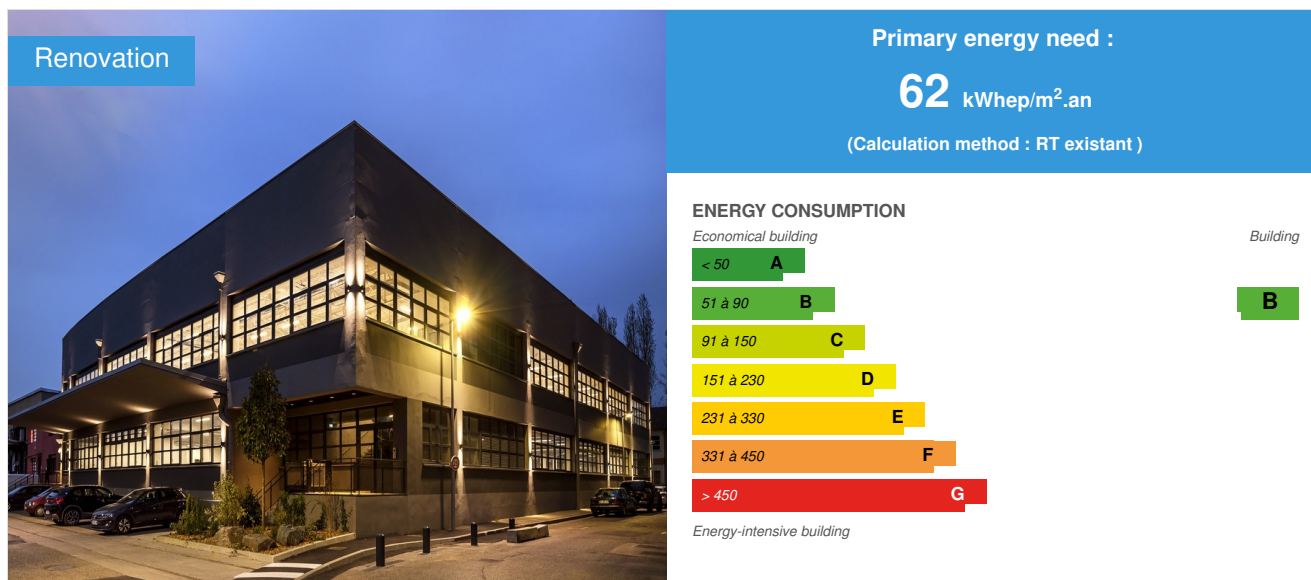


## Green Factory building

by Marc Campesi / 2021-03-25 12:41:57 / France / 10698 / FR



**Building Type :** Other building  
**Construction Year :** 1950  
**Delivery year :** 2021  
**Address 1 - street :** 24 rue Joannes Masset 69009 LYON, France  
**Climate zone :** [Cbc] Mild, dry winter, warm and wet summer.

**Net Floor Area :** 2 870 m² SHON RT  
**Construction/refurbishment cost :** 3 000 000 €  
**Cost/m² :** 1045.3 €/m²

### General information

This building was awarded the Sustainable renovation Grand Prize of the Green Solutions Awards 2020-21 at the international level; and a mention for the same category at the national level.

Located in the former industrial suburb of Lyon, which has been undergoing major changes since the 1990s, Green Factory is a mid-twentieth century building combining a steel frame and concrete structure (posts & beams & ribbed slab). The building was poorly insulated, very energy consuming and not cooled. It was connected to a collective gas boiler room for part of the premises, with additional electric convectors in the offices. It had been disused for several years because it no longer met the comfort and energy criteria that are the norm today. Its roof was made of asbestos cement and rested on a metal frame hidden by a false ceiling. The premises were poorly lit and unattractive and not accessible. The height under the roof varies from 5 to 6.50 m on the first floor and 3.50 m on the ground floor. The building has a floor area of approximately 3,000 m² on two levels.

This rehabilitation is part of a global sustainable building approach that meets the challenges of the coming decades. Social and health issues, the impact on the local economy and the environment, and CO2 emissions are considered with equal value, considering that the construction world should be anchored in a more systemic approach.

The cultural dimension is present in the project. It is reflected in an architecture that preserves and enhances the industrial past of the Vaise district. This district of Lyon has undergone massive restructuring over the last few decades. Its industrial heritage has been erased in favour of new buildings that meet contemporary standards. Preserving the history of the area was one of the challenges of this project. The history of the district will be retraced in the common areas of the building.

Some figures after rehabilitation:

- Ceiling heights of 5 to 6.5 m on the first floor and more than 3.2 m on the ground floor, a heated and cooled volume of more than 12,000 m<sup>3</sup>, in line with the desire to leave the old framework visible.
- An energy saving of more than 60% compared to the initial situation (heating only) including heating and cooling. For the regulatory uses, the estimated consumption is 62 kWhEP/m<sup>2</sup>.an, i.e. -29% compared to the requirements of the BBC renovation label, i.e. less than 9€ +/- / m<sup>2</sup> .an with a Kwh at 15 c excluding subscription, with an average ceiling height of more than 4 m Heating alone represents 13.50 kWhEP/m<sup>2</sup>.an.
- The heating and cooling of this large volume is provided by a thermodynamic double flow ventilation (CTA). This AHU is coupled to a heat pump, and the air is diffused by perforated ducts. The perforated ducts with MIX-IND® technology, also called PULSEURS®, do not "throw" the supply air into the zone to be treated, like all diffusers, but create on their axis a "pressure field" capable of putting in controlled movement the whole mass of ambient air. Online monitoring of consumption is available to users.
- CO<sub>2</sub> emissions are reduced by a factor of 20: 2 kgCO<sub>2</sub>/m<sup>2</sup>.year in the operating phase.
- Air permeability (Q4pa-surf in m<sup>3</sup>/(h.m<sup>2</sup>) is 1.14 (reference value is 1.7 for this type of building).
- An air quality approach with the installation of sensors with an e-mail alert system (fine particles, noise, hygrometry, temperature, CO<sub>2</sub>). Educational support is offered to users for the interpretation of measurements and to propose corrective actions. The double flow ventilation unit is equipped with a filtration of the incoming air and a plate exchanger to avoid recycling the indoor air (reduction of virus diffusion).
- x 2 of the initial glazed surface, i.e. 14% of glazed surface in relation to the thermal floor area (shon RT), including the creation of a central glazed patio for access to natural light and user enjoyment.
- 160 m<sup>3</sup> of hemp and flax insulation and 90% French-made products and equipment
- Recycled materials (acoustic panels, terrace floor and social areas)
- More than 1500 m<sup>2</sup> of restored and preserved steelwork
- More than 20 local companies and design offices
- 1 NF tertiary building label associated with the HQE peqa approach (7 associated qualities) + BBC renovation in the process of being awarded, as of 20 March objectives achieved and exceeded.
- Nearly 3,000 m<sup>2</sup> of flexible surface area that can be adapted without major transformation
- 1 quality of use and educational approach: comfortable and bright social spaces (two comfortable terraces), electric vehicle charging points. Online access to energy consumption and air quality. A building accessible to all thanks to two facilities (PRM platform and lift).

## Sustainable development approach of the project owner

The Lyon developer Marc Pigeroulet d'Arioste has been involved for a few years in a sustainable building approach. In 2016, during the renovation of its headquarters in Lyon, it had its offices certified with the obtaining of an NF Bâtiment durable & BBC Rénovation label. It continued on this path by offering its customers renovated office buildings or upgrades to buildings with high environmental added value. These latest achievements are in line with the ambition of the 2019 tertiary decree resulting from the Elan law and the 2050 objectives in terms of energy performance. For Green Factory, he shared and encouraged the commitment of the project management team to make this project an exemplary and reproducible achievement. Marc Pigeroulet is very attached to the architectural enhancement of old real estate heritage. This very laudable desire requires a fine and creative architectural approach to be compatible with the technical constraints linked to energy issues. Sustainable rehabilitation is the challenge for the coming decades. It must also be undertaken with respect for the historical, industrial and residential heritage.

## Architectural description

This rehabilitation is anchored in a **global sustainable building approach** considering social, economic and environmental issues with the same value. **The architectural project evokes the industrial past of this district located in the North West of the center of Lyon.** In addition to the cultural and environmental aspects, the human aspect of which the well-being of the users is one of the driving forces of the project. The architectural and technical solutions retained offer a reasonable cost and are reproducible for this type of building. The bioclimatic dimension is developed in the other sections.

## If you had to do it again?

This project lacks the renewable energy contribution of a photovoltaic power plant (in self-consumption) but the overload induced by this type of equipment was not compatible with the existing framework. The green spaces have been enhanced but it would have been possible to bring more permeability to the site by depositing the asphalt mixes in the parking lots and substituting them with permeable soil (gravel on or bee).

## Photo credit

Semaphore Lyon and Marc Campesi

## Stakeholders

## Contractor

Name : ARIOSTE

Contact : M. PIGEROULET Marc

<http://www.arioste.fr>

## Construction Manager

Name : MARC CAMPESI - DIAGONALE CONCEPT

Contact : MARC CAMPESI

<http://www.diagonaleconcept.com/>

## Stakeholders

Function : Assistance to the Contracting Authority

MARC CAMPESI - DIAGONALE CONCEPT

M. CAMPESI Marc

<https://www.diagonaleconcept.com/>

Client assistance

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Function : Thermal consultancy agency

SEQUOIA

M. DEHAN Bruno

In charge of certification monitoring

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Function : Thermal consultancy agency

EMCON

M. DUPRE David

thermal and STD studies

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Function : Designer

CECILE REMOND architecte du patrimoine

Mme REMOND Cécile

<https://app.bam.archi/architecte/agence-cecile-remond>

Prior declaration for modification of facades & roofs in collaboration with Ressources Green Building rgb

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Function : Company

INDUSTHERM

M. BULLY Géraud

Heating-Cooling-Ventilation

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Function : Company

JLC MENUISERIE

M. ALEX Laurent

Interior-exterior carpentry

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Function : Company

DDSG

M. DA SILVA GOMES Denis

Plastering; painting ; false ceilings

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Function : Company

CJL ELECTRICITE

M. THENAULT David

Electricity-strong currents

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Function : Company

AS PLOMBERIE

M. GERVAIS Sébastien

Function : Company

PIMENTA JOAO

M. PIMENTA Joao

Masonry

## Type of market

Realization

## Energy

### Energy consumption

Primary energy need : 62,00 kWh/m<sup>2</sup>.an

Primary energy need for standard building : 127,00 kWh/m<sup>2</sup>.an

Calculation method : RT existant

Breakdown for energy consumption : heating 4.5 kWhEF / m<sup>2</sup>.year / cooling 7.6 kWhEF / m<sup>2</sup>.year / ventilation 3 kWhEF / m<sup>2</sup>.year / AUX 2.3 kWhEF / m<sup>2</sup>.year / lighting 6.6 kWhEF / m<sup>2</sup>.year

Initial consumption : 167,00 kWh/m<sup>2</sup>.an

### Real final energy consumption

Final Energy : 24,00 kWh/m<sup>2</sup>.an

### Envelope performance

Envelope U-Value : 0,34 W.m<sup>-2</sup>.K<sup>-1</sup>

More information :

The existing building is a concrete post-beam structure with a concrete ribbed floor between levels. The existing roof was made of asbestos cement, it was replaced by an insulated steel tank cover (16 mc) and waterproofed so as not to overload the preserved metal frame. The building is insulated on the ground and on the walls (14 cm of hemp). The exterior insulation was not used to preserve the industrial character of the building. The interior insulation in hemp & linen contributes to the thermal phase shift (+10 hours in front of the opaque parts). The solar factor g is 0.63 to reduce the greenhouse effect. The inertia is provided by 1500 m<sup>2</sup> of concrete slab kept visible between level.

Indicator : I4

Air Tightness Value : 1,14

### More information

Equipment start-up on March 10. Observation set at 19 °, interior temperature above 21 ° without internal contributions from PCs and users. First return of monitoring July 2021 (heat wave period)

## Renewables & systems

### Systems

Hot water system :

- Individual electric boiler

Ventilation system :

- Double flow heat exchanger

Renewable systems :

- Heat pump

Renewable energy production : 50,00 %

Other information on HVAC :

Double flow thermodynamic double flow coupled to a heat pump. Diffusion by rigid stainless micro-perforated induction ducts allowing a homogenization of temperatures and reduced air mixing rates (less consumption).

VRV equivalent system of the HRV type variable speed COP from 3.5 to 4.5 and the ER 2.7 to 4. Comfort temperature from the maximum STD 28 ° with possible

overshoot limited to 2 (HQE peqa label objective 3.5%)

[Solutions enhancing nature free gains :](#)

En été : Vitrages solaires (fs=0.51) et fenêtres ouvrantes pour ventilations passives sur 3 faces. Inter saison et hiver : grande surface vitrée 14% / surface thermique ( apport gratuit + lumière).

## Smart Building

[Users' opinion on the Smart Building functions :](#)

The building is monitored to monitor energy consumption and air quality (PM1, PM 2.5, CO2 hygrometry) associated with noise and light comfort. Email alerts inform users if reference thresholds are exceeded (OQAI, Ademe, etc.).

## Environment

### Urban environment

Green factory is located in a former industrial suburb of the 9th arrondissement of Lyon, a district which underwent a profound transformation from the 1970s. A few rare industrial or artisanal blocks have survived urban renewal operations: a real cleaning up district leaving little room for the district's rich industrial past and its soul. Public facilities have accompanied this change including the metro and an urban transport hub less than 12 minutes walk from Green Factory. Vaise SNCF train station is a 15-minute walk away. The entrance to the Paris motorway 5 minutes away.

Within the perimeter of the building, there are service, craft, industrial and catering activities.

## Products

### Product

Hemp and linen insulation

Biofib

## Costs

### Construction and exploitation costs

[Renewable energy systems cost](#) : 350 000,00 €

[Cost of studies](#) : 90 000 €

[Total cost of the building](#) : 3 000 000 €

[Additional information on costs](#) :

Double thermodynamic flow including heat pump and micro-perforated air distribution ducts

## Health and comfort

### Indoor Air quality

The project is subject to an air quality process as part of its certification. It was reinforced by making companies aware of the process and a contractual commitment to use materials or equipment with reduced VOC emissions.

In addition, the building is equipped with a sensor with alert thresholds informing occupants if the values exceed the values recommended by the OQAI. A so-called corrective action procedure will be given to users. Each glass unit has openings to complete the double flow ventilation, which is itself equipped with filters.

DETAILS OF MEASURES:

- ▼ The temperature is measured in degrees centigrade.
  - ▼ Relative humidity is measured in percentages.
  - ▼ Brightness is measured on a scale of 0 to 1000, where 0 is darkness (approximately 1 lux) and 1000 is the illumination equal to 100 lux.
  - ▼ The sound level is measured by a microphone circuit, on a scale from 0 to 1000.
- Readings are not calibrated. To find an equivalence scale, a noise value of 500

corresponds to approximately 60 dB.

▼ CO2 is measured in ppm, on a scale from 0 to 10,000.

▼ Fine particles measured PM1 and PM2.5 in  $\mu\text{g} / \text{m}^3$ , on a scale from 0 to 1000.

Temperatures will be between  $21^\circ + -2^\circ \text{C}$ .

Relative humidity between 40% and 70% (NF X 35-102 and NF EN ISO 7730).

## Comfort

### Health & comfort :

The quality of the lighting is the subject of a label target.

The initial glazed surface was doubled to reach 14% of the thermal surface.

Considering the depth of the building, a central patio was created to provide additional natural light in the central areas, in particular on the ground floor.

The building has large caps of 3 to 4m above the ground floor on 2 east and west facades.

The solar factor of the glazing and light transmission allows a fair balance between solar protection in summer and natural light (see energy section)

### Calculated indoor CO2 concentration :

Le système de ventilation double couvre les besoins de renouvellement en lien avec les effectifs. Des capteurs de CO<sub>2</sub> avec des seuils d'alertes permettent aux usages d'être acteur de la qualité de l'air en aérant de manière passive et en ouvrant leur fenê

### Measured indoor CO2 concentration :

Un capteur par niveau est mis en place avec un seuil d'alerte à 1000 ppm.

**Calculated thermal comfort :** 28° en été avec un dépassement inférieur à 2% et en hiver température de consigne  $21^\circ + -2^\circ \text{C}$  , inoccupation 18° calcul avec outil STD Pleiade

**Measured thermal comfort :** Des capteurs de température vont permettre d'analyser le comportement du bâtiment et d'adapter les équipements et le comportement des usages qui auront la possibilité d'accéder à toutes les données de température et d'hygrométrie.

### Acoustic comfort :

In terms of acoustics, the project meets the requirements of HQE targets:

Some numbers:

- insulation against airborne noise is 45 DnT, A, tr measured against 30 required by the label. A first testifies to a visitor Léa: "We see the train passing but we do not hear it.", The railway line is 25 meters away.

- noise of the air supply system 37 DnT, A, tr against 43 requested by the label

**Daylight factor :** >1.2 dans 80% des zones de 1 rang

## Carbon

## GHG emissions

**GHG in use :** 2,00 KgCO<sub>2</sub>/m<sup>2</sup>/an

**Methodology used :**

DPE

**GHG before use :** 20,00 KgCO<sub>2</sub> /m<sup>2</sup>

**Building lifetime :** 50,00 année(s)

**, ie xx in use years :** 10

DPE calculation RT

## Life Cycle Analysis

**Eco-design material :**

- Hemp & linen wall and partition insulation

- Floor on floor insulation: 30 mm chipboard preferred to cement screeds

- EKOE acoustic insulation in recycled PVC

- Recycled PVC terrace slab

No false ceiling

## Contest

## Reasons for participating in the competition(s)

**"To turn this energy-intensive and uncomfortable industrial wasteland into a pleasant place to live and work in all seasons. To respond efficiently to the environmental challenges of the next few decades by proposing an efficient, frugal rehabilitation that respects the building's industrial past and its environment. Rehabilitate, conserve, enhance: these are the strong points of the project."**

The strong points of this eco-committed renovation:

- The industrial character of the building is preserved and enhanced in relation to the history of the district without altering the environmental performance. The old metal framework has been restored and enhanced and is now part of a large heated (maximum height 6.5m) and cooled volume with reduced energy consumption. The bays created and replaced are efficient, and were studied by a heritage architect, a partner in the project, to preserve the overall architectural quality of the building.
- The project is part of an eco-responsible approach with the NF Batiment Tertiaire label associated with the HQE Peqa approach (associated qualities: BBC renovation 62 kWhEP/m<sup>2</sup>.an + summer comfort + indoor air quality + visual atmosphere + acoustics, + quality of construction and ease of maintenance) currently being validated. All the objectives of the label are met and exceeded.
- A thermodynamic double flow ventilation system provides heating and ventilation with a very efficient diffusion process: perforated ducts with MIX-IND® technology, also called PULSEURS®. They do not "throw" the supply air into the area to be treated, like all diffusers, but create on their axis a "pressure field" capable of putting in controlled and gentle movement the whole mass of ambient air. This process is very suitable for large volumes.
- Biosourced materials (160 m3 for the insulation of the walls in 14 cm of hemp&linen, wooden floor) were preferred.
- Circular economy: the terrace floors and acoustic insulation are recycled.
- Carbon footprint: in addition to dividing CO<sub>2</sub> emissions by 20 (see studies), products manufactured in France were favoured, such as external joinery, insulation, HVAC, paint, etc. 100% of the companies, design offices and architects are local VSEs. All of them are committed to an ecological contract to ensure quality. 90% of the companies present have already taken part in our on-site awareness training (life cycle analysis and indoor air quality).
- An air quality approach has been introduced that goes beyond the requirements of the label. In addition to the A or A+ health label required for all products, the double-flow AHU unit is equipped with filters but also a plate heat exchanger without recycling the extracted air and the incoming air, reducing the diffusion of viruses or bacteria. The micro-perforated hot and cold air distribution ducts are metallic (rigid) for easy cleaning (see photos).
- The building is monitored and alerts are triggered when reference thresholds are exceeded (air quality, temperatures or energy consumption). A performance monitoring subscription and recommendations for corrective action is offered to future users of the site. Main IAQ measurements: fine particles, CO<sub>2</sub>, temperature, light, noise. Energy measurements (regulatory and all uses).
- Mobility and accessibility: 20 electric vehicle charging points are available to site users. Bicycle and motorbike spaces are installed. The building is accessible to all with a PRM lift to access the ground floor, which is elevated. A lift provides access to the first floor.
- Flexibility of use: the building and equipment are designed to adapt to changes in use or to a division into 2 or 4 lots without major modifications in order to reduce the carbon impact of changes in layout that are quite common on these large platforms. Some examples: high current braids that can be connected at any point under the technical floor, lighting rails on which any type of source (spotlights, LED strips, etc.) can be simply clipped and antennas created at 90°, an HVAC network designed to be divisible with 4 technical rooms.
- Biodiversity and social spaces: Each green space in the outdoor areas has been re-planted with a greater diversity of species.
- Bright and pleasant social spaces on the ground floor are illuminated by a 50 m2 skylight created in the roof and slab of the first floor. On the ground floor, a covered area opening onto a green space has been created for breaks and informal meetings.

### Some figures

Ceiling height of 5 to 6.5 m on the first floor and more than 3.2 m on the ground floor and a volume of approximately 12,000m<sup>3</sup>.

Energy savings of 60% compared to the initial situation (heating only) with heating and cooling, i.e. 62 kWhEP/m<sup>2</sup>.an, i.e. -29% compared to the requirements of the BBC renovation label, including less than 13 kWhEP/m<sup>2</sup>.an for heating only. Complies with the tertiary sector decree and the 2050 objective.

120 ml of high performance rigid air supply ducts, soft and silent flow, MIX-IND® technology.

CO<sub>2</sub> emissions divided by 20 (20 to 2 kgCO<sub>2</sub>/m<sup>2</sup>.an) according to DPE.

Air permeability (Q4pa-surf in m<sup>3</sup>/(h.m<sup>2</sup>)) is 1.14.

14% glazed area in relation to the thermal floor area (shon RT).

160 m<sup>3</sup> of hemp insulation.

1500 m<sup>2</sup> of restored and preserved steel structure.

0 m<sup>3</sup> of recycled air with a plate exchanger on the thermodynamic double flow ventilation.

6 air quality and comfort measurements (fine particles Pm<sub>2.5</sub> and Pm<sub>1</sub>, CO<sub>2</sub>, hygrometry, temperature, noise level) by sensors on each level. Automated alerts.

2 continuous energy consumption measurement sensors (all uses and regulatory) with live and online display. Monitoring with automatic alerts in case of significant deviation from forecasts.

More than 20 local companies and design offices.

## Building candidate in the category



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