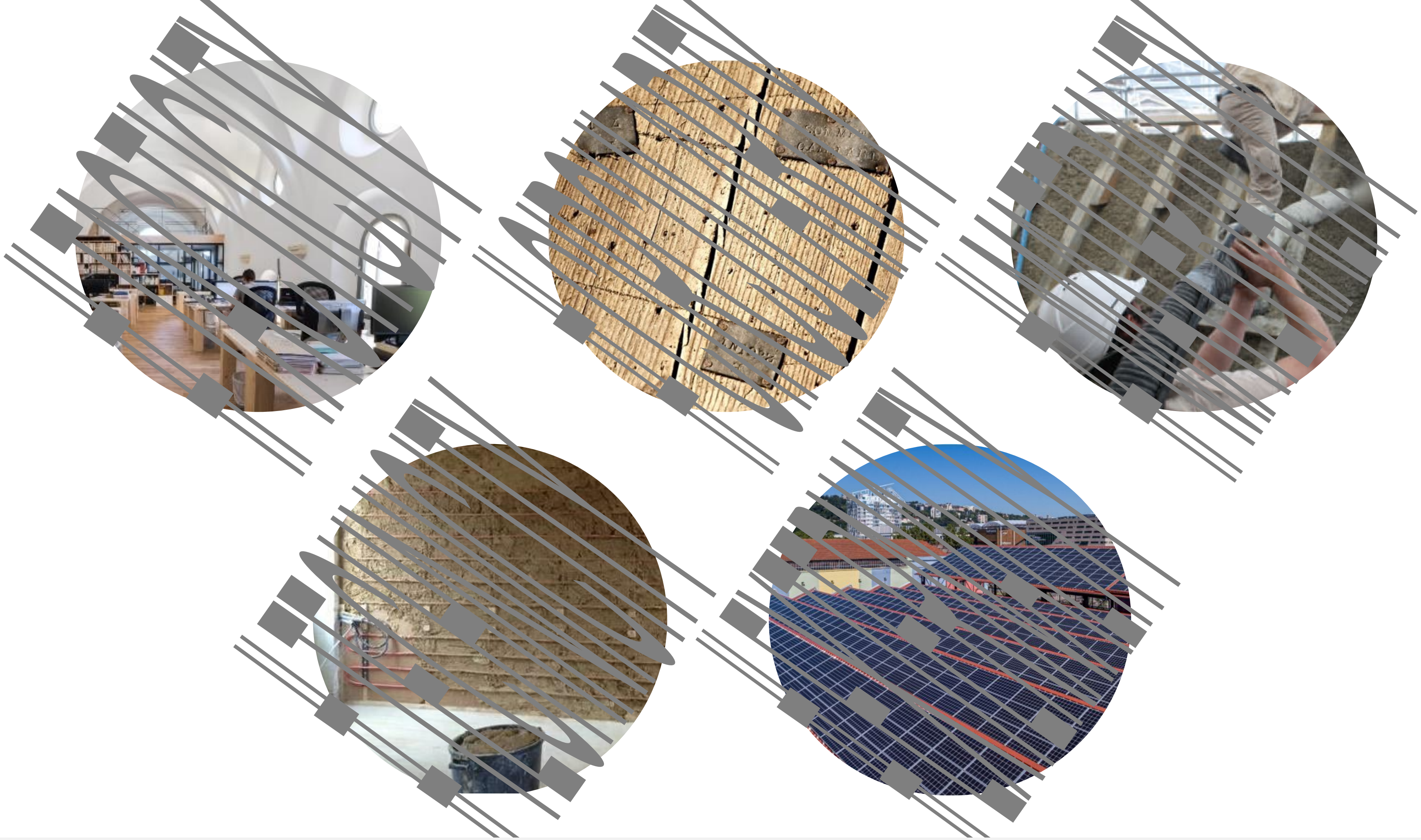


COLLABORATIVE INNOVATION PROGRAMME NZC RENOVATION

Booklet of low-carbon levers in renovation

April 2022 – Index B

00 PREAMBLE

PURPOSE OF THE DOCUMENT

This document is part of phase 3 of the NZC renovation programme. Its objective is to **present the main levers of CO2 reduction applicable** to the renovation market in **France.**

It is composed of the three following parts:

First part:
- Formulate a reminder of the NZC renovation project.
- Perform a short presentation of the French national context of energy renovation.
- Remind the main lessons from the life cycle assessments likely to guide the lever choices.

Second part:
- Present the 5 lever families, detailing for each of them:
  - Their definition
  - The main associated strategies
  - Some orders of magnitude of associated emission sources from the studies carried out in the NZC project
  - Presentation of one or several representative projects.
  - The keys of success to incorporate these levers
  - A temporal scaling of the choices allowing a global vision from design to operation (project timelines).

Third part / conclusion :
- A synthesis of the overall NZC renovation timeline
- Identification of co-benefits of low carbon renovation
- Testimonials from the actors who participated in the project.

THE NZC RENOVATION PROJECT

The NZC Renovation programme aims to identify a consistent method for raising the performance of existing buildings on their entire life cycle. It is led by Alliance HQE France GBC and financed by Fondation REDEVCO. The project focuses on seven representative case studies. It aims to highlight effective levers for reducing carbon emissions on the French renovation market.

The project is made of three steps:
1. Readjusting the renovation LCA method carried out during the HQE Performance test 2017
2. Carrying out representative case studies and their optimisations .
3. Drawing up a guide of good practices and carrying out an optimisation of the projects to get closer to carbon neutrality.

The objective is also to share this work throughout Europe by making available in English the methodology and the case studies carried out. This project is organised in collaboration with World GBC which will allow communication throughout whole Europe thanks to its network and in partnership with AIA ENVIRONNEMENT, member of the Alliance who will provide its expertise in various fields, and will carry out all the life cycle assessments.

Each step aims the measurements, the effective reduction and the growing commitment of professionals concerning emissions throughout the whole lifecycle of existing constructions.

CONSOLIDATION OF THE METHODOLOGY
Harmonisation of the methods for life cycle assessment of existing buildings.

REPRESENTATIVE CASE STUDIES
Detailed analysis of 7 case studies representing the diversity of the French market.

RENOVATION & CARBON NEUTRALITY
Identification of relevant provisions for reducing emissions depending on contextual constraints.

The three steps of the NZC Renovation project

CONTEXT AND ISSUES

NATIONAL LOW CARBON STRATEGY

France, the country which gave rise to the Paris agreement, has set several goals in order to maintain the target of 2°C, like reaching carbon neutrality until 2050, reducing total building greenhouse gas emissions by 49% until 2030 (compared to 2015 in the building sector and much more). To accelerate this transformation, the new French environmental regulation (RE2020) takes the emissions from the whole life cycle into account, calculated by recognised assessment tools which are integrated from 2022 onwards.

The target of carbon neutrality until 2050 is also included in the national energy renovation plan for buildings which provides tools to massify renovation of residential and tertiary buildings. The goal is twofold: reducing the bills and energy consumption in the buildings while responding to social and health issues of fighting against energy insecurity. To achieve that, the national low carbon strategy (SNBC: Stratégie nationale bas carbone) expects an average of 500 000 complete equivalent renovations* per year for the existing housing stock, with a priority for buildings with low energy efficiency.

Beyond the energy dimension, the national low carbon plan aims to resort to carbon-free energies which are best suited to building's typology and to promote renovation products and equipment with lower carbon footprint over the whole life cycle (coming from circular economy or bio-sourced).

TERTIAIRY DECREE

In the framework of the French ELAN law, the tertiary decree sets obligations concerning the energy renovation of tertiary buildings over 1000 m². In the general case, every building, part of a building or group of buildings subject to this obligation shall reach, for each of the years 2030, 2040, 2050, reduction targets of 40%, 50% and 60% compared to a reference energy consumption which cannot be earlier than 2010.

LOW CARBON RENOVATION LCA ISSUES

However, the environmental issue of the renovation cannot be reduced to the mere energy dimension. The strategy must also take the other impact indicators into account.

With the E+C- experimentation and the advent of RE2020, Life Cycle Assessment (LCA) has never been used so much in the building sector! However, this approach still remains rather marginal for existing buildings (renovation or operation).
Yet, the issue is important: under assumption of a massive renovation wave fitting the national strategy, the carbon footprint of materials used in renovation could rapidly exceed that of new constructions.

This low carbon booklet is intended for building professionals who mostly need experience feedbacks and clear orientations to guide the choices concerning low carbon renovation, taking the whole life cycle of the work into account.

500 000

Number of complete housing renovations per year for the existing park to be carried out in the framework of the national low-carbon strategy.

Scenario revised SNBC (carbon neutrality), March 2020 Link

3%

Percentage of the renovated tertiary park per year stated in the framework of the national low-carbon pathway.

Revised scenario SNBC (carbon neutrality), March 2020 Link

- 40 %

Target of energy consumption reduction to be achieved as of 2030 for buildings submitted to the tertiary decree obligation.

Tertiary decree, order of 10 April 2020

* *The energy gain of a complete equivalent renovation corresponds to the gain from the renovation of the whole building to achieve a very high performance*

00 PREAMBLE

LESSONS FROM THE NZC PROJET

We present hereafter the main lessons from the life cycle assessments carried out in the framework of the NCZ project. These lessons shaped the choices of the presented low carbon levers.

LESSON N°1: CARBODIVERSITY

Prioritisation of emissions strongly varies from one case study to another. Thus, the energy impact strongly varies depending on the given possibilities concerning the intervention perimeter and the associated constraints (heritage, presence of asbestos, urban insertion...). The main contributors of construction products and equipment (CPE) are also contrasted.
For each lever, this observation invites to take into account the importance of a contextual assessment based on the singularities of the existing.

LESSON N°2 : AFFORDABLE EXEMPLARITY

For the project panel considered, reaching the best level of the French carbon energy label for new buildings has been observed in most studied cases (level “Carbone 2” for 100% of the cases considering "Construction product and equipment").

Even if the exemplarity of this study should be considered, this observation shows the pertinence of a renovation, compared to demolition/reconstruction: it is possible to reach the best level of Carbon Energy label at an unbeatable price. This also invites to a soberness approach concerning the demolished parts and the extensions.

LESSON N°3: SIGNIFICANT CPE IMPACTS

Over the entire life cycle, the carbon weight of construction products and equipment of the modelled projects is in the range of 30 to 75% of the total balance. It is therefore far from being negligible, despite of the preservation of a great part of the existing structure. Promotion of renovation products and equipment with a lower carbon footprint (coming from circular economy or bio-sourced) is therefore not to be neglected in a renovation context.

LESSON N°4: NEW PRIORITIES

In the framework of the modelled projects, the fluid batches (HVAC, Electrical, Plumbing) represent a significant weight in a renovation. That’s also the case for finishing and partitioning batches which are usually considered as minor in new construction assessments (compared to the structure and the envelope). These two observations invite to go further in optimising the emissions of these contributors. They invite to a more low-tech and frugal design: question with discernment the role of the systems and eliminate unnecessary materials.

LESSON N°5: CARBON TEMPORALITY

The NZC Renovation study allowed the introduction of an indicator, the gross carbon return time of the renovation. It is defined as the time that is necessary for the reduction of emissions (linked to energy savings/carbon-free energy) to compensate the carbon investment linked to the products and equipment installed during the renovation. This indicator varies from 6 to over 70 years, depending of the carbon optimisation level of the renovation. An energy renovation is therefore not always low-carbon! This observation invites again to monitor the balance between the impact of the renovation materials and the generated carbon savings. The study also highlights the importance of changing the energy vector.

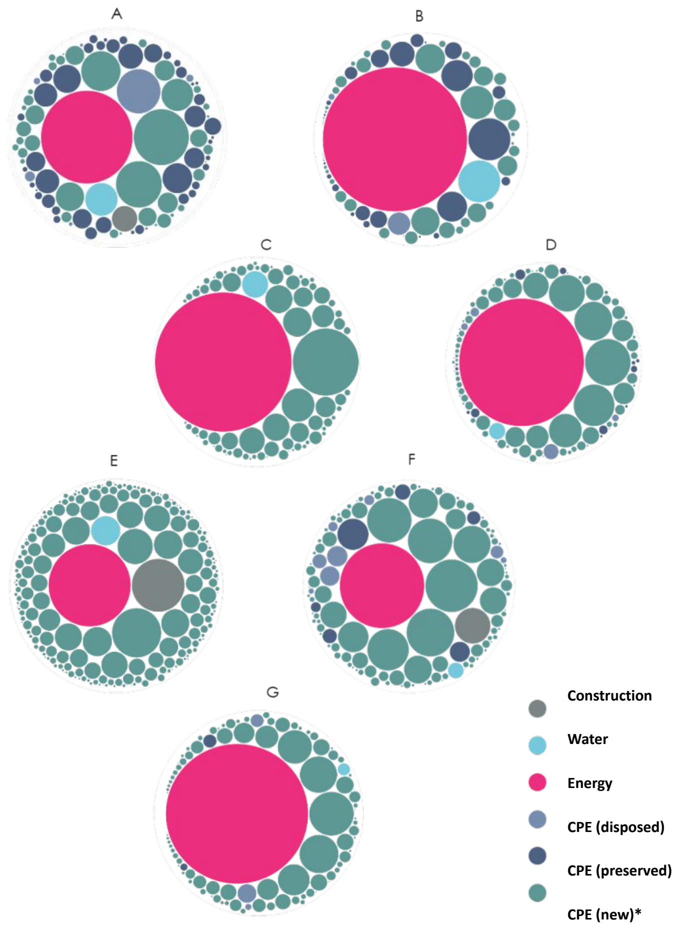


Illustration of the "carbodiversity“ of renovation operations over the 7 projects of the NZC renovation programme. Molecular picture: the size of the bubbles is proportional to the impact of each LCA contributor (The picture shows the "project“ scenario).

LESSONS FROM THE NZC PROJECT

The Life Cycle Assessments carried out in the framework of the NZC project on the 7 project families recalled thereafter allowed extracting orders of magnitude of LOW CARBON KEY FIGURES, as well as feedback concerning the integration of the levers. These elements illustrate the 5 lever families identified in the following thematic factsheets. They are completed by data and references gathered in the framework of the participatory workshop organised in February 2021 and bringing together many building actors.

A – INDIVIDUAL HOUSING IN SPRAWLING URBAN ENVIRONMENT

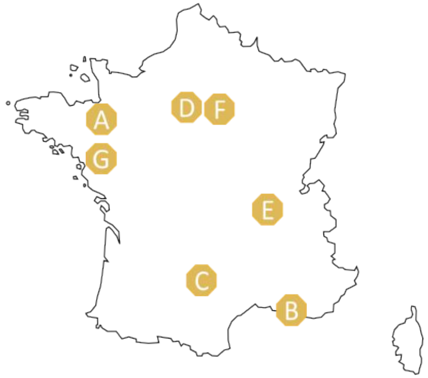
"Zero energy" renovation of 4 individual occupied housing, Chateaugiron (35)

B – LARGE HOUSING ESTATES IN SUBURBAN AREAS

Renovation of 446 collective housing units Résidence la gavotte, Septèmes-les-Vallons (13)

C – ANCIENT HERITAGE BUILDINGS IN MEDIUM SIZED TOWN CENTERS

Refurbishment of 9 housing units and a shared area, Rodez (12)



D – LARGE UNITARY URBAN AREA TO BE REFURBISHED IN THE HEART OF THE CITY

Goujon new head office, Paris (75)

E – INDUSTRIAL HERITAGE IN REGENERATED WASTELAND

H7, French Tech "Totem space", Lyon (69)

F – MAJOR RENOVATION FOR RECENT CORPORATE REAL ESTATE

IBOX tower, Paris (75)

G – URBAN GROUND FLOOR TO BE ACTIVATED

Wigwam office, retail space in a historical building ground floor, Nantes (44)

01 TACTICITY

DEFINITION

IN SHORT: SEARCHING FOR A RIGHT BALANCE BETWEEN PRESERVATION OF THE EXISTING BUILDING AND LONG TERM PERFORMANCE GAIN

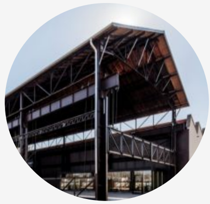
Tacticity is a term freely inspired from chemistry which characterises sequencing of possible configurations in the chain of a molecule (from Greek taktikê, "art of organising"). Adapted to renovation, this concept consists in aiming work to be done to improve performance , while preserving as much as possible both the architectural and environmental heritage of the existing buildings. Combining frugality and sustainability, this consideration aims at maximising the long term use value while minimising resort to unnecessary materials.

ASSOCIATED STRATEGIES

- *Preserving at most existing material of the work, whose service life can easily be extended.*
- *Limiting demolition to parts of the building whose health, regulatory characteristics or obsolescence are strongly constraining preservation.*
- *Adapting planning and zoning of areas to the singularities of the existing (ambience, ceiling height) and not the opposite.*
- *Optimising the use value of the premises depending on the needs identified, before considering an extension scenario.*
- *Considering use reversibility.*
- *Regrouping some programmatic entities whose occupancy schedules are complementary.*
- *Optimising performance of the envelope in a logic of bioclimatism, sustainability and future evolutivity.*
- *Integration during operation of a principle of differentiated renewal of products/equipment depending on their obsolescence.*

LOW CARBON KEY FIGURES

From the 7 generic cases of the NZC Renovation project

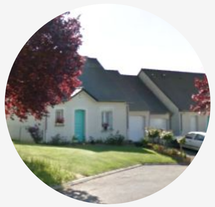


kg eq CO_2 / m² for 50 years

Reinforcing the performance of the existing envelope, preferred to a strategy type like "box in a box".

kg eq CO_2 / m² for 50 years

Replacing joinery and treatment of air tightness details of the envelope.



kg eq CO_2 / m² for 50 years

Generated savings by preserved finishing elements (excluding the structure) compared to replacing them as part of the renovation.

kg eq CO_2 / m² for 50 years

Preservation of various metallic elements that are in good condition like steel coping of acroteria and railings.

01 TACTICITY

PROJECT FOCUS FOR A RENOVATION, RETHINK USES TO AVOID BUILDING MORE

DE DRENTHE SCHOOL – Netherlands

"Make smarter" to valorise the use of existing buildings

KEY INFO

Digital engineering and building: DEERNS

Drenthe campus:

- 10.000 Students
- 1.000 Teachers
- 18 School buildings

Reducing building operation costs:

- 2013: 6.6 M € > 2017: 3.3 M €

DESCRIPTION

The goals of the intervention are the optimisation of the management of the existing school heritage, the arbitration on the decision to build a 19th building, the preparation of the school for new types of education.

The strategy developed is based on the concept of Smart Campus. It combines engineering, information technology and Artificial Intelligence (AI) to integrate the systems and IoT already in place. This approach allowed to review the use, to optimise the functionality of the existing areas and thus to avoid the environmental impacts linked to overconsumption and construction of a new building. Indeed, **the detailed analysis of the existing building and its optimisation allowed to review the needs and showed that it was not necessary to build a new project.**

The innovative process put in place consists in equipping the rooms with sensors to measure their use, identify the real needs and optimisation potentials. Thus, this allowed to **integrate the new needs (m²) into the renovated existing building and to optimise in order to avoid building more**.

The renovation actions and the implementation of the smart campus principle have also enabled **a significant optimisation of operating performance through a pragmatic use of available data.**

Picture of existing Drenthe school

Real-time dashboard, and usefulness of Artificial Intelligence for assessing the use value of existing premises and optimise the use of often unoccupied spaces.

01 TACTICITY

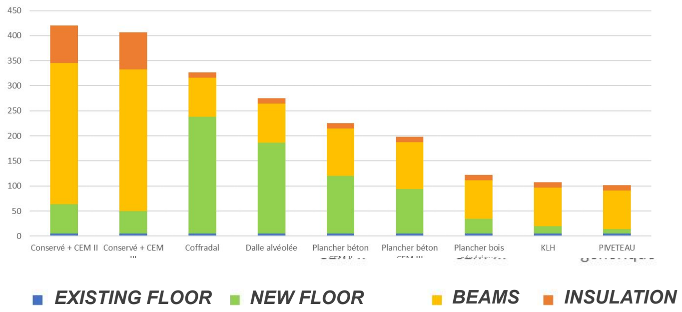
READING KEYS

Complete renovation for more than 50 years or frugal renovation, do we have to chose ?

The projects studied within the framework of the NZC project show the relevance, when the context allows it, of a complete and sustainable renovation of the insulated and tight envelope. The compatibility of this goal with a maximal preservation of existing materials of the project constitutes sometimes a delicate balance. The frugality/sustainability balance should be analysed on a case-by-case basis using sensitivity studies.

Is preservation always the lowest carbon option?

In most cases studied, preservation of an existing structure constitutes the lowest carbon option. Thus, there are notable exceptions to this observation. When this preservation requires substantial structural reinforcing, replacing it by a lighter, less carbonated structure may represent an interesting alternative (see adjacent example).



Capucine project in Paris, renovation of Gaumont movie theatre –comparative study of carbon weight by retaining the existing concrete floor vs use of a new wooden floor. The study concludes in favour of this second option.

PROJECT TIMELINE

POTENTIALITIES

01

Diagnosis

Detailed analysis of the needs and the use value (possible use of digital sensors).
Detailed structural diagnosis.

SPATIALISATION

02

Programming

Techno-economic study of various preservation scenarios, including associated environmental co-benefits.
Grouping of functions with complementary occupancy schedules.

COMPETITION

03

Sketch

Evaluation of carbon impact of architectural proposals.
Assessment of the impact on the existing building and of the valorisation of its qualities.
Definition of processing principles of the heated envelope and associated performances.

DESIGN

04

Draft

Optimisation by dynamic thermal simulation of the performance of the envelope, coupled with a life cycle assessment.
Definition of processing principles of recurring thermal bridges.

02 CIRCULARITY

DEFINITION

IN SHORT: INCORPORATE THE PROJECT IN AN AMBITIOUS CIRCULAR ECONOMY STRATEGY

Circularity refers to the capacity of the project to fall within the circular economy principles. As continuity of the already discussed preservation of the existing structure, this lever relies mainly on recovery of existing products and equipment to be removed. This approach foremost implies to maximise the reused part of materials, favouring in situ or nearby reuse. Then, it looks at strategies of material recycling and material recovery while minimising the degree of transformation. This strategy finally examines possible synergies of the operation with territory actors and channels in process of structuring (or to be developed).

ASOCIATED STRATEGIES

- *Carrying out a detailed "resource diagnosis"*
- *When deconstruction is not an option, carry out an ambitious selective deconstruction strategy with associated reuse objectives.*
- *Use of deconstructed elements in situ for recovery or reuse while reinventing its initial use (up-cycling).*
- *Making site concrete or outside floor covering material from inert material coming from the demolition.*
- *Creation of a recycling depot during the building site to allow recovered materials and renovation waste to find a second life nearby the worksite.*
- *Identification of new operations nearby the building site whose project material source could constitute a resource.*
- *Integrating products coming from external reuse channels into envelope materials or finishing work. Extending the reuse strategy to equipment.*
- *Scenography or specific communication linked to reuse to make the strategy visible and appropriated by the users.*
- *Integrating the circular economy strategy to the sustainable procurement policy of the holder.*

LOW CARBON KEY FIGURES

From the 7 generic cases of the NZC Renovation project

kg eq CO_2 / m² for 50 years

Use of reused false floors

kg eq CO_2 / m² for 50 years

Use reused or second hand mixers for sink and showers.

-6 kg eq CO_2 / m² for 50 years

Use of reused wooden cladding and floor as a substitute of inner lining.

-9 /-45 kg eq CO_2 / m² for 50 years

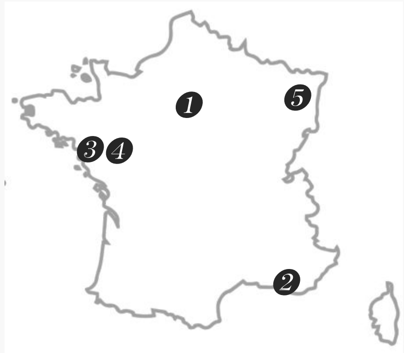
Use of crushed concrete as base layer for road works / recycled asphalt concrete. Calculation assumptions: 10 875 T of crushed concrete backfill recovered at less than 5 km for the renovation of 8000 m² floor area.

02 CIRCULARITY

PROJECT FOCUS REUSE, CONSTRUCTION MATERIALS

Overview of renovation projects

Coming from feedbacks of HQE France GBC partners



❶ PASSAGE AMELOT - EX & IN SITU REUSE – CYCLE UP
Decrease of waste production through reuse of materials from dredging linked to the renovation of the building. Ex-situ reuse: 32 t of waste / 219 tCO2eq saved. In-situ reuse: 807 t waste / 95 tCO2eq saved. In-situ recycling (crushed concrete backfill): 10 857 t waste saved.

❷ LE PRADO - EX & IN SITU REUSE – CYCLE UP
The client, ICADE, wished to implement a strategy of produced waste reduction while favouring material reuse in project of transforming an office into housing in Marseille. The site excess were also recovered through the Cycle Up platform . 62 teq Co2 and 56 t of waste avoided.

❸ THEATRE « LE GRAND T » in NANTES - EX & IN SITU REUSE – AIA ENVIRONMENT. *The project integrates a building site deposit with a reuse workshop in the "Yourte" of the park . A "house of reuse" in the existing ticket office will allow to make this approach visible. An in situ storage and experimentation area of reuse strategies will also be made in the existing mezzanine space.*

❹ MOULD LOFT – IN SITU REUSE - AIA ENVIRONNEMENT, NANTES.
The project includes reuse and highlighting of timber slats from the N+1 floor to cover the nave of the new bow on the town side with interior cladding. Beyond the generated saving of resources, this strategy shows a definite architectural and heritage interest: the floor still bears nominative ship metal plates which were designed in the former mould loft.

❺ REHABILITATION OF THE MANUFACTURE DES TABACS AND EXTENSION OF THE G2EI POLE – IN SITU REUSE - STRASBOURG – *In this renovation project, the reuse of existing structural elements required strategy of reinforcement and differential treatment to insure their sustainability. Original façade joinery, framework, wooden floors and cast iron posts were thus refurbished and reused in situ.*

02 CIRCULARITY

READING KEYS

A limited low carbon source for reuse?

Best practices (cf. "Passage Amelot" project above) show moderate carbon reduction sources for in situ and ex-situ reuse. The most interesting reduction potentials concern recycling or reuse of rather heavy deconstructed materials (ex: recycling of rubble, on site concrete, false floors). However, this observation shall not draw attention away from reuse, whose interest is also expressed in the "Resource depletion" and "waste" indicators. Reuse also constitutes an opportunity to mobilise local channels linked to social and solidarity economy. This approach also constitutes an opportunity to reveal the existing architectural heritage, the history of the area and lastingly insufflate a culture of circularity to the users.
The French "AGEC law" will reinforce these practices.*

** From 1 January 2022, the clients must in particular carry out a Product Equipment Material Waste (PEMD) diagnosis before beginning a deconstruction work of more than 1 000 m², as well as for other significant renovations*

Mould loft – Nantes – The reused wooden floor bears imprints of the ship layout carried out in the old Dugigeon hall. Metal plates show the name of the ships.

PROJECT TIMELINE

FEASIBILITY — 01

Diagnosis

Resource diagnosis and detailed PEMD* of the existing building
Identification of a deconstruction waste recovery objective.
Synergy with nearby operations.

INTEGRATION — 02

Design

Integration of reuse expertise.
Project integration study of materials identified in the resource diagnosis.
Integration of potential external reuse material defined upstream, in synergy with local reuse channels.

CONTRACTUALISATION — 03

Before work

Creation of a reuse batch in the CCTP specifying quantified goals and the role of each stakeholder.
Evaluation of companies under ACT according to their degree of involvement.

FOLLOW-UP AND COORDINATION — 04

Work

Designation of a reuse provider.
Approach monitoring. Installation of a resource deposit.
Coordination/educational site visit.
Circular economy clause included in the client's specifications.

03 MATERIALITY

DÉFINITION

IN SHORT: INTEGRATE THE RIGHT MATERIAL AT THE RIGHT PLACE DEPENDING ON THE SPECIFICITIES OF THE EXISTING CONSTRUCTION AND ITS CONTEXT

The materiality concerns the choice of the new materials and construction products which will be integrated in the renovation operation. If their quantity can considerably be reduced by both former levels, (tacticity and circularity), their quality (emissions linked to their production / transport / end of life) remain major issues for reducing the carbon weight of the renovation. In a heritage context, smooth integration of the materiality and its complementarity of the existing building are fundamental, as well on architectural than technical aspects. The issues of constructive diversity, reinterpretation of traditional know-how and keeping satisfactory hygrothermal properties have to be considered in this lever.

ASSOCIATED STRATEGIES

- *Integration of light constructive modes for structural work interventions or extensions that allow to use the bearing capacity of the existing building.*
- *Choice of bio-sourced, geo-sourced or recycled materials for new construction products.*
- *Recovery of interesting hygrothermal regulation properties of some low-carbon materials (hemp concrete, straw, lime…)*
- *Preservation or integration of a "low-carbon thermal inertia" to participate to a summer comfort strategy.*

- *Recovery / review in the framework of the operation of traditional or local craftmanship know-how, meeting heritage issues.*
- *Visibility and simplicity of implemented materials (raw materials, while limiting unnecessary linings).*
- *Integration of low-carbon criteria for products and materials linked to furniture and interior design (client's specification, sustainable purchasing charter).*

LOW CARBON KEY FIGURES

From 7 generic cases of the NZC Renovation project

kg eq CO_2 / m² for 50 years

Use of wood preferred to steel or concrete for the mezzanine and the inner joinery.

kg eq CO_2 / m² for 50 years

Choice of recycled textile floor covering. Case of a tertiary "open space" area.

kg eq CO_2 / m² for 50 years

Preferred use of wood for external cladding and choice of bio-sourced insulation (wood wool). Case of a single-family house (not very compact).

to -46 kg eq CO_2 / m² for 50 years

Preferred use of wood for joinery and façade cladding depending on various contexts, compactness and glass surfaces (housing / tertiairy).

PROJECT FOCUS EXTERIOR STRAW INSULATION

132 rue de la Convention in Paris, renovated with straw ETI (75)

KEY INFO

Project owner: Paris Habitat
Project manager: Trait Vivant (representative architect), Landfabrik (architect), Qui Plus Est (thermal BET), Yannig Robert (structure BET)
Control office: Apave (L. Dandres)
Companies: Apij Bat, Depuis 1920, Collect'IF paille

Costs for 334m² facade to be treated:
scaffold: 130 €/m²
mulching (including substrate preparation): 140 €/m²
joinery: 50€/m²
lime plaster 4cm: 120€/m²

DESCRIPTION

The 7 floor building is occupied and has a view on large a courtyard. The complex belongs to Paris Habitat. The operation is part of a overall project management (renovation, bringing railing up to standard, staircase smoke extraction). Both facades concerned by ETI are made of rubble, and seem to have never been finished since 1930. This experiment meets an objective of exemplarity in terms of carbon impact. It is an opportunity to increase the skills of "conventional" renovation and ETI companies, and to demonstrate by example ("we can do it"). It responds to a need of feedback to be able to validate the ETI in the Professional Straw Construction Rules.

The first straw bales were installed in July 2020 with two application techniques. The first, innovative, consists of laying the bales horizontally and strapping them with suspenders. The latter are actually plastic straps that are used to strap packaging. They are stretched and mechanically hooked into the wall. On the upper floors, the bales are inserted vertically into a wooden frame using the spine technique, defined by the professional rules published in 2012. The bales are then covered with a whitewash of earth, which protects them from fire and humidity during work, and they will then receive a 4 cm lime-sand coating. Two recent tests at CSTB and FCBA guarantee fire resistance for 2 hours for this complex.

Pictures of the existing gable before and after work.

Focus on the implementation of straw bales on the building site

03 MATERIALITY

READING KEYS

Heritage identity and local know-how

Renovation operations frequently provide an opportunity to review traditional and local materials whose carbon footprint is reduced (adjacent example of Troyes tourist office: stone, hemp, oak and poplar wood, terracotta floor tiles, ochres of Burgundy). A support to local ecological sectors and a re-appropriation of know-how in a clever balance between tradition and modernity!

Hygrothermal qualities to be preserved

Old heritage also has properties valued in terms of hygrothermal comfort: access to inertia allowing temperature stability, perspirant walls guaranteeing a good migration of humidity... When the context allows it, one of the issues of renovation is to maintain these qualities by favouring the use of bio-sourced and geo-sourced materials: raw earth, hemp concrete, straw, stone.

Renovation of Troyes tourist office (10), XVI century. The hemp concrete used to fill wooden frames (30 cm) and the insulation of the roof present both a heritage and hygrothermal interest. An operation based on local know-how, reproducible for the renovation of old buildings in the city center of Troyes.

PROJECT TIMELINE

UPSTREAM SOURCING — 01

Programming or sketch

Identification of materials and heritage know-how of the existing building. Cartography of bio-sourced and geo-sourced products recycled nearby the project (< 150 km).

ASSESSMENTS — 02

Design

Comparing materials (cost/benefit assessment) Assessment of hygrothermal functioning of the project and of the resulting issues (DTS and condensation studies).

VERIFICATIONS — 03

Work

Integration of criteria of origin and carbon weight in works contracts. Regular follow-up of the integration of low-carbon materials (analysis of company variants).

CAPITALISATION — 04

After delivery

Integration of requirements into the policy for replacement of materials and interior furnishing.

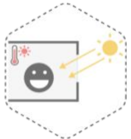
04 TECHNICITY

DEFINITION

IN SHORT: CHOOSE TECHNICAL SYSTEMS WITH DISCERNMENT WHILE AVOIDING COMPLEX OR ADD-ON DEVICES

Technicity is the lever that more specifically focuses on reducing emissions related to technical systems. The carbon impact of technical batches is indeed particularly significant in a renovation context (42% to 63% of emissions on projects). This approach involves finding the fair balance between three components: 1/ a "low-tech" approach aimed at questioning the actual needs in technologies and developing less complex and resource-consuming solutions, 2/ an effective reduction of emissions in operation allowed by an enlightened choice of systems (energy efficiency) and of course 3/ a satisfactory level of comfort for the occupants that can often be obtained by passive strategies (examples for cooling: ceiling fans, natural ventilation).

ASSOCIATED STRATEGIES



- *Differentiated treatment of the atmospheres of the spaces (thermal, light, etc.) as close as possible to the comfort needs of the occupants.*
- *Grouping of spaces with similar needs to allow pooling of equipment and avoid multiplication of systems (example: air handling units).*

- *Integration of a strategy of technological discernment in the operation by questioning the needs and the effort/gain ratio*.*

- *Choice of heating and cooling production systems limiting emissions in operation.*
- *Use of systems and technologies with a known and controlled carbon weight.*
- *Integration of the environmental criterion in the choice of digital system deployment (GreenIT technologies for example).*

- *Use of second-hand or refurbished equipment depending on the possibilities offered by this developing market.*

LOW CARBON KEY FIGURES

From the 7 generic cases of the NZC Renovation project

kg eq CO_2 / m² for 50 years

Implementing a decentralised double flow air handling unit with 80% efficiency energy recovery in a small room on the ground floor.

kg eq CO_2 / m² for 50 years

Implementing a cooling strategy by air fan instead of installing a cooling unit.

kg eq CO_2 / m² for 50 years

Choice of a less emissive refrigerant fluid for the heat pump (R513 A instead of R134 A).

kg eq CO_2 / m² for 50 years

Choice of non motorised rolling shutters

* In particular, the ratio "generated carbon savings / carbon weight of equipment" should be questioned for the choice of energy systems

04 TECHNICITY

PROJECT FOCUS CHOOSE SYSTEMS WITH DISCERNMENT

Pierre Verte – refurbishment of a mansion house into an office in Auch (32)

ADDENDA

KEY INFO

Project owner: SCI Pierre Verte, ADDENDA
Date of construction: about 1760
Surface:
Phase 1 : 1 420 m²
Phase 2 : 1 740 m²
Nature of the intervention:
Heavy renovation (creation of intermediate floors for technical rooms or office mezzanines)
Cost estimation: 2.5 M € before tax
Performance: BEPOS E4C2 and low carbon restructuration project without wall insulation (60 cm thickness while removing cooling),100 % energy self-sufficient, BDM gold label.

DESCRIPTION

The Pierre Verte building is the first European building located in a protected perimeter which has been converted into a positive energy and 100% energy self-sufficient building . The building is an old dressed stone building built by the bishopric between the 17th and 19th centuries, and which was used as gendarmerie barracks for a century.

The insulation strategy was carried out to find a proper balance: impossibility to insulate the building from the outside in order to respect the heritage character of the place and the building and choice of non-insulation from the inside to preserve the old stone structure (migration of water vapour) which allows to avoid air-conditioning. The insulation was therefore concentrated on the roof and a biomass boiler was installed.

In order to reduce the environmental footprint of the operation, the choice fell on wooden structural elements (floors, wall-partitions), raw earth partitions (bricks and plasters), bio-sourced insulation (wood fibre and cellulose wadding) and coatings based on natural products (natural pigments, linseed oil). The main technical innovation lies in the production of "Duoterre" partitions: wooden frame partitions filled with wood fibres and coated with raw earth, patinated with natural pigments and linseed oil. Water pipes are integrated on each side of these partitions, in order to heat, separately or simultaneously, the circulation and meeting spaces.

1st positive energy and low carbon heritage building 100% energy self-sufficient (without wall insulation)

Photovoltaic parking shade area

"Low-tech" heating wall in "DUO TERRE" (wooden structure + wood fibre insulation + earth coating)

04 TECHNICITY

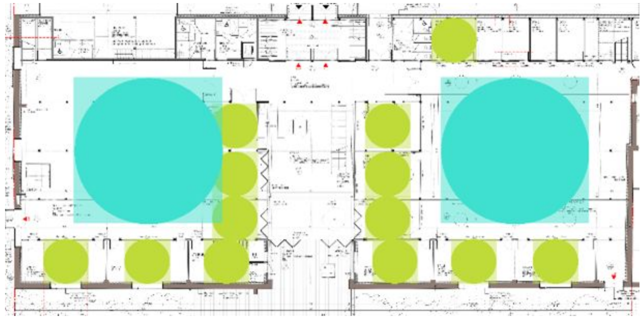
READING KEYS

Do we have to chose between low-tech and comfort?

The reduction in the use of systems frequently raises fears about its consequences on the thermal, aeraulic or respiratory comfort of the occupants (example: lack of air conditioning). Sensitivity studies by dynamic thermal simulation offer the possibility to identify ranges and areas of discomfort to feed arbitrations of the project. This approach underlies focusing on the comfort felt and assessing the robustness of the scenarios used (occupancy and climate change, for example).

The weight of equipment still underestimated?

The carbon weight of equipment represents the missing link in the optimisation strategy carried out in the NZC project. This is explained by a lack of data concerning the equipment as well as an operational difficulty in detailing the contributors (measurements not available). In many cases, standard values, supposed to be maximalist, are therefore used. However, finer modelling of equipment does not necessarily lead to lower values, quite the contrary. Should the carbon weight of the equipment be underestimated? Objectifying this lever of technicity is therefore a high priority.



Choosing a low-tech strategy underlies fine arbitration on the level of comfort felt in the different spaces. Here, the areas of influence of the ceiling fans used on the H7 building in Lyon which identify the preferred comfort zones.

PROJECT TIMELINE

ANALYSIS	SPATIALISATION	VERIFICATION	INTEGRATION
01	02	03	04
Programming	Sketch	Draft	Work
Questioning the differentiated needs of spaces in terms of comfort Technological discernment strategy in the operation	Climate zoning: grouping and pooling of similar spaces Analysis of low-tech solutions that can be integrated into the operation and adapted to the renovation context.	Detailed analysis of the comfort felt by the users (DTS, Givoni, etc.) Sensitivity study of several technical options integrating the overall carbon weight (work+ operation).	Follow-up and verification of technical equipment integrating low-carbon criteria (PEP, refurbished equipment, traceability).

05 EXTERNALITY

DEFINITION

IN SHORT: MAXIMISE AVOIDED OR LOCALY OFFSET EMISSIONS THANKS TO THE PROJECT BY QUESTIONING A WIDENED URBAN PERIMETER

The externality lever questions the opportunity, for any renovation operation, to generate positive environmental consequences on its host territory: CO2 emissions avoided or offset in close proximity of the project. This approach aims to broaden the field of study beyond the built perimeter. It calls for urban logics of synergy and pooling with neighbours, provision of services contributing to reduce emissions (mobility, consumer goods, food, etc.) or even positive externalities on nearby natural or urban environments.

ASSOCIATED STRATEGIES

- *Implementation of interior/exterior layouts contributing to promote carbon-free mobility for users and inhabitants of the neighbourhood.*
- *Establishment of a business/service, reducing motorised travel and contributing to the "quarter-hour city".*
- *Implementation of an urban service contributing to reduce emissions: local food ecosystem, resource deposit, carbon-free mobility accessible to external people.*
- *Pooling of spaces or equipment in synergy with local residents.*
- *Provision of premises for a function with additional occupancy time slots ("chronotopia").*
- *Achievement of carbon sequestration (e.g. tree planting) contributing locally to positive effects of limiting the heat island effect or restoring a natural environment.*
- *Production of excess energy that can be consumed by neighbouring buildings.*

LOW CARBON KEY FIGURES

From NZC renovation cases and various feedbacks

-269 kg eq CO2 / m² for 50 years

Implementation of photovoltaic panels on the roof of individual housing.

kg eq CO2 / m² for 50 years

Implementation of photovoltaic panels on the roof of existing sheds on an industrial hall (N+1) .

-211 kg eq CO2 / m² for 50 years

Choice of bicycle preferred to car for commuting, for 20% of occupants (assumption 10 km / day, saving expressed as 10 m² / occupant in a place of business activity).

-79 kg eq CO2 / m² for 50 years

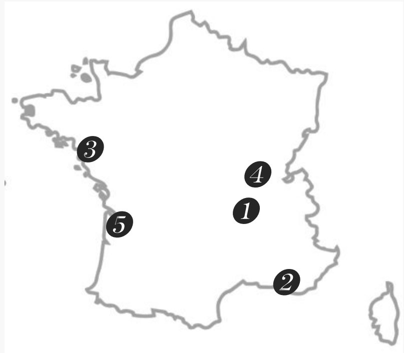
Provision or sharing of 10% of the unused surface with an external or neighboring entity (flex-office, telework, storage, pooling).

05 EXTERNALITY

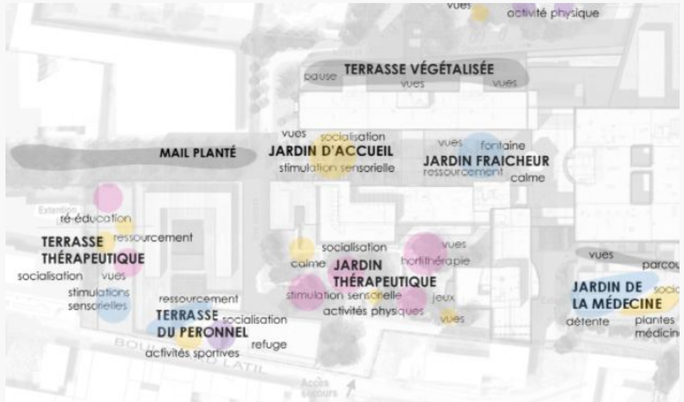
PROJECT FOCUS EXTERNALISE WHAT IS POSSIBLE

Overview of positive externality levers

Coming from feedbacks of HQE France GBC partners

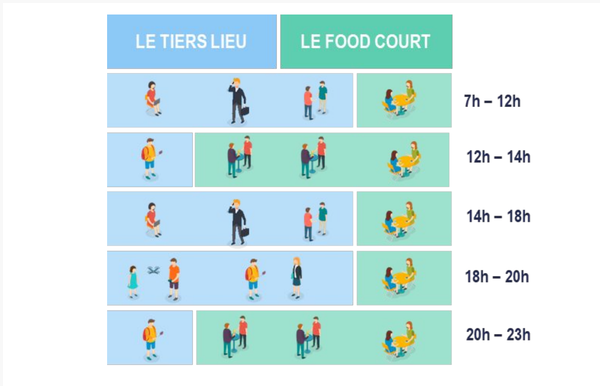


*❶ **SOLIDARITY OF GROUND FLOORS** – In Saint Etienne (42), the initiative "Ici bientôt" of pooling and activity test on ground floors in the Beaubrun-Tarentaize district, favours sharing between merchants and is a vector of social link and professional development.*



*❷ **CARBON SEQUESTRATION AND URBAN RESILIENCE** – In Marseille (13), the renovation of Saint Joseph hospital (AIA LD) shows an opportunity to make the ground less artificial, to create a therapeutic garden and thus on a broader level to reduce the urban heat island effect.*

*❸ **SOLAR CO-ROOFING** – In case of constraints preventing an implementation of photovoltaic panels on a renovation project, it is possible to contribute to an implementation on a nearby roof and to gain inherent benefits! Here, the example of the Minawatt project in Nantes (44), by Cowatt.*



*❹ **URBAN CHRONOTOPIA (Lyon) – M**aximising the use of a place by enhancing the complementarity of occupancy schedules, is in fine also limiting the urban carbon footprint (less new construction and less travel). Here is an example of a hybrid third party place / food-court programme.*

*❺ **SERVICES RELATED TO SOFT MOBILITY** – The Darwin ecosystem in Bordeaux, in the Niel barracks is an example of integration of low-carbon services with a bicycle repair shop (l'étincelle), concept stores around recovery and reuse of materials and an offer of organic food services.*

05 EXTERNALITY

READING KEYS

Multiple benefits to be objectivised

Taking externalities into account is constrained by the lack of shared methodology and quantified feedbacks (sequestration, mobility, food, sharing, etc.). Many externalities are based on multiple contextual parameters and question social sciences. To progress on these issues, a rigorous approach to follow-up and capitalising on the before/after results could be proposed.

Normative and organisational constraints

Examining a broader scope than that of the operation often represents an investment in terms of time with a significant risk factor. The lack of valuation (performance, savings) and the complexity of this approach (legal arrangement, liability) constitute significant obstacles. Partnerships and synergies with local actors must therefore be formed as soon as possible.

Example of the BedZED project in the United Kingdom for which a 360° assessment of positive externalities of the project has been made (food, mobility, waste, health). An approach to be imported to France in a context of renovation?

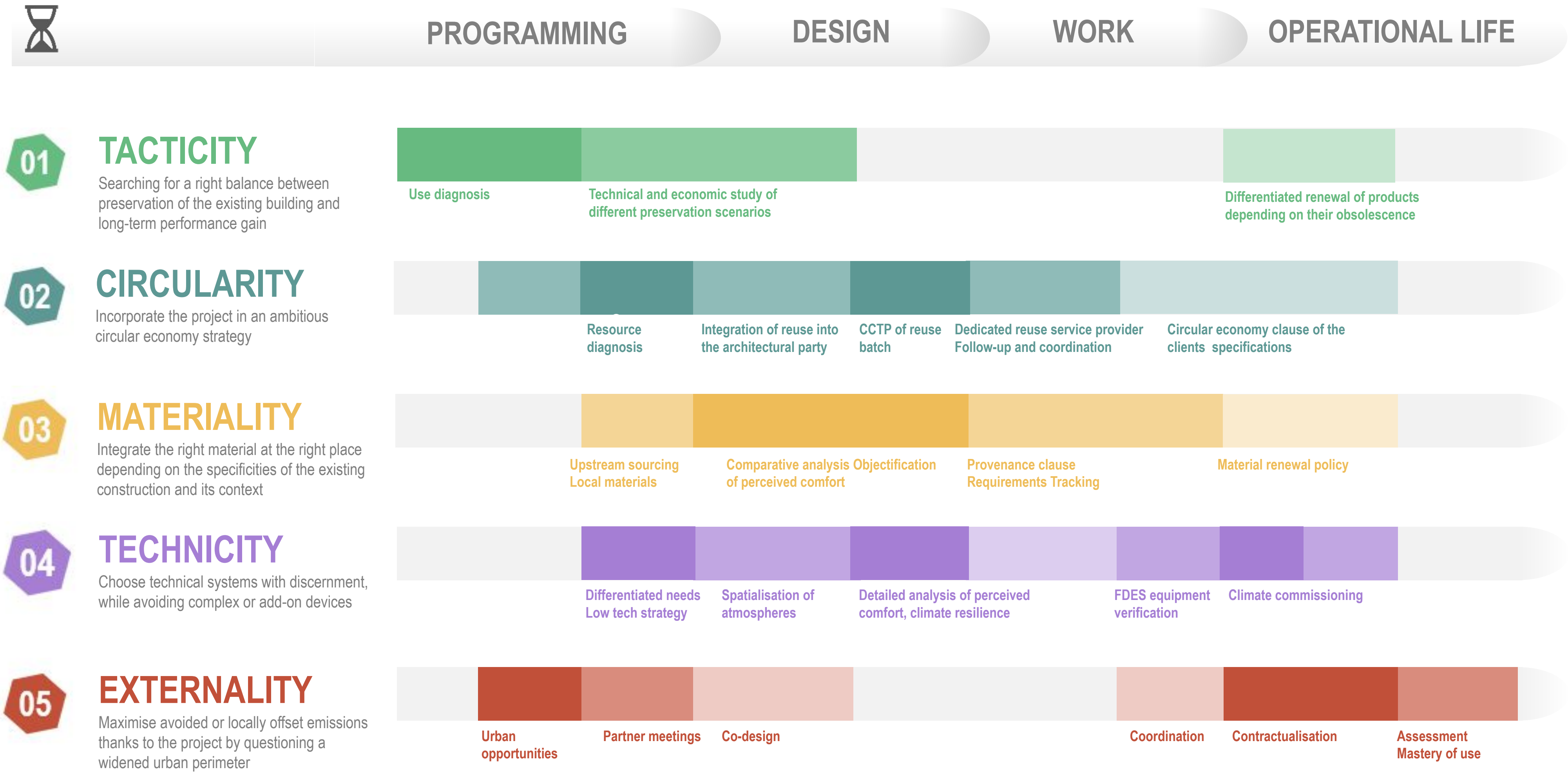
PROJECT TIMELINE

ANALYSIS	COMPATIBILITY	CONTRACTUALISATION	ASSESSMENT /ADAPTATION
01	02	03	04
Programming	Design	At delivery	After delivery
Urban opportunity study included in the site analysis or at the consultation step. Encounter with stakeholders. (associational network, communities, ESS actors) Identification and feasibility of possible positive externalities at the district level?	Co-design meeting with stakeholders external to the project. Compatibility of spaces concerned, e.g. compatibility with different uses, adapting access, scalability.	Implementation of a legal/financial system (e.g. AFUL, agreement, etc.) to frame externalities (responsibility, scope).	Support to users (e.g. mastering use).Periodic follow-up and quantified analysis of emissions really avoided and of socio-health co-benefits. Capitalisation of experiments

CONCLUSION

NZC RENOVATION TIMELINE

The low-carbon renovation strategy questions all the stages of the project, from programming (including diagnosis and feasibility) to life in operation. The diagram below represents the different key phases of the 5 levers. It identifies the actions to be taken, whose relevance is to be questioned depending on the context and the opportunities offered. It highlights the importance of the upstream phases (diagnosis/feasibility/sketch) but also opens up avenues for the operating phases to guarantee the effective continuity of the provisions envisaged (control of use and operation, commissioning, renewal policy , responsibility management…).*

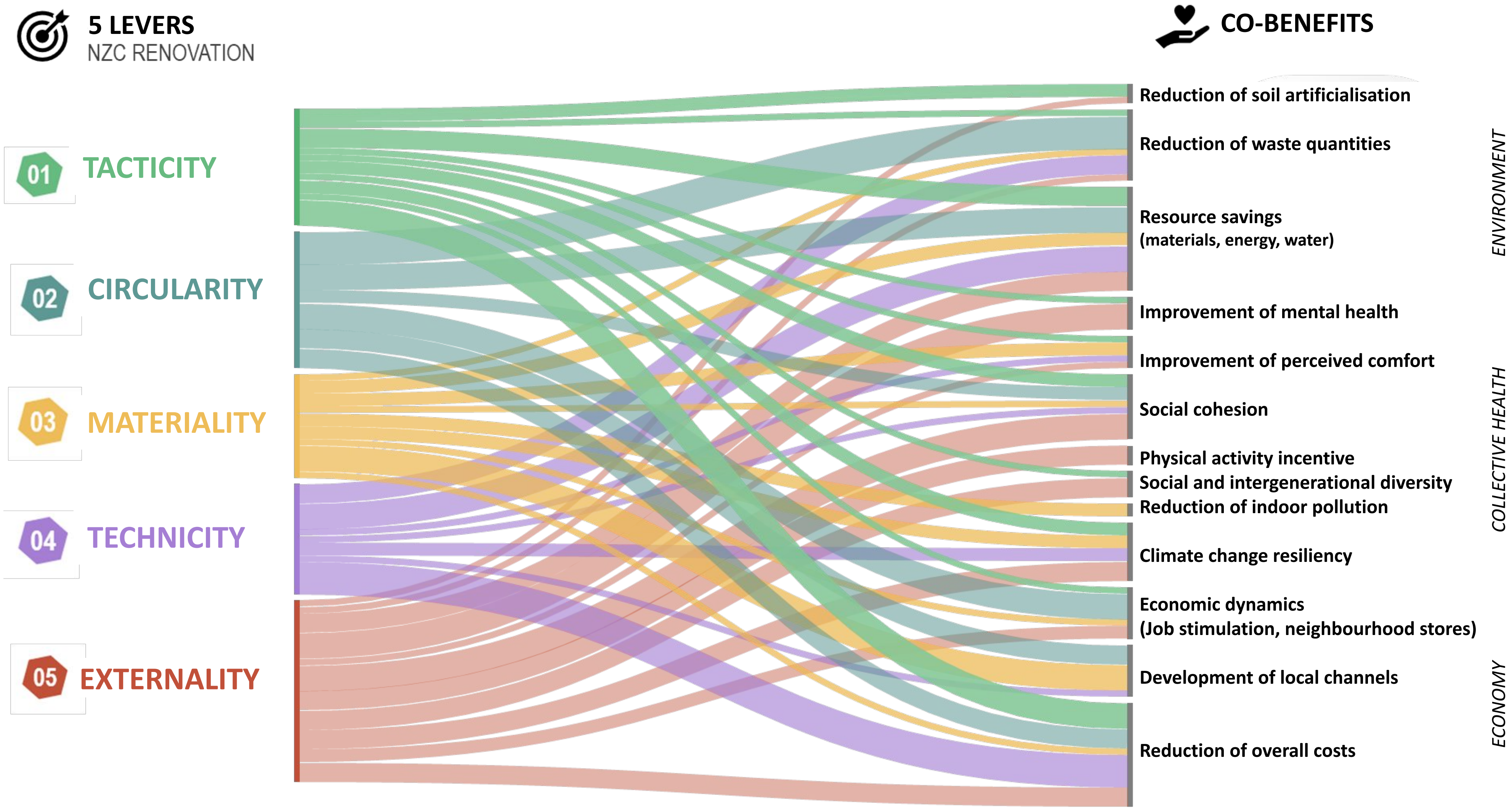


** Caption: the darker the color, the more crucial the issue of this phase is for this family of levers.*

CONCLUSION

CO-BENEFITS OF LOW CARBON RENOVATION

Low-carbon renovation generates multiple co-benefits in environmental, social and economic fields. The figure below provides a map based on the analysis of the different strategies associated to the levers presented in this document. The renovation strategy can therefore not be reduced to a single carbon indicator: it must simultaneously question these various expected benefits which are both complementary and interdependent (multi-criteria analyses clarifying the arbitrations to be made).*



** In particular, the thickness of the bonds is conditioned by the number of identified links within the framework of the NZC study from the detailed strategies corresponding to each lever.*

CONCLUSION

CROSS VIEW

Vision of an environment engineer

INTERVIEW WITH: **Paul CLEMENT**

Project director at TERAO

WHAT ARE THE CURRENT TECHNICAL OBSTACLES FOR SUPPORTING THE DESIGN OF A LOW-CARBON RENOVATION PROJECT?

« The design of a low-carbon renovation project is a priori "technically" simple, by combining good practices in low-carbon construction and common sense linked to the conservation of what already exists. »

The main obstacles that we identify are more "cultural" and based on (mis)knowledge and habits of the sector:

• A still low level of awareness of the environmental impact of the act of building, or that of conserving. In the absence of regulations or strong initiatives related to the implementation of low-carbon renovation, the issues and orders of magnitude are not known by most of the sponsoring players. A very large part of the assistance for the implementation of low-carbon renovation strategies is dedicated to raising team awareness rather than to developing technical solutions.

• Carbon calculation methods that are still too esoteric to date, complicating the debates on technical choices and constituting a brake for the appropriation of subjects. Methods which should be harmonised and simplified by the NZC Renovation working group.

• Cultural habits and projections, in particular on big tertiary renovation projects, where the "minimum thermal" renovation project is sometimes conceived as a heavy restructuration, accompanied by the creation of complementary surfaces, revisions of vertical circulation... retaining of the existing building only a part of the structure...and getting closer to standards of new construction.

Vision of an associative social housing actor

INTERVIEW WITH: **Karine VENOT**

Director at SOLIHA D'Aveyron

WHAT DIFFICULTIES DO YOU HAVE TO FACE FOR A LOW-CARBON RENOVATION WHILE GUARANTEEING HOUSING QUALITY AT THE BEST COST IN SOCIAL HOUSING?

« Our accommodation is aimed at a social or even very social population. We therefore favour the use of robust and durable or inexpensive materials that can be easily renewed in order to have decent accommodation for all our rentals. »

In the context of development of social housing, the viability of projects is subject to constrained budgets and is hardly compatible with the use of bio-sourced materials which would allow to reduce the carbon impact of the projects because they are often more expensive.

In addition, the supply modes of the latter and finding qualified workers to use these practices are two significant points to take into account.

Another difficulty, the preservation of existing materials such as partitions and ceilings does not always allow the redesign of dwellings to make them accessible to people with reduced mobility, and can disturb the heat or acoustic treatment of the dwellings. Existing materials are also difficult to adapt to current configurations and standards.

CONCLUSION

CROSS VIEW

Vision of a LCA modeller

INTERVIEW WITH: **Maxime HAVARD**

Low-carbon manager at AIA ENVIRONNEMENT

WHAT SIGNIFICANT DIFFERENCES CAN WE HAVE ON THE DEVELOPMENT OF THE LCA BETWEEN NEW BUILDINGS AND RENOVATION? WHAT ARE THE DIFFICULTIES? HOW TO OVERCOME THEM ?

« ***The success of an LCA in renovation lies in the adaptability of the modeller to fill in the gaps in data collection and in his rigorous knowledge of the project.*** »

The success of a renovation LCA results simultaneously from good collection of input data, understanding of the issues and constraints, and an in-depth critical assessment. Unlike the LCA of a new project, which is based on DPGF (Global price breakdown), an energy calculation and CCTP, there is no formalism of the input data. The other difference is the overall knowledge of the project. Indeed, during a renovation LCA, it is necessary to understand the history and the role of each material and equipment constituting the project (removed or preserved, renewal since the creation of the building, etc.).

These two differentiating points constitute the major difficulties of this calculation method.
Regular exchanges with the design team, project management and managers are essential to understand the context and the existing state of the project. These interviews must be completed by a visit of the site which must be targeted according to the deficiencies of the data retrieved.
Finally, a regular practice of LCA (new and renovation) allows to become familiar with orders of magnitude in terms of results but also measurements and consumption.

Vision of a private housing actor

INTERVIEW WITH: **Jean - Eric FOURNIER**

Sustainability director at COVIVIO

HOW CAN LOW-CARBON RENOVATION BE ADAPTED TO A HERITAGE CONTEXT?

« **Favour renovation and fighting urban sprawl are at the heart of our battle.** »

In 2021, Covivio raised its target of reducing its greenhouse gas emissions between 2010 and 2030, setting it to -40% (compared to 34% initially planned).

On our commercial portfolio under direct management, we are aiming to align with a 1.5°C trajectory and achieve a "net zero emission" contribution by 2030. Today, more than 50% of our new operations relate to restructuration of existing buildings, with an objective of "zero net artificialisation", or even disartificialisation, to favour biodiversity, sequester carbon, and fight against the urban heat island effect. By combining reuse of the construction and circular economy, use of sustainable materials and installation of high-performance equipment for efficient building management, greenhouse gas emissions are reduced over the entire life cycle of the asset. We are using all the levers at our disposal to meet the challenges we have set ourselves.

CONCLUSION

CROSS VIEW

Vision of a public actor

INTERVIEW WITH: **Marjolaine MEYNIER-MILLEFERT**

French deputy of 10th circumscription of Isère

HOW TO MASSIFY LOW-CARBON RENOVATION?

« From the LTECV* law to the climate law, energy renovation is becoming a reality and constitutes an important step on the way to the low-carbon renovation of buildings which, we become aware, also serves health and quality of life, social and economic purposes. »

In order to better understand these co-benefits, the NZC Renovation study proposes a return on carbon investment indicator and five levers guiding the environmental orientations to be taken in a rehabilitation project. In a world where we are targeting 1.5°, using this information is vital for taking decisions and, to do this, the massive acculturation of construction actors for this type of modelling is essential.
Finally, today, our sector is facing a growing need of finding a workforce able to transform climate objectives into actual renovation sites. Addressing young people through a training offer in environmental renovation is another major challenge to respond to the climate emergency.

** LTECV : Loi de transition énergétique pour la croissance verte = Low for the energy transition and the green growth which was published in France in august 2015. Specifically, this law sets the objective of renovating 500 000 housing units per year.*