh/m²/yr), calibrated with the energy balance, is presented in Figure 28. It corresponds to a final energy consumption for dwellings of 131.4 kWh/m²/yr, and to an average net energy requirement (NER) for heating of 105 kWh/m²/yr.



Moyenne	Average

Figure 28. Bars on left: average Espec of housing stock (kWh/m²/yr) – Bars on right: corrected specific primary energy consumption (kWh/m²/yr), calibrated with the energy balance

Long-term target performance

The strategy's average target for residential buildings is a decarbonised A rating. The EPB rating reflected by the EPB rating is a function not only of the energy requirement for EPB uses (efficiency of the envelope), but also of the way of meeting this (local energy sources). To individually assess the impacts of envelope and systems improvements and the use of decarbonised energy carriers, an assumption is made as to the average NER value corresponding to the A rating. Different assumptions about the systems (mix of heating technologies and associated returns) are evaluated, as indicated in the body of the strategy.

Analysis of the COZEB data indicates that the average NER (weighted by representation of the different stock typologies) of the least expensive solutions (adjusted total cost) for achieving an A rating is 54 kWh/m²/yr for single-family houses and 34 kWh/m²/yr for apartments. **A target NER of 55 kWh/m²/yr is used for the analyses.**

Average contribution of renovation measures to energy saving potential

The schedule for implementation of the renovation strategy is based on gradual implementation of the batches of work that will be identified in the renovation roadmap included in the housing audit. To assess the resulting energy savings, the average contribution to energy savings (on a path towards an A rating) of these batches of work needs to be specified.

The following contributions are considered on the basis of the results from COZEB:

Measures	Share of reduction in requirements for the A rating	Share of reduction in final energy consumption for the A rating
Roofs	35%	30%
Floors	10%	9%
Walls	35%	30%
Windows	20%	17%
Technologies	-	13%

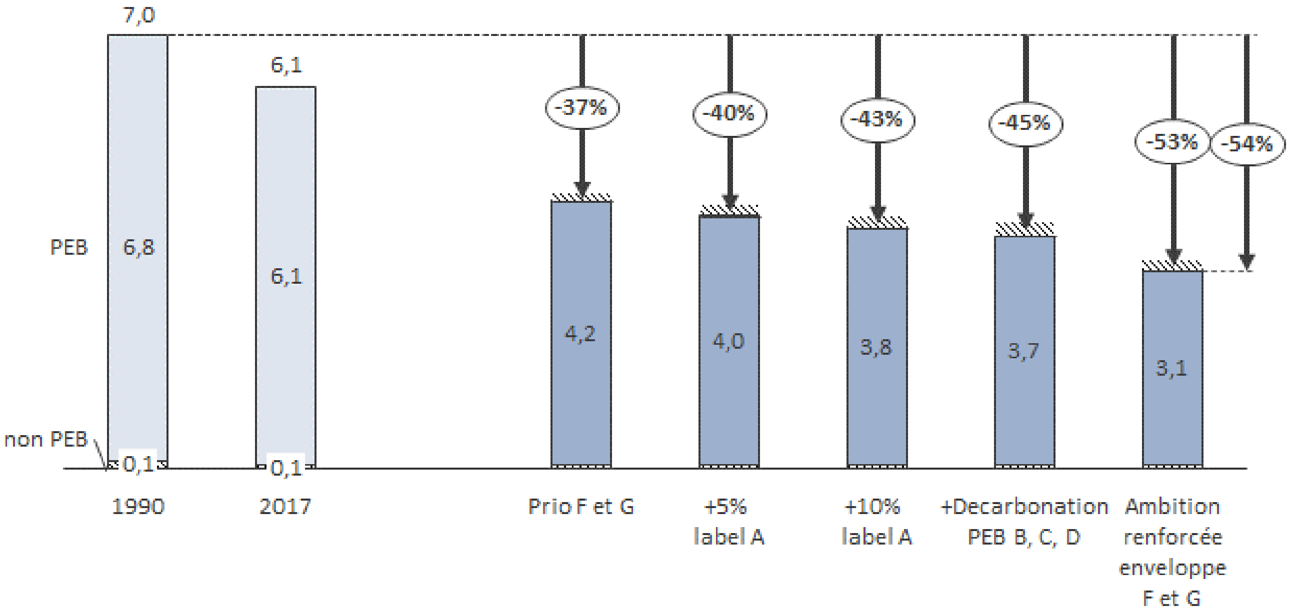
2) SCENARIO ANALYSIS

The scenarios are structured around the implementation of the batches of work for the various segments of the building stock. EPB labels are used to segment the building stock. Two families of scenarios were considered. In both families of scenarios, the ambition for renovations directly achieving the decarbonised A rating is gradually pushed to reach the -55% target by 2030, as well as to decarbonise buildings where this is already possible.

	1. Concentrate efforts on the least efficient buildings	**2. Trigger the renovation of all buildings**
a. Minimal ambition	• By 2030, the roof of all F and G ratings is insulated (90,000 roof insulations per year from 2024). • From 2025, wall and window insulation is accelerated, to reach the renovation pace required to insulate all buildings by 2040 (60,000 renovations per year) by 2030. • From 2025, roof insulation for other buildings is accelerated, to reach the renovation pace required to insulate all roofs by 2035 (100,000 roofs per year) by 2030.	First batch of work (identified by the renovation roadmap) is implemented for all buildings by 2030. The following batches are carried out on a 5-year cycle.
b. +5% renovation to decarbonised A rating	In addition to the 'minimal ambition' scenario, 5% of envelope renovations are started as part of a global renovation project to move towards the decarbonised A rating (9,000 renovations to decarbonised A rating/year).	
c. **+10% renovation to decarbonised A rating**	In addition to the 'minimal ambition' scenario, 10% of envelope renovations are started as part of a global renovation project to move towards the decarbonised A rating (15,000 renovations to decarbonised A rating/year).	
d.+ 10% renovation to decarbonised A rating + systems and renewable energy sources for ratings B, C and D	In addition to the previous scenario, the replacement of combined systems and deployment of renewable heating is accelerated wherever appropriate (EPB ratings B, C and D are considered as proxy for these situations in the scenarios), to reach the renovation pace required to decarbonise all these buildings by 2040 (35,000 systems per year replaced with decarbonised solutions in EPB-rated B, C and D buildings) by 2025.	
e. **Increased ambition for F and G envelopes + 10% renovation to decarbonised A rating**	Rather than considering advance action on more efficient buildings, there is a focus on the least efficient buildings, on which the first three batches of work (roofs, walls, windows) are started by 2030.	-

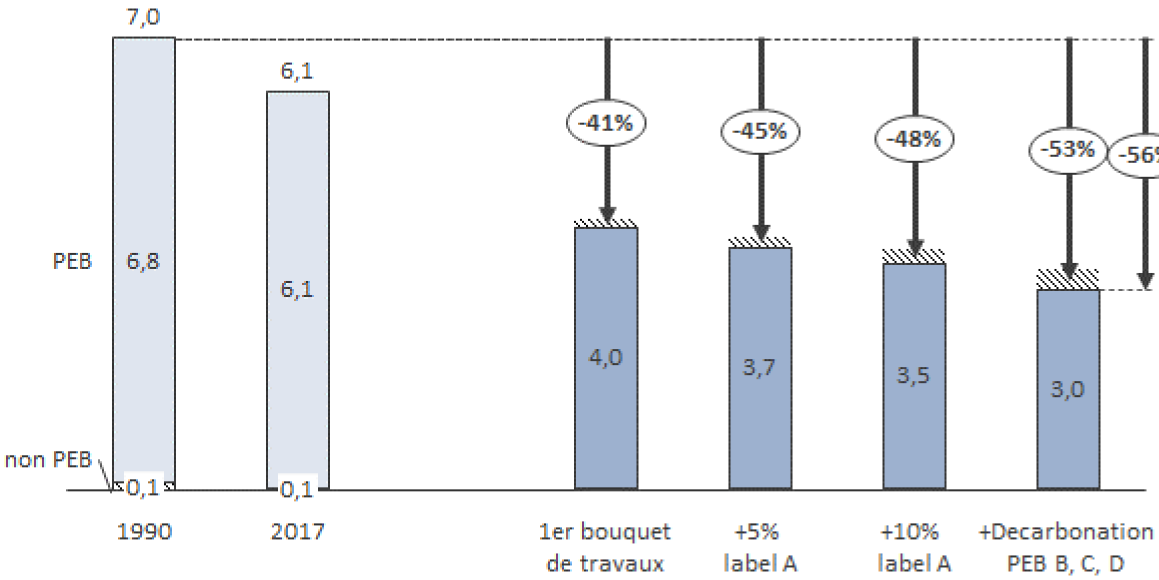
Table 20. Description of scenarios assessed in drawing up the implementation schedule for the renovation of residential buildings

The results are presented in the form of ranges that illustrate the impact of the heating energy mix on the results.



FEB	EPB
non FEB	non-EPB
7,0	7.0
6,8	6.8
0,1	0.1
1990	1990
6,1	6.1
6,1	6.1
0,1	0.1
2017	2017
-37%	-37%
4,2	4.2
Prio F et G	Prio F and G
-40%	-40%
4,0	4.0
+5% label A	+5% A rating
-43%	-43%
3,8	3.8
+10% label A	+10% A label
-45%	-45%
3,7	3.7
+Decarbonation PEB B, C, D	+Decarb. EPB B, C, D
-53%	-53%
-54%	-54%
3,1	3.1
Ambition renforcée enveloppe F et G	Increased ambition envelope F and G

Figure 29. GHG emissions from residential buildings: past history and projections to 2030 according to different ambitions for implementing the renovation strategy, in scenarios that target the least efficient buildings. The reductions indicated reflect the average value for each scenario.



PEB	EPB
non PEB	non-EPB
7,0	7.0
6,8	6.8
0,1	0.1
1990	1990
6,1	6.1
6,1	6.1
0,1	0.1
2017	2017
-41%	-41%
4,0	4.0
1er bouquet de travaux	1st package of works
-45%	-45%
3,7	3.7
+5% label A	+5% A rating
-48%	-48%
3,5	3.5
+10% label A	+10% A label
-53%	-53%
-56%	-56%
3,0	3.0
+Decarbonation PEB B, C, D	+Decarb. EPB B, C, D

Figure 30. GHG emissions from residential buildings: past history and projections to 2030 according to different ambitions for implementing the renovation strategy, in scenarios that accelerate the first batch of work towards A rating for all buildings. The reductions indicated reflect the average value for each scenario.

B. SCENARIOS FOR RENOVATION OF NON-RESIDENTIAL BUILDINGS

1) ASSUMPTIONS

Performance of buildings in the reference year

There are still only limited data available to characterise non-residential buildings. The model is established on the basis of final energy consumption, without specifying the energy requirement for heating.

The following figures, taken from the region's energy balance, are considered to model the non-residential building stock, based on area and final energy consumption (schools and hospitals are considered as public buildings, and buildings labelled ‘other’ are split 50/50 between public and private).

	Sector	**Final energy heating and cooling** (GWh)	Final energy lighting (GWh)	Area (Mm^2)
Public sector	Health	844	155	8.0
	Schools	1,264	215	10.3
	Offices	780	132	5.1
	Other	459	282	4.0
Private	Shops	3,106	906	14.8
	Offices	997	185	10.8
	Other	459	282	4.0

Table 21

Long-term target performance

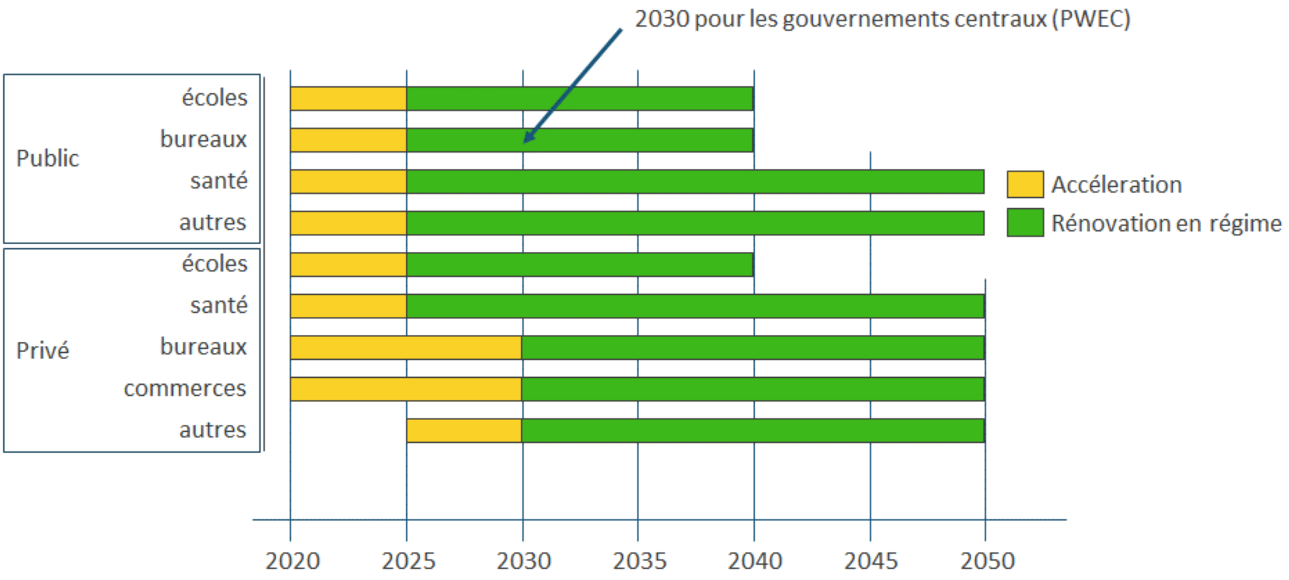
On the basis of the COZEB results, an incompressible average residual final consumption of 80 kWh/m²Ach/yr is identified for office buildings, to be produced or covered by renewable sources. At this stage, this is the target for all non-residential buildings, but it could be refined by breaking it down for each sub-sector on the basis of additional data.

2) SCENARIO ANALYSIS

Five scenarios were tested, starting with a representation of current ambition in the national energy and climate plan approved at the end of 2019, and gradually strengthening to achieve GHG reductions by 2030 compatible with the reduction target of -55% in the DPR.

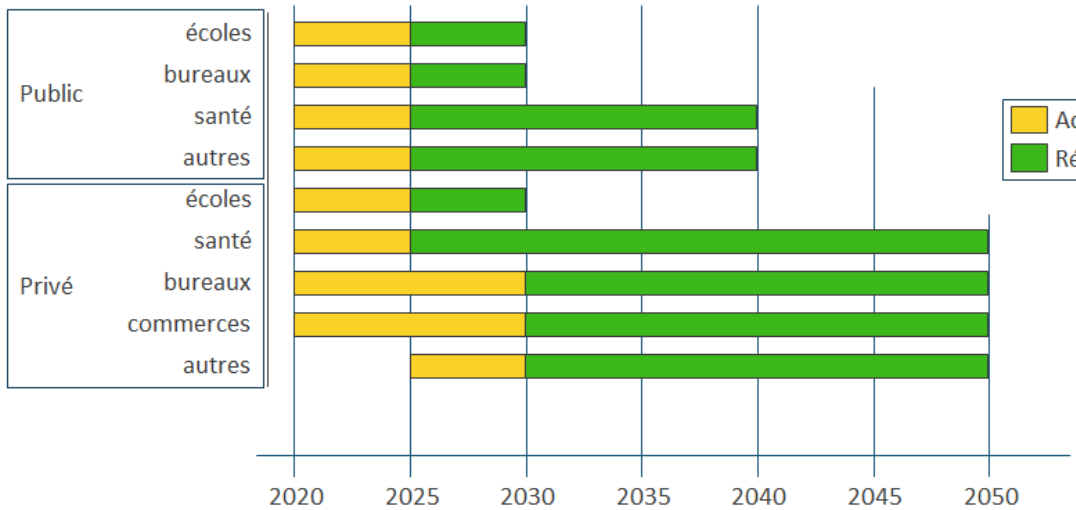
- Scenario NR1 - Milestones set in the Walloon energy and climate plan
- Scenario NR2 - Carbon neutrality by 2030 for priority public buildings
- Scenario NR3 - Carbon neutrality by 2030 for all public buildings
- Scenario NR4 - Carbon neutrality by 2030 for all public buildings, and by 2040 for private buildings
- Scenario NR5 - Carbon neutrality by 2035 for schools, offices and shops, and by 2040 for the rest

The NR5 scenario is proposed as a more realistic alternative to the NR4 scenario, compatible with the reduction targets by 2030. These scenarios are illustrated in the figures below; the GHG reductions by 2030 are illustrated in Figure 37.



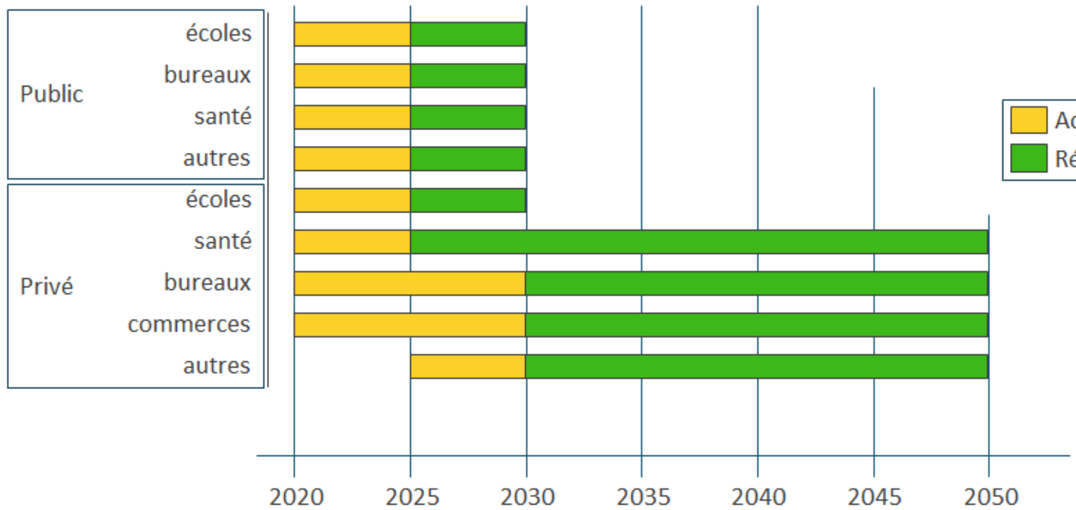
Public	Public
écoles	schools
bureaux	offices
santé	health
autres	other
Privé	Private
écoles	schools
santé	health
bureaux	offices
commerces	shops
autres	other
2030 pour les gouvernements centraux (PWEC)	2030 for central governments (PWEC)
Accélération	Acceleration
Rénovation en régime	Renovation ongoing
2020	2020
2025	2025
2030	2030
2035	2035
2040	2040
2045	2045
2050	2050

Figure 31. Scenario NR1 - Milestones set in the Walloon energy and climate plan



Public	Public
écoles	schools
bureaux	offices
santé	health
autres	other
Privé	Private
écoles	schools
santé	health
bureaux	offices
commerces	shops
autres	other
Accélération	Acceleration
Rénovation en régime	Renovation ongoing
2020	2020
2025	2025
2030	2030
2035	2035
2040	2040
2045	2045
2050	2050

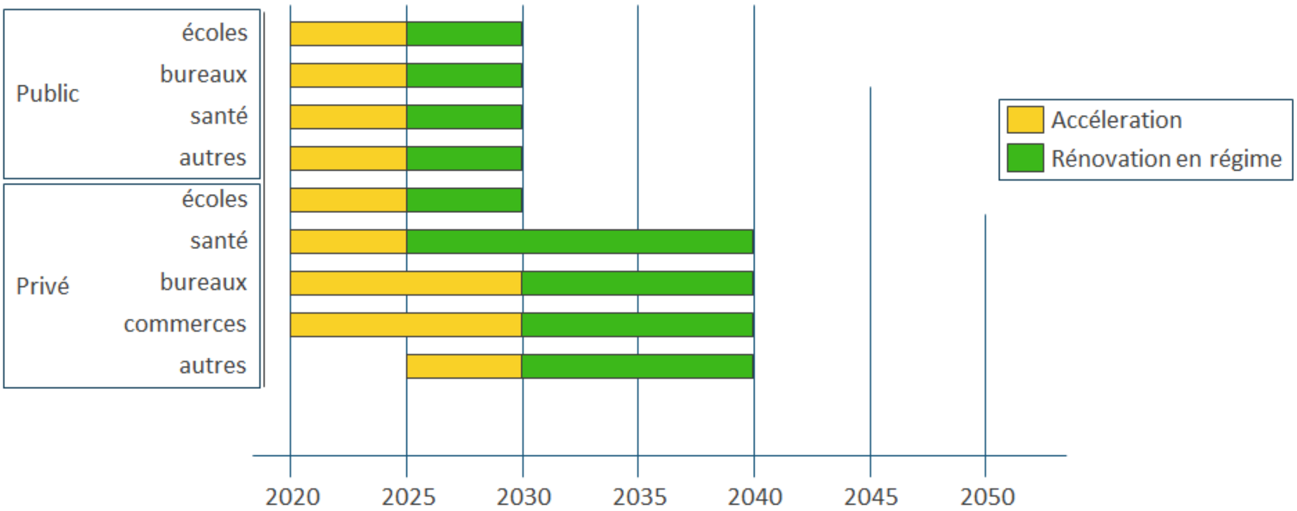
Figure 32. Scenario NR2 - Carbon neutrality by 2030 for priority public buildings



Public	Public
écoles	schools

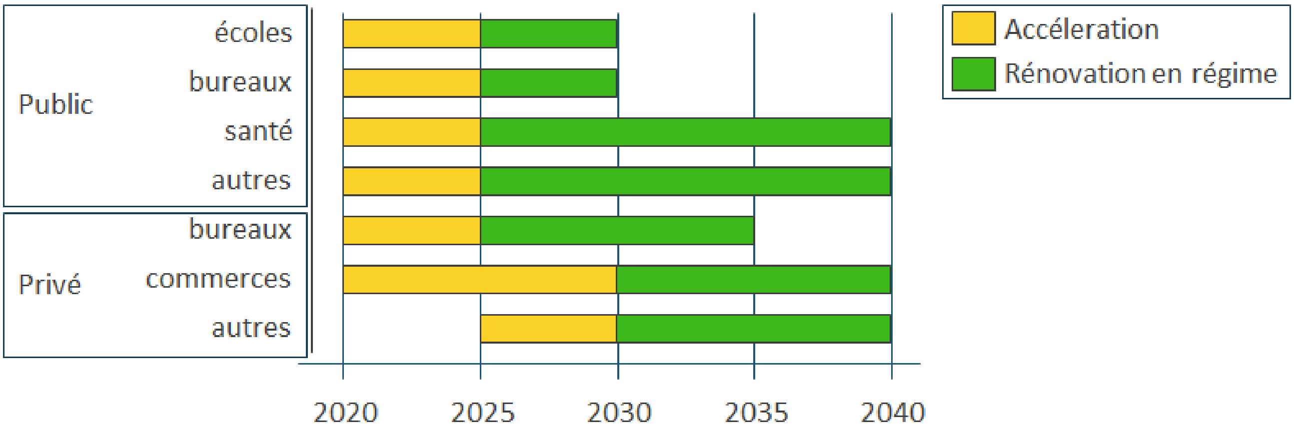
bureaux	offices
santé	health
autres	other
Privé	Private
écoles	schools
santé	health
bureaux	offices
commerces	shops
autres	other
Accélération	Acceleration
Rénovation en régime	Renovation ongoing
2020	2020
2025	2025
2030	2030
2035	2035
2040	2040
2045	2045
2050	2050

Figure 33. Scenario NR3 - Carbon neutrality by 2030 for all public buildings



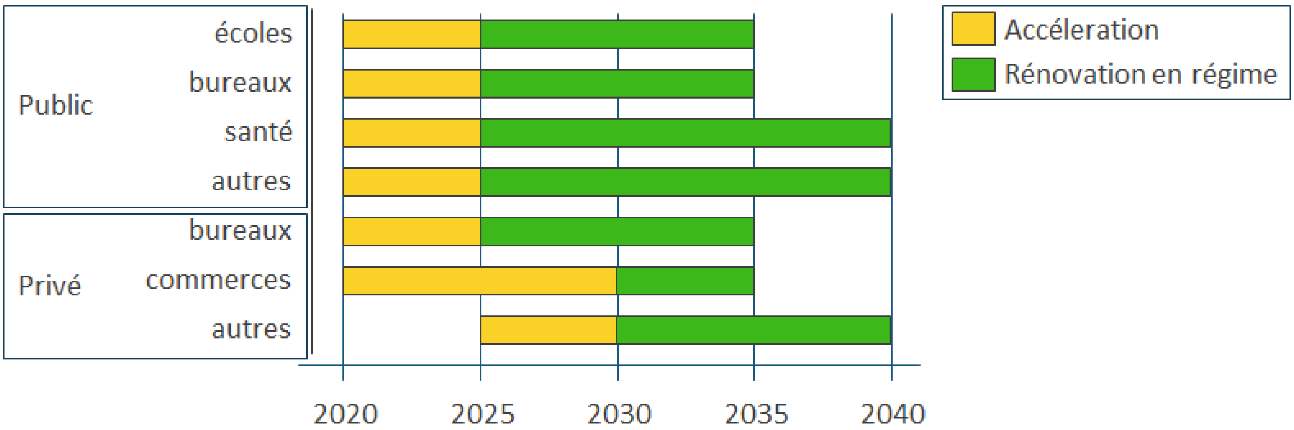
Public	Public
écoles	schools
bureaux	offices
santé	health
autres	other
Privé	Private
écoles	schools
santé	health
bureaux	offices
commerces	shops
autres	other
Accélération	Acceleration
Rénovation en régime	Renovation ongoing
2020	2020
2025	2025
2030	2030
2035	2035
2040	2040
2045	2045
2050	2050

Figure 34. Scenario NR4 - Carbon neutrality by 2030 for all public buildings, and by 2040 for private buildings



Public	Public
écoles	schools
bureaux	offices
santé	health
autres	other
Privé	Private
bureaux	offices
commerces	shops
autres	other
Accélération	Acceleration
Rénovation en régime	Renovation ongoing
2020	2020
2025	2025
2030	2030
2035	2035
2040	2040

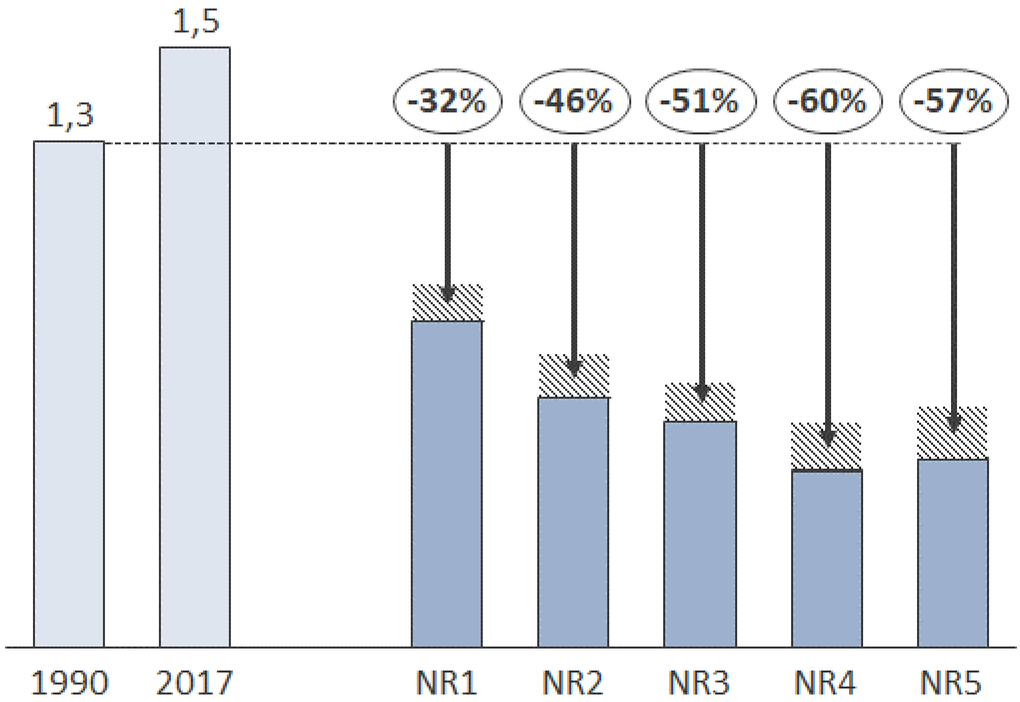
Figure 35. Scenario NR5 - Carbon neutrality by 2030 for schools and public offices, 2035 for private offices and 2040 for the rest



Public	Public
écoles	schools
bureaux	offices
santé	health
autres	other
Privé	Private
bureaux	offices
commerces	shops
autres	other
Accélération	Acceleration
Rénovation en régime	Renovation ongoing

2020	2020
2025	2025
2030	2030
2035	2035
2040	2040

Figure 36. Scenario NR6 - Carbon neutrality by 2035 for schools, offices and shops, and by 2040 for the rest



1,3	1.3
1990	1990
1,5	1.5
2017	2017
-32%	-32%
NR1	NR1
-46%	-46%
NR2	NR2
-51%	-51%
NR3	NR3
-60%	-60%
NR4	NR4
-57%	-57%
NR5	NR5

Figure 37. GHG emissions from non-residential buildings: historical and projections to 2030 according to different ambitions for implementing the renovation strategy. The range of reductions reflects fuel mix assumptions. The reductions indicated reflect the average value for each scenario.

Annexe 5. EPB requirements

The tables below show the EPB requirements in force since 1 January 2017 and from 1 January 2021. Details are available online on the Administration's Energy portal at: http://energie.wallonie.be/fr/reglementation-wallonne-sur-la-peb.html?IDC=7224.

The EPB regulatory procedure ONLY applies to works subject to a permit (town planning or single). However, the EPB requirements apply to all types of work, regardless of whether they are subject to a permit.

<table>
<tr><th colspan="4" rowspan="2">NATURE DES TRAVAUX SOUMIS À PERMIS</th><th>Valeurs U</th><th>Niveau K</th><th>Niveau E_w</th><th>Consommation spécifique</th><th>Ventilation</th><th>Surchauffe</th></tr>
<tr><th>U</th><th>K</th><th>E_W</th><th>E_{spec}</th><th>V</th><th>S</th></tr>
<tr><td rowspan="4">Procédure AVEC responsable PEB</td><td rowspan="3">Bâtiment neuf ou assimilé</td><td>PER</td><td>Maisons unifamiliales Appartements</td><td rowspan="3">≤ U_{max} (1)</td><td rowspan="2">≤ K35 + nœuds constructifs</td><td>65</td><td>115 kWh/m²an</td><td>Annexe C2</td><td>< 6.500 Kh</td></tr>
<tr><td>PEN</td><td>Bureaux Services Enseignement Hôpitaux HORECA Commerces Hébergements collectifs …</td><td>90/65 (2)</td><td></td><td>Annexe C3</td><td></td></tr>
<tr><td>I</td><td>Industriel</td><td>≤ K55 + nœuds constructifs</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Rénovation importante (4)</td><td>uniquement éléments modifiés</td><td></td><td></td><td></td><td>(3)</td><td></td></tr>
<tr><td rowspan="2">Procédure SANS responsable PEB Déclaration PEB simplifiée</td><td colspan="3">Rénovation simple, y compris Changement d'affectation chauffé > chauffé (4)</td><td rowspan="2">≤ U_{max} (1) des éléments modifiés et neufs</td><td></td><td></td><td></td><td>(3)</td><td></td></tr>
<tr><td colspan="3">Changement d'affectation non chauffé > chauffé (4)</td><td>≤ K65 + nœuds constructifs</td><td></td><td></td><td>Annexe C2 ou C3</td><td></td></tr>
</table>

NATURE OF WORKS SUBJECT TO PERMISSION				U values	K level	E_w level	Specific consumption	Ventilation	Overheating
				U	K	E_w	E_{spec}	V	S
Procedure WITH EPB manager	New building or equivalent	REP	Single-family houses Apartments	≤ U_{max} (1)	≤ K35 + structural nodes	65	115 kWh/m²/year	Annex C23	<6 500 Kh
		NEP	Offices Services Education Hospitals Hospitality Shops Collective accommodation			90/65 (2)		Annex C3	
		I	Industrial		≤ K55 + structural nodes				
	Major renovation (4)			modified elements only				(3)	
Procedure WITHOUT EPB manager Simplified EPB declaration	Basic renovation, including Change of use heated > heated (4)			≤ U_{max} (1) modified and new elements				(3)	
	Change of use unheated > heated (4)				≤ K65 + structural nodes			Annex C2 or C3	

Figure 38. Table of requirements applying since 1 January 2017, depending on nature of works (Source: energie.wallonie.be).

Building element		U_{max} [W/m²K]
External surfaces for protected volume		
	Roofs and ceilings	0.24
	Walls (1)	0.24
	Floors (1)	0.24
	Doors and garage doors	2.00
	Windows: - Frames and glazing combined - Glazing only	1.50 1.10
	Curtain walls: - Frames and glazing combined - Glazing only	2.00 1.10
	Transparent/translucent surfaces other than glass: - Frames and transparent part combined - Transparent part only (e.g. polycarbonate roof dome, etc.)	2.00 1.40
	Glass bricks	2.00
Surfaces between 2 protected volumes on adjacent plots (2)		1.00
Opaque walls within protected volume or adjacent to a protected volume on the same plot (3)		1.00

Figure 39. Table of requirements for U_{max} values in force since 1 January 2017 (Source: energie.wallonie.be). Table 9

NATURE DES TRAVAUX SOUMIS À PERMIS				Valeurs U	Niveau K	Niveau E_W	Consommation spécifique	Ventilation	Surchauffe
				U	**K**	**E_W**	**E_{spec}**	**V**	**S**
Procédure AVEC responsable PEB	Bâtiment neuf ou assimilé	PER	Maisons unifamiliales Appartements	≤ U_{max} (1)	≤ K35 + nœuds constructifs	**45**	**85** kWh/m²an	Annexe C2	< 6.500 Kh
		PEN	Bureaux Services Enseignement Hôpitaux HORECA Commerces Hébergements collectifs …			**90/45** (2)		Annexe C3	
		I	Industriel		≤ K55 + nœuds constructifs				
	Rénovation importante (4)			uniquement éléments modifiés				(3)	
Procédure SANS responsable PEB Déclaration PEB simplifiée	Rénovation simple, y compris Changement d'affectation chauffé > chauffé (4)			≤ U_{max} (1) des éléments modifiés et neufs				(3)	
	Changement d'affectation non chauffé > chauffé (4)				≤ K65 + nœuds constructifs			Annexe C2 ou C3	

NATURE OF WORKS SUBJECT TO PERMISSION				U values	K level	E_w level	Specific consumption	Ventilation	Overheating
				U	K	E_w	E_{spec}	V	S
Procedure WITH EPB manager	New building or equivalent	REP	Single-family houses Apartments	≤ U_{max} (1)		45	85 kWh/m²/year	Annex C2	<6 500 Kh
		NEP	Offices Services Education Hospitals Hospitality Shops Collective accommodation		≤ K35 + structural nodes	90/45 (2)		Annex C3	
		I	Industrial		≤ K55 + structural nodes				
	Major renovation (4)			modified elements only				(3)	
Procedure WITHOUT EPB manager Simplified EPB declaration	Basic renovation, including Change of use heated > heated (4)			≤ Umax (1) modified and new elements				(3)	
	Change of use unheated > heated (4)				≤ K65 + structural nodes			Annex C2 or C3	

Figure 40. Table of requirements applicable from 1 January 2021, depending on nature of works (Source: energie.wallonie.be).

Travaux soumis à permis ou non		Performance	Calorifugeage	Comptage énergétique
		Exigence systèmes – Annexe C4		
Bâtiments existants	Installation Modernisation Remplacement	- Chaudières gaz - Chaudières mazout - Pompes à chaleur - Chauffage électrique direct - ECS électrique - Machines à eau glacée - Récupérateur de chaleur	- Conduites d'eau chaude - Conduites d'eau glacée - Conduits d'air	- Comptage par installation - Comptage entre bâtiments - Comptage entre unités PEB
Bâtiments à construire et assimilés [2]	Installation	–	–	Uniquement[1] : - Comptage entre bâtiments - Comptage entre unités PEB

Works subject or not subject to permission		Efficiency	Lagging	Energy metering
		Systems requirement - Annex C4		
Existing buildings	Installation Modernisation Replacement	- Gas boilers - Oil boilers - Heat pumps - Direct electric heating - Electric DHW - Water coolers - Heat recovery	- Hot water pipes - Chilled water pipes - Air ducts	- Metering per installation - Metering between buildings - Metering between EPB units
New buildings and equivalent [2]	Installation	-	-	Only [1]: - Metering between buildings - Metering between EPB units

Annexe 6. Overview of initiatives to promote smart technologies and skills

Skills and training

NAME	Description	Scope	Duration	Budget
RENOVALT	Integrated apprenticeship in the energy renovation of buildings. ⇨ Acquisition and recognition of skills needed for the energy renovation of buildings + increase in fluidity and mobility of workers within employment areas + improved match between training offer and needs. Objectives: ⇨ Develop technical and educational tools for professionals and apprenticeship providers; ⇨ Run a joint training offer on the topic of energy renovation; ⇨ Support target audiences (learners, workers, companies); ⇨ Provide recognition of skills acquired; ⇨ Create a cross-border partnership agreement between apprenticeship providers and professional federations to ensure sustainability of the project activities The 'training' module will focus on: - digital tools - cross-cutting diagnostics - insulation-ventilation-air tightness - materials encountered/used in renovation - coordination/communication. Creation of two types of training sheets: one for novices, one for those with experience	Champagne (FR), Marne (FR), Namur (BE), Luxembourg (BE) Partners: IFAPME, CCW, CAP Construction, FFB Grand-Est, BTP CFA Grand-Est, Constructiv, CCCA-BTP	4 years (mid 2018 - mid 2022)	€1,246,416.96

<table>
<tr><td></td><td>Objectives:
Introduce four additional modules, intended for learners who are already registered on a construction training course (note: long courses, not in-service training):
- digital tools (40 h)
- cross-cutting diagnostics (40 h)
- insulation-ventilation-air tightness (40 h)
- Materials encountered/used in renovation (40 h)
These modules will be offered to learners as an option, on a voluntary basis.

A new 240-hour ‘energy renovation coordinator’ course will be introduced. This will cover the four topics above, plus a fifth topic, ‘coordination/communication’ (80 hrs).</td><td></td><td></td><td></td></tr>
<tr><td>CCW Academy</td><td>Training available:
⇨ Air tightness
⇨ Energy and construction course
⇨ Site Manager course
⇨ New heating technologies
⇨ Plastering over insulation
⇨ Retrofit insulation of cavity walls
⇨ Ventilation of residential buildings
⇨ Good on-site practice for EPB
⇨ Sustainable construction advisor
⇨ Environment course
⇨ Waste management and environmental permits
⇨ Impact of EPB on my trade.</td><td>Target audience: Students, workers in training</td><td>/</td><td>/</td></tr>
<tr><td>EPB Unit of Walloon Public Service (SPW)</td><td>Ran (until 2018) training on EPB, but DISCONTINUED (lack of participants)
Included: Envelope, Solar gains, Constructive nodes, Air tightness,</td><td>Target audience: Students, workers in training</td><td>Discontinued since 2018</td><td>/</td></tr>
</table>

	Ventilation, Heating, Renewable energies, Lighting, Case Studies.			
University courses	Mainly in architectural studies, many focussing on EPB and pure construction, little on new technologies, home automation, etc. e.g. University of Liège: Technologies and Energy, Environmental Performance of Buildings, Sustainable Construction Techniques for Buildings, Architectural Project Approach: Bioclimatic Composition, Heat Transfer, Digital Architectural Modelling, Housing and Environmental Footprint, Design of High Environmental Performance Buildings, Sustainable Architectural and Urban Design, Physics of Buildings and Air Conditioning, Sustainable Building Construction Techniques: Renovation, Environmental and Territorial Policy, Urban Recycling: Land and wastes Also new Masters in Environmental Sciences and Management at ULB and UCL e.g. UCL: Interdisciplinary Advanced Master in Science and Management of the Environment and Sustainable Development (https://sites.uclouvain.be/archives-portail/ppe2019/en-prog-2019-envi2mc)	Target audience: Students	Unlimited	/
Reno+ accelerator	RENO+ aims to mobilise the construction sector to achieve a renovation rate of 2% by 2024 and support efforts towards 3% beyond then. Objective: promote existing initiatives and provide a stimulating and coordinated framework to catalyse large-scale deployment of measures covering the entire energy renovation process for buildings.	Initial partnership between CCW, BBRI and GreenWin but aiming to mobilise a much broader range of actors.	4 years (2020-2024)	€80 million over 4 years (including 50% private funds)

	This involves enabling, in direct relation to the European context (Renovation Platform of the Green Deal, Build4People partnership 2021-2027), the upscaling of innovative energy renovation solutions by working on the following: - stimulating demand, based on a broad customer-centric approach; - offering integrated solutions supported by new business models and financially accessible through innovative partnerships and economies of scale; - improving execution in conjunction with partners in the field; - training actors and making the sector attractive. Reno+ includes the following: - funding Living Labs projects and innovative public-private partnership projects; - developing a capacity to respond to work pooling (RENOSPRONG); - introducing training initiatives (RENOFORM); - ‘Sprint’ mobilisation of the private sector for deployment of industrial renovation solutions (RENOSPRINT).			

Promotion of Smart Technologies

NAME	Description	Scope	Duration	Budget
BUILD4WAL	Initiated by the BBRI with two other Walloon research centres, CETIC and CENAERO, in collaboration with the CCW. Construction 4.0 Build4Wal demonstrator project consisting of three parts: ⇨ mobile hub, which will bring together new construction technologies (fully equipped van) and will travel to construction sites and various events; ⇨ 750 m² demonstration hall in Limelette: showcasing demonstrations and real-time tests of new construction technologies; ⇨ building dedicated to 'Smart Building and digital simulation': integrating the most energy-efficient solutions, a building providing living experience through both its design and its use, and based on the collaborative BIM process; ⇨ in parallel, strong links will be established with training under the aegis of the CCW. Expected impact: ⇨ raise awareness, promote and support by highlighting the potential of digital technologies to improve productivity, profitability and product quality for construction companies; ⇨ create scenarios as required (in relation to different technologies and different trades); ⇨ link technologies to training needs; ⇨ serve as a springboard to the market (national and international) with an important role in incubating R&D projects (particularly through co-working sessions).	Wallonia - (buildings based in Limelette and Charleroi)	1/1/2019 to 31/12/2021 (Opportunity to extend by 2 years)	€3,592,371 (over 5 years)
Events organised by the Walloon Commission for	1) Event on 4 April 2019: 'Collective Self-consumption' Day (FAQ, talks, awareness raising,	1) & 2) Wallonia	1) One-off	/

Energy (CWaPE)	etc.) 2) Website: explanations of existing 'smart' technologies, such as the smart meter. e.g. electronic meter, two-way communication and potential for remote operation (switching on and off, managing level and payment, etc.)	1) & 2) Target audience: Entrepreneurs, Individuals	event 2) Unlimited	
Wallonie Energie (SPW – DGO4) web portal	Website promotes R&D in Wallonia (particularly in relation to energy) as well as non-commercial applications, including social acceptance.	Target audience: Entrepreneurs and individuals	Unlimited	/
TWEED Cluster / ReWallonia Events	• General meeting – 25 April 2019: Promotion of new technologies/ideas/projects in relation to energy consumption. e.g. Collective self-consumption in Wallonia and Brussels-Capital Region (BCR), Internet of Energy, energy transition and related R&D in Wallonia, future city projects (smart cities, multi-energy solutions, local energy communities, Wal-e-Cities, cold storage, etc.). • Conference – 21 February 2018: Digital Energy – Internet of Things (Charleroi) – 53 participants • EU Industry Days Workshop – 27 February 2019: Collective self-consumption	Target audience: Interested parties, Stakeholders Interested parties, Entrepreneurs Interested parties, Entrepreneurs "	One-off event One-off event One-off event "	/ / / /

	• Event – 27 September 2018: Machine Learning and Artificial Intelligence in the Energy Sector – LLN – 45 participants		/	/
	• Has also mapped (all?) existing energy transition projects in Wallonia and the BCR in order to increase their visibility and facilitate access.	Target audience: Professionals, Customers	2019	/
	• Launched a call, in conjunction with MécaTech, for Walloon projects focused on CERACLE (Renewable Energy Communities through Local Collective Self-consumption of Energy) in 2019.Objective: bring together projects working along the same lines and create true synergy. Outcome: around 50 Walloon actors responded (companies and research centres, universities and colleges).	Target audience: Walloon professionals	2019	/
	• Launched a call for Walloon projects focused on construction materials, techniques and systems to support energy transition (with GreenWin) in 2019. e.g. integrating renewable energy sources into buildings, managing consumption for heating, lighting, air conditioning and ventilation, potential for buildings to provide new services, digital technologies (monitoring, modelling, smart management, etc.), integrating buildings into renewable energy communities, etc.	Target audience: Walloon professionals	2019-2021	Agence du Numérique:

	• CERACLE project (partially supported by *Agence du Numérique*), which aims to: - introduce strategic piloting of innovative Walloon projects relating to collective self-consumption (CSC) and local energy communities (LECs); - create mapping of Walloon stakeholders in the value chain in relation to development of CSC and LECs; - inform companies, towns and communities of opportunities presented by the emergence of digital technologies in the context of developing CSC and LECs. • Mapping of Walloon ESCO actors: Energy Service Companies. An ESCO is responsible for assessing and implementing energy saving projects for companies. It self-finances this investment. The investment reduces energy consumption and thus the energy bill. The company then uses some of these savings to pay for the new installation. Once the installation is paid for, the company becomes full owner of the installation and continues to benefit from energy savings and a reduced energy bill.	Target audience: Walloon professionals /	/	€230,000 /
DigitalWallonia.be	Website highlights Walloon companies operating in the Smart Building sector.	Target audience: Interested parties, Professionals	/	/
Belgian Building Research Institute (BBRI) events	Conference: Smart Buildings – The Challenges of building 'Ready 2 Services' by Arnaud Deneyer Objective: Promote technologies to support smart buildings, improving energy performance, environment (from a health perspective), user comfort, etc., particularly through the Internet of Things.	1) & 2) Target audience: engineers, estimators, quantity	One-off event (1 day)7/9/2018	/

	‘Smart Buildings and Smart Building Sites’ event/conference as part of their Summer University on 4 September 2019 in Brussels + ‘Smart Buildings for Smart Cities’ conference on 5 September, same location.	surveyors, project managers, contractors, architects, design offices, public developers, etc.	One-off events (2 days) 4/9/2019	
Comice Smart Cities	Covers four skills areas: Energy in urban areas, Energy networks, Interactive and energy-efficient buildings and Technology provision. Dedicated to research into smart cities and energy efficiency of buildings (EEB)	Wallonia Professionals	/	/
Wal-e-Cities	Portfolio of R&D projects aimed at building innovative solutions in sectors such as mobility, EPB, well-being, etc. Walloon project supported by Digital Wallonia, highlights and promotes (in particular) the Internet of Things for EPB.	Target audience: Walloon professionals	/	€20,000,000
Energrid (or NRgrid)	Creation of a prototype distributed nanogrid, including components for energy production and storage. Using 2 MWh Li-ion energy storage and managed production and consumption, the stakeholders have succeeded in reducing electrical peaks and increasing self-consumption (includes PV).	Partners: Klinkenberg, University of Liège and Henallux	3 years (2016-2019)	€563,000
SmartUser	Assessment of the multiple impacts of installing smart meters – and a system for monitoring consumption – for diverse customers, helping to control and manage consumption. 144 smart meters have already been installed on one site; a further site is still to be equipped. Statistically significant (around 6%) reduction in consumption through using smart meters in the first year of monitoring.	Partners: UMons and Ores	4 years (currently running)	€1,047,000

Annexe 7. Additional information on investment mobilisation mechanisms

A. CALCULATING THE COST OF RENOVATING THE REGIONAL BUILDING STOCK AND CAPACITY TO ACT

The Building Renovation Strategy approved by the Walloon Government in April 2017 needs financing. The first step towards this is to determine the scale of the task, the number of buildings involved, the average cost of renovation and several other variables.

The word ‘variable’ is not used randomly; it indicates that the total amount needed is a function of various inter-relational factors. We have some level of control over a number of these factors.

We need to be aware that our short-, medium- and long-term choices will influence the pace and intensity of the necessary investments, as well as the intended contribution from the Region.

To help with this, we propose the following formula to calculate the public investment needed.

$$\mathbf{X} = (\sum_{i=0}^{n} 0.03\alpha a_i\ \beta b_i * c_i) + \boldsymbol{\gamma d} - \boldsymbol{e}$$

where X represents the **annual cost** to be borne by the Region for implementation of the strategy, in order to achieve the objectives considered as given and therefore unalterable.

$\sum_{i=0}^{n}$ The sum relates to the various phases that constitute a complete renovation, but do not necessarily have to be carried out at the same time. As a result, the necessary investment has a temporal dimension which must be taken into account in assessing the annual financing needs. For a given budget year, the sum therefore adds up all the work financed in that year.

0.03 represents the proportion of the building stock that must be renovated to maintain the overall trajectory towards achieving the objective. This is not a variable but an average datum set in the Strategy.

α is an index that influences the rate of renovation over time. The strategy provides for a non-linear pace of renovation. This index, linked to 0.03, which is an average rate, enables the annual adjustment of the budgetary effort required for the relevant phase of the Strategy.

a represents the number of buildings to be renovated to meet the energy performance objectives set in the strategy. This is a proxy enabling us to estimate the cost of the Strategy. It would probably be better to refer to m^2 for roofing or other surfaces, in order to differentiate small from large buildings, or to protected volume (m^3) to better reflect multi-family housing. Lack of information available is a barrier to precise calculations.

β is a multiplier of the average cost of works according to the targets[17] from year to year. For example, if the emphasis is on renovating roofs over a five-year period, this policy will influence the average cost of renovation, which this index will reflect.

[17] The ‘targets’ referred to here are the particular focus for implementation of the strategy over time. For example, Flanders wants all roofs in the region to be insulated by 1 January 2020. The principle here is to concentrate on intermediate objectives that help to achieve the overall objective.

b is the average cost of an energy renovation, i.e. a theoretical figure resulting from dividing the cost of all renovations by the number of renovations[18]. Precision is needed here to ensure that these are only costs directly linked to energy efficiency work[19].

c represents the leverage effect of public funding: its value shows how many private euro will have been generated for each public euro. This can be considered a measure of the 'budgetary efficiency' of public action in promoting energy renovations.

γ represents an additional index that influences the following variable, d, showing the fixed cost of managing the Strategy[20]. The index enables us to refine the calculation by considering this cost open to influence; it is not an invariable datum.

d represents the management costs of the Strategy. Since this management is provided by the government, we could ignore it or consider it a constant. Giving it a value would enable us to more precisely assess the total cost of the Strategy, and to also quantify the effects of potential outsourcing the management, or of deploying additional internal human resources. These costs should not be overlooked.

e represents existing finance that is reallocated to the implementation of the Strategy. Including this enables us to specify the quantity of new finance necessary to achieve the objectives. We must bear in mind that these amounts are currently allocated to incentives and other programmes under various action plans. When it comes to reallocation of finance, it is recognised that these amounts are allocated for the implementation of the Reno Strategy, no longer that of the previous programme or incentives. We are considering here a true alignment of policies and the means allocated to them.

Clarification:

The point of this breakdown of the overall cost is to recognise that **we can act on various factors that will influence the final result.**

It also highlights that we are not subject to a single, exogenous constraint but have a capacity to act, which enables us to specify the efforts needed, reduce them under certain conditions and affect the temporal aspect by adjusting the phasing of the work to be carried out.

[18] The Renovation Strategy indicates an average unit cost for energy renovation of €60,000 to €70,000. It is obviously problematic to propose a single value for a wide range of different circumstances; this figure must be seen for what it is – nothing more than an arithmetic mean.

[19] During heavy energy efficiency work, developers will often include other work to improve comfort (new furniture, redecorating, etc.), the costs of which obviously cannot be included within the strict remit of this calculation.

[20] Initially, the management costs can be considered as a fixed datum; in this case the index is equal to '1'. However, this constraint can be relaxed later, in the event that accelerating or slowing down the implementation of the strategy results in an increase or decrease in management costs.

Possible actions

The whole point of the formula is to give us the option to influence the various data, to ultimately allow adjustment of the final result. For example, we can adjust the following:

- the number of buildings: a difference in the number of buildings to be renovated will have an immediate effect on the funds to be allocated to the delivery of the Strategy. It is therefore important to make sure the figure is as exact as possible. There are an estimated 270,000 empty buildings[21] in Wallonia, which are doubtless in need of renovation but are not emitting greenhouse gases as they are unoccupied. Moreover, whatever the efforts made, the Government will not succeed in convincing 100% of owners to undertake the necessary work; it is therefore meaningless to include these diehards in the funds to be mobilised. Hence the all-important question: how many buildings for renovation are we talking about?

- the average cost of a renovation: small apartment or large villa? Bringing an EPB rating 'G' or 'C' up to EPB 'A' entails very different costs[22]. Critical mass will reduce unit costs; research will bring progress in techniques and materials. We can refine the average cost of a renovation and thus come closer to the true figures to be mobilised. In addition, costs will evolve over time, so an average value to be applied to the remaining stock to be renovated[23] must therefore be adjusted.

- the leverage effect: according to the figures available to us, Wallonia has achieved a leverage effect of 1:4. We may consider that this is not a good result, but that there is also room for strong progress. For example, GRE-Liège obtains a leverage effect of 1:29 with its RenoWatt programme[24]. The higher this leverage effect, the fewer funds the Region will have to release to achieve its objectives.

- the redirection of existing funding: the Region is already mobilising significant budgets for the energy renovation of buildings in Wallonia. Therefore, the cost of the Strategy does not represent new resources, but rather a combination of existing budgets, the redirection of budgets that have become unnecessary[25] and, lastly, new resources.

B. EUROPEAN FUNDING FOR THE ENERGY RENOVATION OF BUILDINGS

[21] This represents the difference between the number of existing buildings and the number of active electricity meters. The aim here is to exclude ruined or seriously unsafe buildings; this does not refer to viable housing needing minor work and temporarily without a tenant.

[22] Substantial differences can be seen even in the case of two buildings that are similar at the start, but for which different renovation choices are made.

[23] It is probably easier to address specific targets for implementation of the Strategy, such as the oldest buildings to be renovated as a priority. Once the renovation of this segment has been carried out, the calculation data will be different since there will (almost) no longer be any energy sieves. The average costs of a full renovation will probably be reduced, while the ratio between investment and energy efficiency gains will probably be less favourable.

[24] To achieve this result, GRE incorporates UREBA subsidies. The leverage effect is calculated in relation to European funding: for €1 of European funds, the project gathered €29 from other sources, including Walloon regional subsidies.

[25] The 'heating fund' helps low-income households having difficulty paying their energy bills. There is a correlation between low-income households and the occupancy of low energy efficiency housing, therefore requiring support to cover the bills. In a perfect world, if all the homes of low-income families have been renovated up to an EPB 'A' rating, the residual energy bills will no longer require assistance from the 'heating fund', and these funds will then become available.

- **ELENA** – European Local ENergy Assistance, a joint initiative of the European Investment Bank (EIB) and the European Commission under the Horizon 2020 programme. As such, grants are awarded for technical assistance.
- **JASPERS** – Joint Assistance to Support Projects in European Regions. This is a technical assistance partnership for large projects of over €50 million, managed by the EIB and co-financed by the European Commission (Directorate-General for Regional and Urban Policy) and the European Bank for Reconstruction and Development (EBRD).
- Sharing experience in the field of public-private partnerships (PPP). The European PPP Expertise Centre (**EPEC**) enables its public sector members to share their expertise and experience, pool their analyses, discuss best practice and help to increase revenues. Limiting EPEC membership to public sector entities helps to ensure that information exchange remains free and open. However, the EPEC maintains a regular dialogue with the private sector, in particular during the private sector forum which is held twice a year. As one of the main funders of PPP, the EIB also contributes to the debates.
- European Fund for Strategic Investments (**EFSI**). A joint initiative of the EIB Group and the European Commission, EFSI aims to help bridge the investment gap by mobilising private finance for strategic investments. Particular mention should be made of the Smart Finance for Smart Buildings Initiative (SFSB) in association between the EFSI and Structural Funds.
- In connection with the previous point, the European Investment Advisory Hub (**EIAH**) and European Investment Project Portal (EIPP) constitute the **second part of the investment plan for Europe** and were set up to achieve the objectives of the European Fund for Strategic Investments. It aims to act as a one-stop shop for investors or project promoters seeking advice regarding investment projects and financing. It is managed in accordance with a separate agreement between the Commission and the EIB.
- Natural Capital Financing Facility (**NCFF)**. The EIB and the Commission have partnered to create the Natural Capital Financing Facility (NCFF), a financial instrument that supports projects delivering on biodiversity and climate adaptation, through tailored loans and investments backed by an EU guarantee. In addition, these projects must generate revenue or demonstrate cost savings.
- The Private Finance for Energy Efficiency (**PF4EE**) instrument is a joint agreement between the EIB and the Commission which aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments. The instrument targets projects which support the implementation of National Energy Efficiency Action Plans or other energy efficiency programmes of EU Member States.
- Loans to finance investments in research and innovation (**R&I**) made by companies or private and public institutions, or public-private partnerships, among others, located in the EU; neighbouring countries or countries in the rest of the world are eligible. Depending on the country and the nature of the entity concerned, this product may be eligible for support under the European Fund for Strategic Investments (EFSI), the InnovFin mechanism or other mandates managed by the EIB.
- **InnovFin** (EU Finance for Innovators) is a joint initiative by the European Investment Bank Group – EIB and European Investment Fund (EIF) – and the European Commission under the Horizon 2020 programme. This system covers a range of financing tools (a wide variety of loans and guarantees) and integrated and complementary advisory services offered by the EIB Group and covering the entire research and innovation (R&I) value chain, to support investments made by companies regardless of their size.
- **JEREMIE** (Joint European Resources for Micro to Medium Enterprises) is a joint initiative of the European Commission (Directorate-General for Regional and Urban Policy) and the EIB Group, mainly implemented through the European Investment Fund. JEREMIE offers EU Member States, through their national or regional Managing Authorities, the opportunity to use part of their EU Structural Funds to finance SMEs in a more efficient and sustainable way. Its financial resources have

been deployed through selected financial intermediaries across the EU, which have provided loans, equity and guarantees to SMEs.

- The **SME initiative** is a joint financial instrument of the Commission (through COSME and/or Horizon 2020) and the EIB to stimulate SME financing by partially covering the credit risk taken by financial institutions which lend to companies.
- **Guarantees and securitisation**. The EIB provides guarantees covering the risks inherent in large and small-scale projects, as well as in loan portfolios, in order to make them more attractive to other investors or to alleviate any regulatory and economic capital constraints. These guarantees can relate to senior or subordinated loans. The beneficiaries of these guarantees can be private or public promoters of large projects, or intermediary partner banks that grant financing to intermediate-sized companies (mid-caps). Guarantees for SME loan portfolios are provided by the EIF. Depending on the underlying financing structure of the operation, an EIB guarantee may be more advantageous than an EIB loan. This is because it can either provide greater added value or reduce the consumption of capital.
- The **Project Bond initiative**: an innovative instrument for financing infrastructures which is a joint initiative by the European Commission and the EIB. Its objective is to stimulate capital market financing for large-scale infrastructure projects in the sectors of trans-European networks for transport (TEN-T) and for energy (TEN-E). The Project Bond initiative is designed to enable eligible infrastructure projects promoters, usually public-private partnerships (PPP), to attract additional private finance from institutional investors such as insurance companies and pension funds. For these investors, project bonds are a natural counterpart to their long-term commitments.
- **European Investment Fund.** This is a provider of risk finance to SMEs, and part of the EIB Group. In addition to the EIB's own resources, funds come from the European Commission and a number of public and private financial institutions. They provide bank guarantees, leasing guarantees, microcredit guarantees and guarantees for shareholding funds.
- **Structured finance**. The EIB can give additional support for priority projects using certain instruments with a higher risk profile than it normally accepts. These priority areas include trans-European transport and energy networks and other infrastructure, the knowledge economy, energy and SMEs. Such has been the success of the Structured Finance Facility (SFF) that its scope was recently doubled to enable the EIB to generate operations up to a maximum of EUR 3.75 billion. This support is provided by the SFF using a mix of the following instruments: senior loans and guarantees, subordinated loans and guarantees ranking ahead of shareholder subordinated debt, mezzanine finance[26], project-related derivatives.
- The European Horizon 2020 **Energy Efficiency** programme is offering €194 million of support for energy efficiency R&D projects.
- The European Energy Efficiency Fund (**EEEF**)[27] offers junior and senior debt, guarantees or equity investments for projects launched by public authorities or ESCOs working under public contract. The fund is managed by Deutsche Bank. In particular, the programme finances the development of activities for projects it is financing through other routes. The minimum leverage factor required is 20. The funds come from partners such as Delta Lloyd, the Italian public company *Cassa Depositi e Prestiti SpA* (CDP), the EIB and the European Union. The fund was created to support the promotion of the renewable energy market and the protection of the climate in the European Union.

[26] Mezzanine finance is a form of credit which is a hybrid of debt and equity financing. It allows companies to finance their growth without having sufficient guarantees to use bank loans.
[27] There are some doubts about this mechanism. Although it bears the same name as the previous one, it does not have the same definition or the same funders. The question remains as to whether or not it is the same mechanism.

- **Other EU finance sources**: The multilingual site http://www.accesstofinance.eu helps in applying for additional sources of funding supported by the EU.
- Support for urban development **JESSICA** (Joint European Support for Sustainable Investment in City Areas) supports integrated, sustainable urban-renewal projects through a series of sophisticated financial tools, including equity investments, loans and guarantees, offering new opportunities for the use of EU Structural Funds.
- Cross-border programmes such as **Interreg**, a European instrument designed to promote cooperation between European regions and the development of shared solutions in the fields of urban, rural and coastal development, economic development and environmental management. It is funded by the European Regional Development Fund (ERDF) with a budget of €7.75 billion. The current programme covers the period 2014-2020. There are three separate initiatives under Interreg, in addition to the five territorial programmes covering Wallonia:
    - **URBACT** is an exchange programme for sustainable urban development. It supports cooperation between European cities to promote their economic, social and environmental development.
    - **INTERACT** targets the institutions and organisations that have been set up around Europe to manage territorial cooperation programmes – especially managing authorities and joint technical secretariats, as well as monitoring committees, national contact points, certifying authorities and audit bodies.
  - European Observation Network for Territorial Development and Cohesion (**ESPON**).
  - European Long-Term Investment Funds (**ELTIF**): new fund targeting institutional and retail investors, with the aim of providing long-term investment in unlisted companies, listed SMEs, infrastructure projects and other non-liquid assets.
  - Public Sector Purchase Programme (**PSPP**): debt purchase programme.
  - The **social development bank** CEB contributes to the financing of social projects and socially oriented investment projects such as the renovation of infrastructure or social housing.

C. EUROPEAN FUNDING OPPORTUNITIES FOR PUBLIC BODIES

Main funding opportunities

Economic, social and territorial support

The Cohesion Policy (regional policy) supports economic, social and territorial cohesion in the regions eligible for funding.

The European structural and investment funds comprise five major funds that jointly support economic development in all EU countries:

- the European Regional Development Fund (ERDF);
- the European Social Fund (ESF);
- the Cohesion Fund;
- the European Agricultural Fund for Rural Development (EAFRD);
- the European Maritime and Fisheries Fund (EMFF).

All EU regions are eligible for ERDF and ESF. The Cohesion Fund is reserved for less developed regions.

Large infrastructure projects

JASPERS is a technical assistance instrument jointly developed by the European Commission, the European Investment Bank Group and other financial institutions.

It helps public authorities to prepare large projects which can be co-financed by EU funds.

Financial instrument advisory services

The technical assistance instrument fi-compass was jointly developed by the European Commission, the European Investment Bank Group and other financial institutions. It is a platform for advisory services on financial instruments under the European Structural and Investment Funds (ESIF), and on microfinance under the Programme for Employment and Social Innovation (EaSI).

Other financing opportunities available to public bodies for the renovation of buildings (directly or indirectly)

- Youth employment support helps young people who are not in employment, education or training, in areas where the youth unemployment rate exceeds 25%. Public bodies are eligible for the financial aid granted under this initiative.
- Depending on the priorities set by the country or region concerned, a public body established in a rural area may be eligible for EAFRD funding if it is working to improve living conditions in rural areas or improve the rural environment and economy.
- The Horizon 2020 programme is also open to public bodies wishing to encourage innovation and provide more efficient public services.
- Local and regional authorities and certain administrative bodies can participate in projects funded under the Connecting Europe Facility (CEF).
- Eurostat issues calls for proposals open to national statistical institutes and other national authorities responsible for collecting, compiling and publishing official statistics. These bodies are eligible for grants under the European Statistical Programme.
- The financial instrument for the environment (LIFE) provides various funding opportunities for public bodies.

D. ANALYSIS OF THE NEW LIFE PROGRAMME

Introduction

A proposal for a regulation of the European Parliament and of the Council was recently released in order to extend the LIFE programme from the previous Financial Framework to the one for the period 2021 to 2027. The full text can be found at the following link: https://ec.europa.eu/transparency/regdoc/rep/1/2018/EN/COM-2018-385-F2-EN-MAIN-PART-1.PDF

Summary of the document

Environmental and climate problems impact on the health and quality of life of EU citizens as well as on the availability and status of natural resources, implying social and economic costs. The transition to a low-carbon and circular economy is a project of economic modernisation for Europe[28].

The LIFE programme will contribute to small-scale innovation, helping citizens to take action for the climate and for their communities.

With its relatively modest budget, it is targeted at a niche between EU programmes supporting research and innovation on the one hand and EU programmes financing large-scale deployment on the other hand. Thus the programme bridges the gap between the development of new knowledge and its implementation. LIFE's main impact is indirect through its role as a catalyst supporting small-scale actions. Integrating a Clean Energy Transition sub-programme (currently funded under Horizon 2020) into LIFE, as well as a sub-programme on 'Climate Change Mitigation and Adaptation'.

The LIFE programme is directly managed by the Commission; the implementation of some components has been delegated to the executive agency EASME (which already managed it in 2014-2020).

The Clean Energy Transition should be integrated into LIFE (post Horizon 2020) since the objective is not to fund excellence and generate innovation, but to facilitate the uptake of already available technology that will contribute to climate mitigation.

The biggest gaps in financing relate to the investments in the decarbonisation of buildings (energy efficiency and small-scale renewable energy sources). One of the objectives of the Clean Energy Transition sub-programme is to build capacity for project development and aggregation[29], thereby also helping to absorb funds from the European Structural and Investment Funds and catalyse investments in clean energy also using the financial instruments provided under InvestEU. (https://europa.eu/investeu/home_en).

Lack of adequate financing is one of the main causes for insufficient implementation of nature legislation and of the biodiversity strategy. The main Union funding instruments, including the European Regional Development Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund, can make a significant contribution towards meeting those needs.

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[28] This definition is important because it reflects the EU's strategic priorities: quality of life, reduction of dependency on raw materials through exploitation of secondary sources and world leadership in the low-carbon economy.

[29] It is this aspect in particular that opens doors for DGO4 and its partners. The key words are: application of proven recipes, small-scale trials, aggregation of small projects to achieve sufficient critical mass and access to underutilised EU financial instruments.

The programme should prepare and support market players for the shift towards a clean, circular, energy-efficient, low-carbon and climate-resilient economy by testing new business opportunities, upgrading professional skills and facilitating consumers' access to sustainable products and services[30].

The LIFE programme

In terms of vocabulary, we will need to differentiate between 'strategic projects', 'strategic integrated projects', 'technical assistance projects' and 'standard action projects'[31].

We should also highlight 'blending operations', which combine non-repayable forms of support and/or financial instruments from the EU budget with repayable forms of support from development or other public finance institutions, as well as from commercial finance institutions and investors[32].

Programme objectives

The general objective[33] of the programme is to contribute to the transition towards a clean, circular, energy-efficient, low-carbon and climate-resilient economy, including through the transition to clean energy, to the protection and improvement of the quality of the environment and to halting and reversing biodiversity loss, thereby contributing to sustainable development.

There are three specific objectives:

- develop, demonstrate and promote innovative techniques and approaches;
- catalyse the large-scale deployment of successful technical and policy-related solutions for implementing the legislation;
- support the development, implementation, monitoring and enforcement of the legislation.

Structuring of the programme in two fields and four sub-programmes[34]

- Environment field
  - Nature and Biodiversity

[30] The goal is very much economic as well as ecological. It is about adapting by creating new products, new services and new trades, and developing typically European expertise in this area. The stakes are very high. Not being left behind by the new leaders such as China and India, reducing our dependency on resources, turning our waste into new wealth. Creating new foundations for employment since our traditional businesses have been largely relocated. Strengthening exports while reducing dependency on imports.

[31] The difference between these concepts will be important when writing future projects, but it is not necessary in this document.

[32] Funding sources increasingly wish to strengthen their impact by combining with other sources. No single fund wants to bear a risk alone any more, and combining funding enables a greater impact for lower individual investment. This provides an answer to the question of how to do more with less.

[33] The key to setting up a project that has any chance of being accepted and funded is to understand (and distinguish) between the (sole) general objective and the individual specific objectives.

[34] It is surprising to find a programme with a budget of €5.5 billion that has such a simple structure. It is one of the stated objectives of the Union to be more accessible and understandable.

- Circular Economy and Quality of Life

- Climate Action field
  - Climate Change Mitigation and Adaptation
  - Clean Energy Transition
  -

Budget

A total €5.5 billion; roughly two thirds of this is for the first field, but there is still €1 billion for the clean energy transition (18%).

Eligible activities

Information and communication, studies and surveys, preparation, implementation, monitoring, checking and evaluation, workshops, conferences, meetings, networking and other activities.

Grants may be awarded without a call for proposals for specific projects on the initiative of the Commission.

Evaluation for the past year

The evaluation for the latest financial year highlights the catalytic effect of LIFE, which had an average leverage factor of 1:22.

The LIFE programme should strengthen Private Finance for Energy Efficiency (PF4EE) and the Natural Capital Financing Facility (NCFF): http://www.eib.org/en/products/blending/ncff/index.htm)

Beneficiaries of the projects are a wide range of different organisations: from small to large enterprises (enterprises receive 44% of the total, of which 33% are SMEs), to private non-commercial organisations (24%), to public bodies (32%).

Challenges for Wallonia

The current LIFE programme is still a 'small' programme, relatively unknown and little used by project developers. The Horizon 2020 Framework Programme is much more popular and involves much more money, but it is highly competitive with many applying and very few being successful. As such, the current LIFE programme represents a good ramp-up plan for entities with prior experience of small, fairly easily accessed programmes such as Interreg, that now want to apply for European projects but without jumping straight into the Horizon 2020 arena.

However, with the expected shifts from Horizon 2020 to LIFE, the 'small' programme is getting bigger and it is likely to become much more complicated to secure funding for a project.

The various iterations of the LIFE programme have had increasingly large budgets: €400 million for LIFE I, €450 million for LIFE II and €957 million for LIFE III.

The current LIFE programme has a budget of €3.45 billion and the next programme, incorporating several strands from the current Horizon 2020, will have a budget of €5.45 billion.

There are two sets of challenges for Wallonia. The first is in involving our research teams, universities, research centres, companies and authorities in European projects. There are numerous benefits to this, constituting a virtuous spiral for all participants.

But it is also about an important source of funding that we would be ill-advised not to consider. Especially since we contribute to its budget. Belgium contributes 3.09% of the EU budget and Wallonia contributes 24.1% of Belgian GDP (on which the national contribution is calculated). Therefore, Wallonia is contributing a total of 5.45*3.09%*24.1% = €40.58 million to LIFE over the seven years of the programme.

The least we can do is to try to receive at least our natural share of it. Incidentally, the Department is currently involved in delivering a LIFE project in collaboration with the Flemish Region and several test cities (BE REEL! project).

Key considerations

If we want Wallonia to retain its place in this European programme, we must establish a coordinated strategy. We must ensure that the procedures established open doors as wide as possible for us, that the calls for projects include topics of concern to us and that the teams in a position to respond have been consulted, informed and know what to expect from forthcoming programmes. We also need to have partnership opportunities ready and project proposals under constant development so no time is wasted. We will need experienced proposal writers. There is also a need to keep co-financing ready to respond to projects that are accepted. We need to work in conjunction with LIFE assessors for effective coaching, and we need to attend project approval committees to advocate for our deserving applicants. We must also have professional project management teams to ensure that the funded projects run smoothly over time.