CONTACT

// ALL THE LATEST NEWS FROM CSTB RESEARCH

The CSTB's quarterly newsletter dedicated to the defining issues in the construction and development industry, taking a global and multidisciplinary approach.

CSTB
LE FUTUR EN CONSTRUCTION

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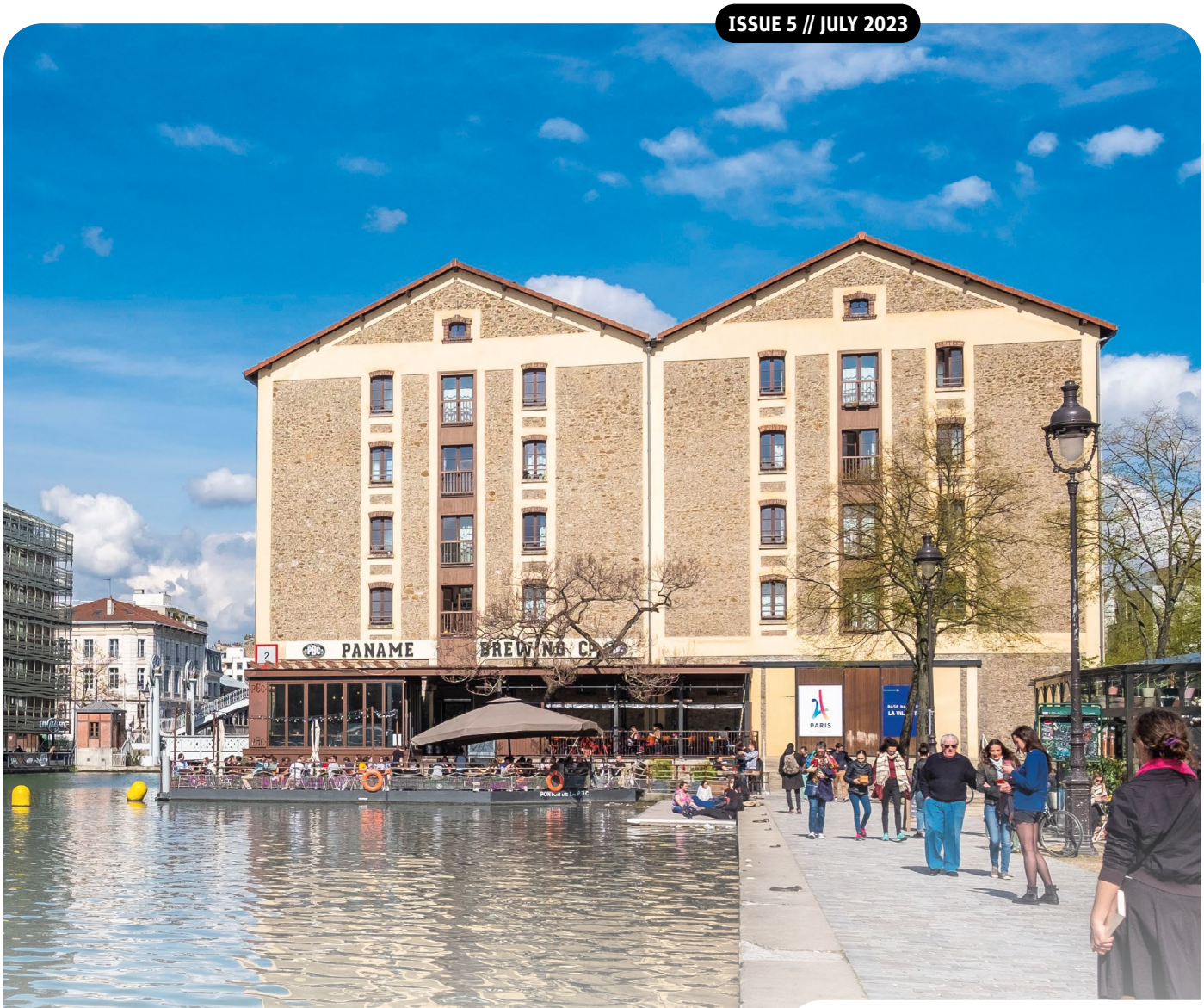


// HEADLINE NEWS

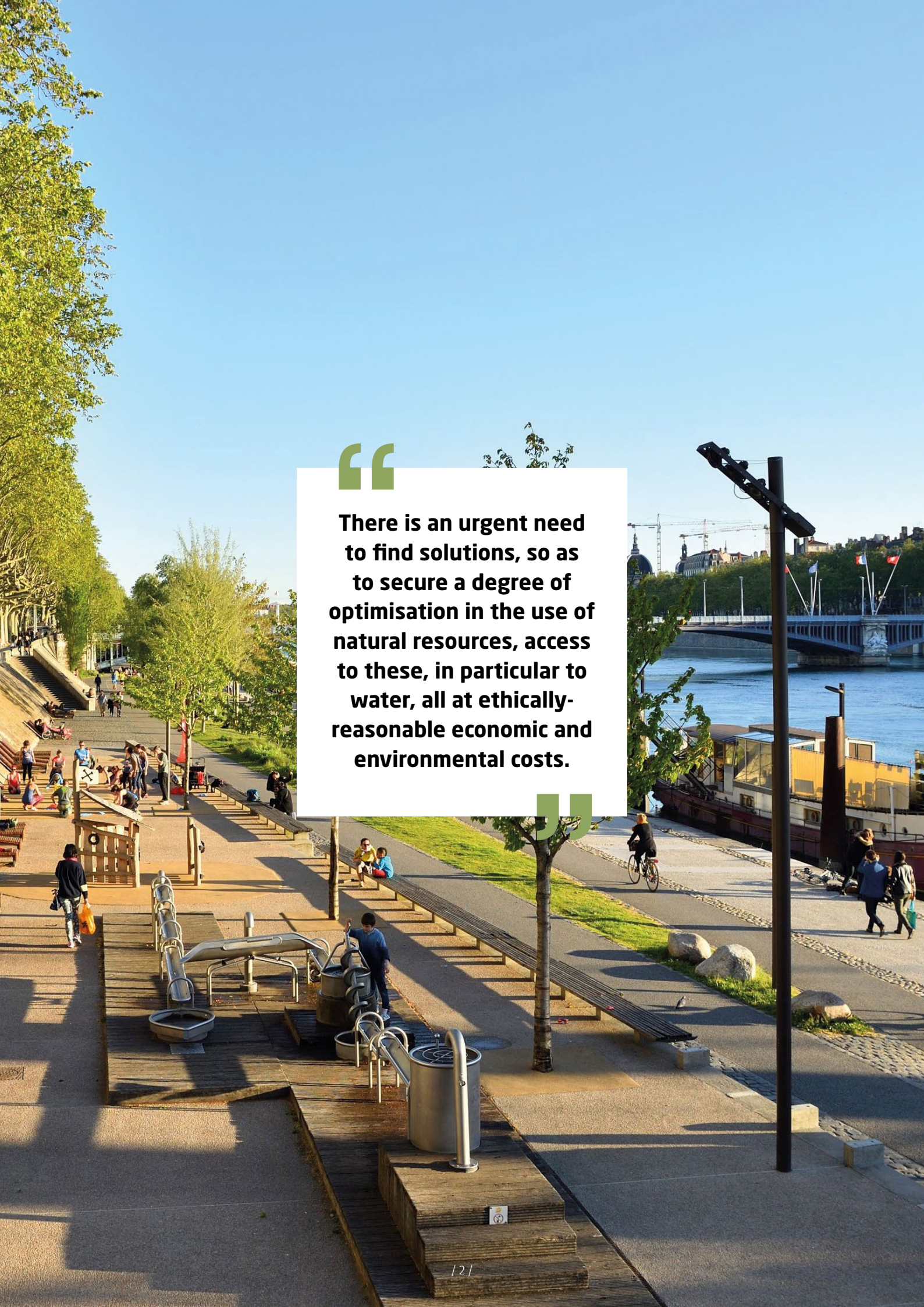
HOW CAN WE OPTIMISE THE USE OF RESOURCES IN THE CONSTRUCTION SECTOR?

One aspiration: Buildings and neighbourhoods that foster good community living

One imperative: Buildings and cities in the face of climate change

Works in progress: Renovation, reliability assurance in construction, and innovation

Means for action: The circular economy and resources for construction



> **There is an urgent need to find solutions, so as to secure a degree of optimisation in the use of natural resources, access to these, in particular to water, all at ethically-reasonable economic and environmental costs.**

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THE DEFINING ISSUES

by Hervé Charrue,
Deputy Director General,
in charge of Research
and Development

Buildings are essential to our everyday lives. Consequently, they lie at the heart of the challenges society faces. And yet, the complexity of its uses and interactions at every scale – from the building to the urban environment – whether socio-economic or technical, remains difficult to grasp in its entirety.

The newsletter CONTACT is precisely designed to throw light on this complexity and the scientific issues associated with it, in order to make the questions asked of research and the results it brings to the building and urban sector more accessible to all.

Climate change, the energy and environmental transition, the digital revolution and the necessary attendant shifts in society have prompted the CSTB to redefine its research around four strategic areas of action: an ambition, 'Buildings and neighbourhoods to foster good community living'; an imperative, 'Buildings and cities in the face of climate change'; projects, 'Renovation, reliability assurance in construction, and innovation'; and resources, 'Circular economy and resources for the building industry'.

Current developments in energy and the environment compel us to focus more specifically on these issues, and therefore on the levers we can activate to develop the circular economy and preserve resources, both of which are the themes of this first issue.

The "Circular economy and resources for construction" roadmap addresses major issues. The first is the reduction of pressures on the environment. In that it extracts the raw materials needed for the construction, renovation and use of buildings, as well as for end-of-life management, the construction industry is responsible for considerable environmental impacts. There is an urgent need to find solutions, so as to secure a degree of optimisation in the use of natural resources, access to these, in particular water, all at ethically-reasonable economic and environmental costs, to avoid the risk of increasingly frequent economic and regional crises.

The recent implementation of the Extended Producer Responsibility (EPR) system, made mandatory by the French Anti-Waste and Circular Economy Act (AGEC), alerts us precisely to the increased and imperative need for restraint in the use of resources, through better waste recovery and, by extension, the development of recycling, reuse and eco-design. These practices demand the creation of an ecosystem that involves all the players in the construction industry, taking into account each stage of the circular economy: from the identification of sources of Products, Equipment, Materials and Waste (PEMD) to the reuse of products in building projects or the recycling of materials in production chains to replace new materials.

They also raise numerous questions about the health viability, durability of performance and insurability of products that are reused or incorporate recycled materials.

All of these are issues on which the CSTB and its partners are working to respond to and usher in the massification of the circular economy. This assumes the removal of scientific, technical and regulatory obstacles, but does underline the fact that this movement is clearly underway.

A CLOSE-UP

by Alexandra Lebert,
Director of the Strategic Research Action Area

To address all the issues presented by Hervé Charrue in his introduction, the CSTB has made it a goal to help professionals move towards a circular economy by supplying them with new knowledge and objective metrics so that they can share common ambitions.

The approach draws primarily on the creation of methods, tools and guides, but also includes formalising protocols and factoring in experience from the ground. Concretely, it materialises as three complementary research programmes.

The purpose of the **Circular Economy and Design** programme is to develop conceptual frameworks and metrics to objectivise the deployment of the circular economy at different scales, and in particular to measure the efforts made by the respective players. The EC2 project, for example, carried out in partnership with the Alliance HQE and Evea, focuses on the development of indicators at the scale of structures. This programme rests on a thorough understanding of current and future material flows, via the tool BTPFlux in particular. As a robust tool, it meets the needs of developers, local authorities and asset and land managers, enabling them to prioritise, anticipate and determine a strategy with respect to the circular economy.

On a more operational scale, the platform PEMD makes it possible to identify deconstruction and renovation operations, as well as the flows of resources that are to be recycled. Developed by the CSTB, ad mandated by the public authorities, and set up to support the overhaul of the Waste Diagnostic into a Products, Equipment, Materials and Waste Diagnostic (PEMD), the platform is designed to enable smoother contact-building between the sector's players. Lastly, the CSTB also publishes guides to support the deployment of deconstruction practices with a view to reuse.

It develops methods and protocols for characterising the performance of products when they approach the end of their life cycle.

The subject of characterising performance over time, in the laboratory and on construction sites, is central to the **sustainability of component performance** programme. New products are emerging, and the compositions of material formulations (such as low-carbon concretes) are evolving. Laboratory measurements and accelerated ageing protocols need to be pitted against real-life observation and the future climate as projected.

> Through its partnership-based research, the CSTB aims to provide concrete and rigorous solutions for the widespread adoption of circular practices.

The water cycle is also a key factor in adapting to climate change, albeit subject to severe constraints. **The Water Management** programme deals precisely with the issues of restraint and knowledge of water consumption in buildings, as well as the qualification of characteristics (technical, sanitary, economic, appropriation by users) and protocols for the circular use of water at the scale of structures, neighbourhoods and catchment areas. Another area of focus is the maintenance and renovation of our water supply assets. Lastly, the CSTB is continuing its work on effluent treatment (particularly in non-collective sanitation) to improve water quality.

Inside the CSTB, these research programmes bring together a wide range of skills: economists, statisticians, experts on the environment and eco-design, life cycle analysis specialists, data analysts, chemists, specialists in the physics of materials, in air quality and in digital simulation, who experiment in the laboratory as well as on the ground.

Today, the subject of the circular economy is not only driven by research, but also by industrial companies, which have their products or systems assessed to remove the obstacles to reuse and recycling identified by project owners and contractors. Through its partnership-based research, the CSTB aims to provide concrete and rigorous solutions for the widespread adoption of circular practices.

HEADLINE NEWS

Reuse, as the spearhead of the circular economy

As a large consumer of resources, a major emitter of greenhouse gases and a producer of waste, the construction sector must step into the age of the circular economy and, in particular, build on one of its pillars: reuse.

Reuse makes it possible for resources to be used in a way that is largely decoupled from energy consumption or carbon emissions In that sense, it is the most far-reaching vision of the circular economy. Wrongly considered a new practice today, it is awakening public consciences and challenging the entire way in which we design and manage products, as well as construct buildings.

Pausing to look back at history

In the late 18th century, when structures were demolished, public calls for tender were issued: market players paid to recover the resulting materials. Over the next two centuries, this practice gradually fell into disuse and ultimately became the exception to the rule. Consequently, reuse was not given consideration when the modern-day interplay between construction sector figures and the related responsibility-sharing were developed post-war. The product standards, technical building requirements, construction insurance and, more generally speaking, all the enactments that govern the sector's functioning today, were set out without a thought for reuse. The current system, which until very recently rested on easy access to energy, mineral, metal and bio-sourced resources, is thus a historical parenthesis of sorts, which is now drawing to a close, with the re-emergence of reuse.

> "The current system, which until very recently rested on easy access to resources, is a historical parenthesis of sorts, which is now drawing to a close, with the re-emergence of reuse."

A still-marginal, but structuring practice

Considering reuse anew thus implies that all the rules progressively established over more than 70 years be challenged, through research in several directions:

- **what are the new methods for proving products to be high-performance and fit-for-purpose? How can health risks be reined in? How can we better anticipate future usages from as early as the product and equipment design stage?**

As all these questions indicate, reuse sparks us to look into the durability of product performance in the light of a new cycle: increasingly lengthy lifespans, measurement protocols for sites and in the laboratory, consideration of the future climate, etc. The dismantlability of building components also carries with it the topics of building reversibility, renovation with reduced waste production and eco-design with a view to possible reuse or recycling;

- **how can flows be traced and roles, responsibilities and opportunities shared within the new chains of players? How can we secure the match between supply and demand, and balance out business models, in an environment where the cost of materials has experienced a record-setting drop compared to the cost of labour?**

The data collected on the flows, current and future, of reusable, recyclable, and recoverable components are beneficial to the fabric of socio-economic players, the recycling industry and the public authorities. Organising the sector to better grasp these flows implies facilitating their capture, all the while reflecting on the initial dispersion of resources, the improvement in sorting levels at sites (whether construction, renovation or demolition) as well as on production, recycling and reconditioning practices;

- **what are the new metrics for characterising the impacts of reuse?**

If reuse is to come into massive use, all of these issues must be jointly addressed, taking an all-encompassing perspective. The responses to these structurally-defining questions will necessarily inform other circular solutions in the sector. A powerful catalyst, the massification of reuse will bring about that of the circular economy, which will in turn gradually impact the value chain as a whole.

INTERVIEW IN A FLASH

Interview with **Camille Golhen**, Head of the Circular Economy and Sector Analysis Division of the CSTB's Economy and Resources Department.

The CSTB is setting in motion to foster reuse

What are the defining issues in reuse today?

C. G. According to the European project Interreg FCRBE, after initial use, less than 1% of construction elements in north-western Europe are reused today. The aim of the new Extended Producer Responsibility (EPR) scheme, which was extended to the building sector on 1 January 2023, is precisely to gradually increase the proportion of reused products to 5% by 2028. In other words, the goal is to achieve a tenfold increase in reuse flows in just five years, for which purpose the sector will need to be completely restructured. Also endorsed by the RE2020, which does not include reused materials in the calculation of carbon impact, and fostered by the Products, Equipment, Materials and Waste diagnostic, the starting point for a true materials recovery strategy, reuse is emerging as a driving force for the circular economy. However, multiple obstacles - technical, logistical, economic and insurance-related - first need to be removed. Its development requires, for instance, the ability to identify the resource reservoirs available, which also implies structuring a collection, reconditioning and distribution network. It is also vital that the residual properties of reused products be characterised, so as to identify the presence of hazardous substances and to define, as is done for new products, rules for their implementation..

How are the sector's players and the CSTB taking action to meet the various challenges associated with reuse?

C. G. More and more players are taking the matter up, and developing tools and expertise to make it more widespread: contracting authorities incorporating reuse objectives into their contracts, project management assistants and consultancy firms specialising in reuse, physical reconditioning platforms and digital platforms bringing together supply and demand, etc. Anchored in a favourable regulatory environment, reuse is now being structured collectively, beyond these individual initiatives, with the creation of the Syndicat Professionnel du Réemploi dans la Construction (SPREC), for example. The CSTB is playing its full part in this dynamic. One year ago, it set up a new Economy and Resources Division (DER) for itself, divided into two teams, one dedicated to the Circular Economy and Analysis of Sectors, which aims to raise players' awareness in the face of today's challenges: ensuring availability of resources, making the transition from a linear economy to a circular economy and building economic models that can last. In this context, the CSTB proposes two major avenues for work: on the one hand, support and recognition for the processes of reconditioning platforms, with, in particular, the signing of a structure-building partnership with the Grand Paris metropolitan area; and on the other, the development of shared and recognised methodological guides for assessing performance with a view to reuse, materialised through the SPIROU Research Project (Sécuriser les Pratiques Innovantes de Réemploi via une Offre Unifiée - Securing Innovative Reuse Practices via a Unified Offer). Our aim is to create the framework that will enable us to move from a case-by-case approach to a standardised approach, and thus help us to massively expand our practices.

> "The aim of the new EPR sector is to gradually achieve 5% reuse by 2028"

These various lines of action in favour of reuse tap several areas of expertise within the CSTB. How does this cross-disciplinary collaboration play out?

C. G. The DER works in close collaboration with all of the CSTB's departments. Its action is aligned with the "Circular Economy and Design" research programme associated with the "Circular Economy and Resources for Buildings" strategic action area of the Research and Development Division. To produce the guides, the DER approached the various operational departments of the CSTB to set up a cross-functional organisation in project mode. The lead authors of these deliverables are either assessment engineers from the Soils & Coatings and Safety, Structures & Fire, or Climatology, Aerodynamics and Aeraulics Departments for structures and transport, or research engineers who benefited from the support of the latter. In addition, tests were conducted by CSTB's Health and Comfort department to characterise emissions of volatile organic compounds and formaldehyde on reused carpet tiles. All in all, more than half of CSTB's operational departments are involved in this work, with cross-fertilisation covering all the performance aspects (technical, health, economic, environmental, etc.) that must be taken into account when considering reuse.

RESEARCH PROJECT
BTPFlux

Estimating Product, Equipment, Material and Waste Flows from the Construction Industry

In practical terms, how does BTPFlux help the local authorities, land planners or heritage managers to define their circular economy strategy as applied to buildings?

As a tool for analysing the flow of Products, Equipment, Materials and Waste (PEMD) from buildings, BTPFlux helps decision-makers to better anticipate and understand flows in order to establish a circular economy strategy tailored to the specific characteristics of their territory. For this purpose, it is essential that the existing stock of buildings in a given territory and its dynamics be characterised by taking into account, for each year, the construction, deconstruction and renovation rates for each type of building, and thus quantify the amounts of WEEE generated and consumed by the latter. This is what BTPFlux proposes to do for each region of mainland France, with the possibility of integrating more specific regional features, such as major urban planning projects or the consideration of local recovery channels.

What other tools is it connected with?

To achieve the best possible characterisation of the building stock, BTPFlux draws on two other digital systems developed by CSTB, bringing together some of the most accurate and comprehensive databases in France:

- the National Buildings Database (BDNB), which provides information essential in estimating the materiality of buildings, such as the period of construction, the main use, and even the primary structural material or for instance the type of insulation;
- the tool TyPy, in which a database of generic building components is embedded.

Each component contains a set of properties that can be used to perform different types of calculation (thermal, life cycle analysis, quantity of PEMD, etc.). Thanks to a range of algorithms, TyPy can 'reconstruct' a building from a limited amount of information and thus characterise its materiality.

Édouard Sorin,
Research and Expertise Engineer, CSTB Economics and Resources Department

By coupling the information from the BDNB with the power of TyPy, BTPFlux offers an extremely detailed characterisation of the materiality of the existing building stock in mainland France. However, as with any modelling exercise, this approach is not perfect, as the estimates made by BTPFlux are much more reliable with residential buildings than non-residential buildings. Better recognition of the latter is one of the development objectives planned for this year.

What are the prospects for this tool?

As the materiality of buildings is described at the level of the components, BTPFlux has the potential to offer an estimate of the flows for each associated category of waste and for each potentially reusable product or equipment, which is perhaps its greatest strength. At present, we have only integrated a bit more than ten categories of waste, but developments are underway through a project carried out in partnership with such players as the Île-de-France Region to increase this to around forty categories and achieve a granulometry precise enough that we can build the most effective circular economy strategy possible. Linkages with the future nomenclature of the PEMD platform are planned.

Having focused our efforts on flows arising from the existing stock, we have also initiated work to integrate, in the near future, flows from new construction, as these are not only the main consumers of materials, but also producers of waste. There are many further opportunities for development (improving the accuracy of the model by integrating more specific data, linking it with recovery channels, extending the scope taken into account, etc.), which will be refined in the light of the needs reported by users and their stakeholders.

RESEARCH PROJECT EC2

Assessing circularity at the scale of structures

Gwenn Le Seac'h,
Head of Quality, Environment and Energy at Alliance HQE

and **Élodie Macé,**
Circular Economy Project Manager at CSTB's Economy and Resources Department

EC2, a tool designed by Alliance HQE and CSTB to analyse the circularity of components in new buildings, is currently under development. In what context was it developed?

E. M. Mechanisms designed to stimulate the circular economy have been in place in France and Europe for several years, and particularly in the construction sector. However, the harmonised methods they use to measure the environmental impact of projects focus on the carbon indicator and do not enable us to assess a project's contribution to the circular economy. The environmental and health declaration forms (EHDS) and product environmental profiles (PEP) do, in contrast, contain materiality indicators that make it possible to translate certain aspects of the circular economy, but are currently little used.

The HQE Alliance has been working on the circular economy since 2017, and in particular has been testing out a method for analysing material flows on several pilot operations developed by Evea and Cerqual in order to express circularity indicators for construction projects.

This testing has attracted great interest from players in the sector, but the method proved time-consuming, mainly due to the lack of a suitable tool. The aim of the EC2 project is thus to facilitate the deployment of this method by developing an ad hoc tool. The existence of the INIES database, its expansion accelerated by the RE2020 and the regulatory requirement to carry out life cycle analyses are a real opportunity for large-scale deployment.

What are the key principles underpinning the tool?

EC2 draws on the regulatory RSEE files (standardised summaries of energy and environmental studies) produced within the framework of the RE2020. The aim is therefore to base the process as much as possible on information that has already been produced elsewhere. Connected to the INIES database, it can automatically make use of all the information in the environmental declarations of the components of a project, particularly those pertaining to material flows. Indicators on incoming secondary, reused or biobased materials, outgoing materials for recycling or reuse, and transport flows are calculated and then reported in the form of Sankey diagrammes.

An initial test phase of this tool was launched in December 2022. What lesson have you learned from it?

G. L. S. The aim was to carry out a test under real-life conditions with future users (mainly project managers). The information they escalated enabled us not only to correct certain errors in the IT, but also offer additional features to better meet their needs.
In addition, the testers appreciated the time they saved compared with the initial method, how simple and intuitive the tool is to learn, and its visual identity, which provides an attractive showcase for projects.
However, their feedback showed that the method's end-purpose needs explaining, specifically on how to understand the indicators, as well as training and benchmark figures at the project level, as the results can sometimes seem abstract.
The experiment also revealed an interest in other development points for multiple factor analysis, to go into greater depth on certain scenarios, all of which open up new development prospects for us to envision.
It is also important to specify that, when the test was launched, few projects had complete RSEEs, as the RE2020 had been active for only a few months. Likewise, the results are not very representative when projects are based primarily on environmental data by default. Improvements are expected on all those aspects, given the context of the RE2020 and the continuing growth of available data.

What are some of the tool's other prospects for development?

To respond to the need for training and reference values, we plan to launch a large-scale HQE Performance test, over an extended period, so that as many projects as possible can enter the EC2 tool and thus provide us with an observatory. The aim of this test would be to fine-tune a set of circular economy indicators so that they can be grasped by as many people as possible. It would also enable the functionalities of the associated digital tool, developed by the CSTB, to be finalised.

Beyond the issue of the reference values needed to foster eco-design, there are numerous possibilities for future development, including adapting the scenarios to the specific reuse of each project or adapting them to renovation projects.

Once these reference values have been established, we could consider incorporating the method into the HQE reference frameworks.

RESEARCH NEWS

Reuse as a lever in the decarbonisation roadmap for the construction industry

Propelled by recent regulatory changes (RE2020, the Extended Producer Responsibility (EPR) system for the building industry, the PEMD diagnosis) and great enthusiasm from project owners and local authorities, reuse is about to enter a phase of massification. The EPR sector has established a target of increasing reuse flows tenfold over the next five years, so that they account for 5% of construction products and materials in the building sector by 2028.

In order to make these practices more secure and thus more widespread, it will be necessary to specify the protocols for assessing the quality and suitability for reuse of building materials in order to guarantee their insurability, and to support the structuring of the sector and the development of reconditioning centres.

We also need to plan for the reusability of future structures by anticipating the reuse of materials and components as soon as they leave the factory, by optimising their future re-usability and the traceability of materials. The CSTB is working to implement each of these actions through its research and assessment activities in order to clarify the best practices in reuse and facilitate the division of responsibilities between the various players, a prerequisite for the massification of practices.

ROADMAP
decarbonising the construction industry

Ecoscale: characterising the circularity potential of construction products, equipment and materials

Ecoscale is the environmental assessment of circularity developed by the CSTB. It is underpinned by solid scientific foundations and is in line with one of its four roadmaps for research: *"Circular Economy and Resources for the Building Industry"*, in particular the characterisation of eco-design at the product/material level.
Its objective is to characterise the circularity potential of construction products, equipment and materials in a robust and independent manner.

Assessment is structured around four indicators covering the full life cycle of a product or piece of equipment:
- the recycled and renewable material content indicator;
- the dismantlability indicator;
- the reusability indicator;
- the recyclability indicator.

These indicators are assessed by analysing 17 criteria covering all the different characteristics that have an impact on circularity. The criteria are then weighted according to their degree of importance, to make up the overall score for the indicator. Ultimately, each product is given one of five ratings (A, B, C, D or E) depending on the score it achieves for each of the four indicators. The results of the assessments are entered into a database accessible to the public, so that construction industry players can be assisted in identifying circular economy products and equipment.
This environmental assessment of circularity is scientifically grounded and carried out by an independent player so as to limit the effects of communication and facilitate the use of circular products and equipment.

VIEW THE MOTION DESIGN

CSTB'Lab: the circular economy is inspiring start-ups

At the CSTB'Lab, the circular economy is also a hot topic. Six start-ups are currently being mentored by CSTB experts and are offering a variety of innovative solutions to meet the challenges of preserving resources in the building sector:
- Revibat offers rigid insulation panels made from recycled glass wool waste;
- Cycle Terre produces a range of materials from raw earth;
- Ostrea Design develops a material based on recycled shells for the indoor and outdoor furniture sector;
- Raedificare helps players with the identification of reusable materials and the incorporation thereof into the design of their projects;
- Metamo offers a range of services for transforming metal elements into street furniture;
- Skop enables resources to be inventoried using image recognition, managed and directed towards the relevant channels.

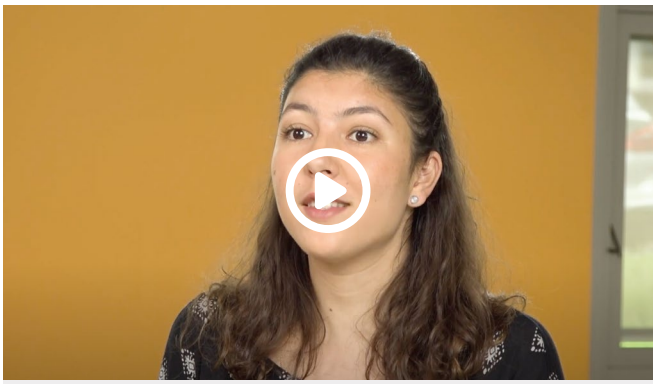
The CSTB'Lab is operated in collaboration with Impulse Partners..

The PEMD platform: when research leads to regulation

The Products, Equipment, Materials and Waste (PEMD) diagnosis will replace the Waste diagnosis from 1 July 2023. This change comes as a result of the public authorities' determination to deepen the initial diagnosis and make it the solid foundation for a genuine materials recovery strategy.
The objectives are to boost reuse and recycling, and to ensure that material sources are made visible upstream of dismantling operations, so that supply and demand can be better matched.
After consultation with industry players, this anticipation led to the introduction of a dedicated regulatory platform, the development of which was entrusted to the CSTB.
The CSTB drew on research conducted in parallel about the state of knowledge of PEMDs, formed by existing buildings, their location, their potential for reuse and recycling, the quantities historically used and their placement in the structure, as well as an analysis of the structuring of the recovery channels and their economic models.
By making material sources more visible upstream from the launch of removal contracts, the PEMD platform will give sectors more time to coordinate and structure optimal recovery of their resources.

WHAT'S NEW, PhD STUDENT ?

Thesis: Development of indicators of pressure on mineral and metal resources for a performance-based approach to the circular economy



Nada Bendahmane,

École des Mines de Saint-Étienne

PORTRAIT | DOCTORAL STUDENT | THÈSE

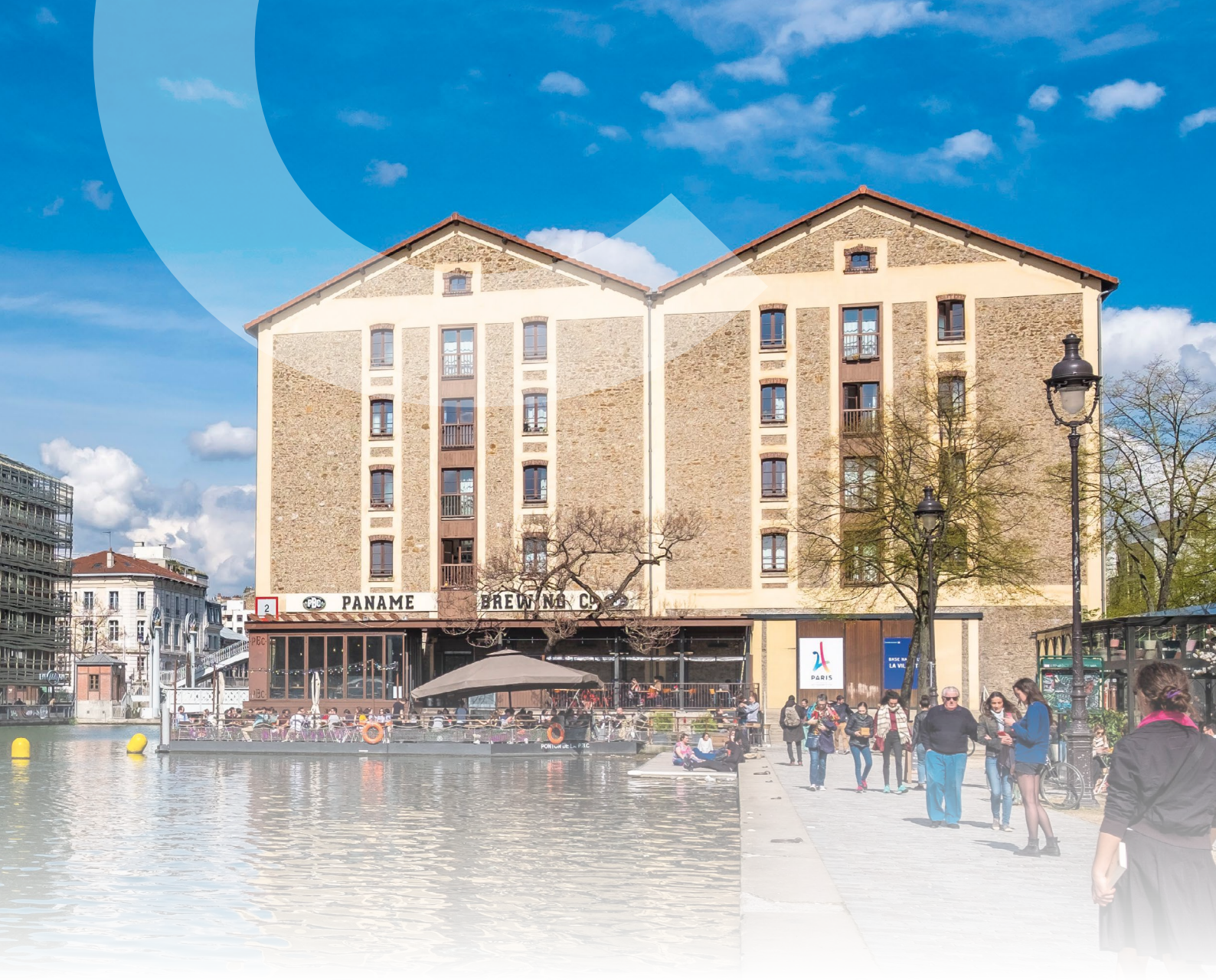
"I served an internship at CSTB Grenoble to produce default environmental data for construction products and building equipment to pave the way for the RE2020. Although I was far removed from the field of research, the talks I had with the other doctoral students and the support I received from the CSTB Environment team during my internship made me want to continue in this direction. Working on a thesis at CSTB means being able to quickly come into contact with the field and be constantly in touch with the concrete needs of the players involved."

ENJOY THE INTERVIEW IN VIDEO FORM

RESEARCH: THE MAGIC BEHIND THE CURTAIN

The sustainability of building component performance: the role of laboratory ageing tests, by Rémi Bouchié, Head of the Research and Expertise Division in the Building Envelope Department, CSTB and Yann Faisant, Head of the Assessment Division of the Windows and Glass Division, CSTB.

ENJOY THE INTERVIEW IN VIDEO FORM



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