CASE STUDY

LIVE IN POSITIVE ENERGY

The Mixed-Use HIKARI Complex: A Successful International Collaboration Delivers Positive Energy

Completed in 2015, the HIKARI buildings are one of the first large scale mixed-use positive energy building (PEB) complex in Europe. The buildings proved the viability of ambitious energy targets by combining cutting edge energy generation, saving and storage technologies and benefiting from consumption peaks of the various uses controlled by an innovative building energy management system.

The HIKARI complex is located on the most emblematic site of the new Confluence District, a mixed-use development site that brings together commercial, residential and leisure functions in the South West of the centre of the French City of Lyon. Located at the corner of the Charlemagne course and overlooking the new Place Nautique, the complex is in the centre of a vibrant new urban development area that was conceived as a “smart city” prototype.

HIKARI is a great collaboration example, harnessing public-private synergies between France and Japan. The partnership provided the necessary governmental, technological and financial conditions to form a multidisciplinary team of urban planners, architects, engineers, builders and managers.

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Background image on case study title page:

https://www.usinenouvelle.com/article/et-l-energie-fut-moindre-pour-hikari-a-lyon.N350800

Table of Contents

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The Positive Energy Building in its Local Context

The HIKARI (= light in Japanese) building complex, completed in 2015, is located in the City of Lyon's 150-hectare redevelopment area La Confluence. The central site is located on a peninsula, which is created by the confluence of the rivers Rhône and Saône. It is planned that the area is to be fully developed into a smart city district by 2025. Key development goals for the area include environmental sustainability, harnessing technology and ensuring walkability as well as social, cultural and economic vibrancy. Responding to these ambitious development goals, Japanese architect Kengo Kuma designed the HIKARI complex on bioclimatic principles, paying particular attention to how building structures can best respond to solar energy / natural lighting conditions.

The HIKARI complex consists of three buildings:

- HIGASHI (East): a 5,500 m² office building with shops on the ground floor;
- MINAMI (South): an apartment building with 36 dwellings and shops on the ground floor, with total net floor space of 3,400 m²;
- NISHI (West): a 5-story office building (2,600 m²) with shops on the ground floor and a further 2 floors stacked on top that provide space for 4 high-end penthouse apartments (700 m²).

Image 1

The bioclimatic architectural design of the HIGASHI building. Source: TESS/Fr Atelier d`Ingenierie

Image 2

Partly glazed balconies of MINAMI with integrated PV-modules. Source: Kengo Kuma and Associates

The Building's Special Features

The bioclimatic design features of the NISHI and HIGASHI buildings include expansive glazed surfaces as well as cuts / notches in the building form so as to capture natural light and reduce artificial lighting needs. Next to the well-considered design choices, the HIKARI complex also stands out for its state-of-the-art smart energy technologies.

In addition to expansive photovoltaic (PV) installations on the roofs of the complex, the MINAMI building in the center of the 3-building complex is equipped with additional PV panels that are embedded into the glazed façade. The design team placed considerable attention on hiding the wiring of modules and arranging their spatial distribution. This approach illustrates how renewable power generation and architectural design choices were jointly developed.

Additional energy-related technological features of the complex include a rapeseed oil cogeneration system, a geothermal system and an absorption heat pump, thermal and electrical storage solutions as well as external adjustable sunshades.

"… renewable power generation and architectural design choices were jointly developed."

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Reducing energy consumption is of paramount importance when designing PEBs. In the context of the HIKARI complex, energy savings were achieved by installing highly efficient LED lighting and a radiation panel air conditioning system. The latter improves air conditioning efficiency by circulating hot or chilled water through pipes embedded in ceilings.

Building and home energy management systems (BEMS and HEMS) have been employed in the HIKARI buildings to control energy generation, storage and saving functions as well as comfort levels.

Additional sustainable design considerations incorporated in the complex included the avoidance of thermal bridges in building envelopes, specifying concrete building cores for thermal energy storage and release, harnessing natural ventilation and harvesting rainwater.

Lastly, the complex also includes electric vehicle charging stations and multiple bicycle parking spaces in front of the buildings.

Selected Performance Indicators

Electricity Generation per year:
0.14 kWh/m^{2}y (Photovoltaics)

Energy from Co-Generation Plant:
37.18 kWh/m^{2}y

Net Electricity Demand: 0.12 kWh/m^{2}y

(Simulated) Annual Energy Balance:
- 259 MWhpe

Building Envelope Performance:

U-Values of Walls: 0.15-0.18 W/m^{2}K
Triple Glazing: 0.75 W/m^{2}K
Air Tightness Value: N50 < 0.6 1/h

CO_2 emission according to BEPos
1.8 kg-eq CO_2/m^{2}y

Local Energy Mix
57% fossil (gas and oil) 43% renewable

To what Percentage is the PEB Energy Positive?

100.02%

Key Technologies Installed

- Cogeneration plant: The 75 kW Combined Heat and Power (CHP) plant uses locally produced rapeseed oil to provide heat and domestic hot water to the HIKARI complex.
- Photovoltaic power plant: The 168 kWp PV-system [700 x Panasonic HIT-N240 (240 Wp)] on the roofs of the buildings are expected to yield 182 MWh per year, whilst the 21 kWp see-through PV system [1120 x Neo Solar Power NP6 multi crystalline / AGC SunEwat PV modules] has an expected yield of 15 MWh/year.
- Geothermal system and absorption pump: An absorption chiller, which is powered by the heat from the CHP and the heat from the Saône river is used to cool down office spaces.
- BEMS & HEMS: The buildings' energy management system uses data from 10,000 sensors, including image-based motion, temperature, CO_2 and humidity sensors. HEMS allows building users to monitor, remotely control and specify automatic / scheduled control functions, such as air conditioning, lighting and blinds.
- Thermal and electrical storage technologies: The complex features 63 m^3 (warm) and 20 m^3 (cold) thermal storage, which allowed designers to specify a smaller energy generation system overall. A 100 kWh battery storage system increases the self-consumption of generated electricity.

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Non-Exhaustive List of Involved Stakeholders

Lyon Métropole collaborated with the Japanese innovation accelerator NEDO in the context of the La Confluence redevelopment to explore smart community solutions. This collaboration also included work on the HIKARI complex with PEB technologies provided by companies such as Toshiba and Panasonic. On the French side, the developer Bouygues Immobilier brought on board a host of French specialist firms to create the ambitious design of Kenjo Kuma architects.

Developer
Bouygues Immobilier SLC
www.bouygues-inmobilier.com

Area Redevelopment Management
Lyon Confluence
www.lyon-confluence.fr

Developer
SLC Pitance
www.slcpitance.com

Engineering
SETEC BATIMENT
http://www.batiment.setec.fr/

Consulting / Assistance
MANASLU Ing
http://manaslu-ing.com/

Construction Economics
VOXOA
https://voxoa.fr/

Building Façades
T/E/S/S
https://www.tess.fr/

Lighting Design
COBALT
www.cobalt-lumiere.com/

Photovoltaic Engineering
TECSOL
http://www.tecsol.fr/

Acoustics
Europe Acoustique Ingenierie
www.eai-acoustique.com/

Technology Provider
Toshiba Inc.
www.toshiba.com

Lighting Engineering
INGELUX
http://www.ingelux.com/

Technology Developer & Innovation Accelerator
NEDO (New Energy and Industrial Technology)
www.nedo.go.jp

Architect
Kenjo Kuma architects
www.kkaa.co.jp

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Catalysts, Challenges & Results

The HIKARI complex is a pioneering example of how state-of-the-art smart energy technologies and design innovation can be harnessed to overcome challenges associated with complex buildings, external conditions and use-patterns. In light of this, the project is considered as a significant role model for the future development of PEBs. The French-Japanese collaboration provided a great opportunity to test a variety of innovative technologies and accumulate know-how. Based on the lessons learned, HIKARI has already inspired the development of more PEBs in France and other countries with the utilization of various levels of sophisticated technology. Whilst the building is well known for having used the most advanced smart energy technologies at the time, it should be noted that, in practice, there were concerns about the cost burden for users and complexity in terms of management.

Mr. David CORGIER of Manaslu, who was engaged in the construction of the HIKARI Building as a technical consultant, commented:

"The HIKARI Building is an ideal building in terms of the efficient use of energy, but because it is a collection of state-of-the-art technologies, hurdles on the budget, management and operation are a little bit high. On the other hand, we were able to experience the maximum specifications of technologies in the HIKARI Building. If we appropriately choose and combine necessary functions and technologies from among them, we will be able to expand PEBs to other cities." Source: Smart Community Demonstration Plan in Lyon, France. www.nedo.go.jp

The HIKARI Building became a symbol of Lyon Confluence district showing a new attitude towards environmental planning and design. The complex attracts hundreds of visitors from all over the world every year.

As is the case with many highly innovative projects that explore new technology applications, HIKARI faced specific hurdles such as the unwillingness of insurance companies to cover custom-made building products like the see-through photovoltaic façade. This impasse was overcome by establishing general approval test procedures and administrative protocols for the various engineering and design proposals.

Image 3

Waterfront view of the NISHI and MINAMI buildings
Source: Christian Genin

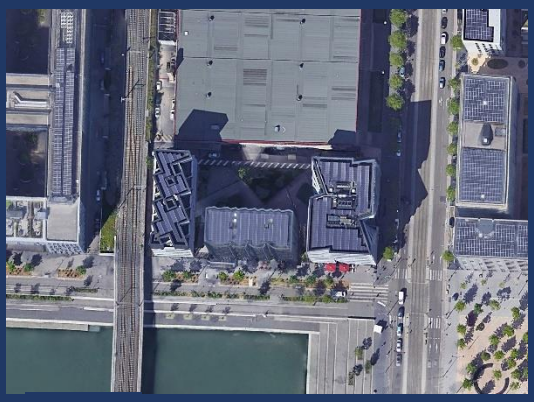

Image 4

Birdseye view of the HIKARI complex, showing the expansive PV installation. Source: Google Earth

"…known for having used the most advanced smart energy technologies…"

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Replication Potential

Already during the project design phase in 2011, HIKARI was being developed in a way to be a world pioneer amongst PEB buildings. Consequently, HIKARI has been a replication model for almost ten years. This set of buildings represent a groundbreaking example for future buildings across Europe, both at urban and architectural scales. Firstly, the idea of proposing these mixed-use buildings as the iconic center of a new vibrant regional activity center went beyond mere commercial motivations, demonstrating the vision of the client and involved companies. Secondly, designers were given the opportunity to explore innovative design approaches, such as using one building´s geometry to protect the adjacent building from solar exposure or using facades as vertical photovoltaic farms.

Considering the positive current attitude towards PEBs, especially in Europe, buildings such as HIKARI have high replication potential with few technology adaptation needs. What is undoubtedly more challenging is putting together a well-balanced and perfectly aligned group of stakeholders as HIKARI did, especially in the political, technological and real estate fields.

HIKARI was developed in close collaboration between France and Japan, bringing to the consortium the best know-how of PEBs from both countries.

Greater international cooperation between European countries can be a key factor for PEBs development. In Southern Europe, climate conditions make it easier for "medium budget" developers to join in the efforts to achieve energy efficiency in a continuously growing market. Companies located in Northern Europe provide support through the specialized industry and innovation in technology.

Conclusions & Lessons Learned

In addition to the valuable collaboration between France and Japan, the fact that HIKARI was a mixed-use building was essential to the work. Working with residential, offices and retail spaces with their different energy consumption patterns was a key factor to achieve an ambitious set of energy efficiency goals.

However, as with many construction projects, there is room for improvement. During the first couple of years, HIKARI had problems to achieve the PEB standard because of non-expected energy demand factors, such as 24 hours servers in office buildings or additional air conditioning needs from specific users. Such problems were resolved by a complex calibration process of the equipment. Ideally, the energy demand should be taken into account from the beginning in order to reduce expenses that usually fall into the final user´s budget.

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Selected References

- GBPN (published 22/'9/2015) A success story: The HIKARI project
- www.bouygues-immobilier-corporate.com / HIKARI
- https://zenodo.org/record/834534/files/6DO.7.1.pdf?download=1
- Hikari: A positive energy building with an architecturally integrated PV facade and a PV rooftop system
- https://www.construction21.org/data/sources/users/24246/ilot-hikari.pdf [FR]

Local Context Details

Address: 25, Quai Antoine Riboud, Lyon, 69002, France

Geographic Coordinates [Google | EPSG:4326 – WGS 84]: 45º 44' 26,58'' N, 4º 49' 09,80'' E

Local Government: City of Lyon

Population: 513,200 (2016)

Total Area Administered: 47,87 km²

Municipal Budget: 930 Million €

Total annual GHG emissions: 7M tons CO2 (2016)

Local Economy: Banking, Chemical, Pharmaceutical and Biotech Industries

Local Climate Plans: Territorial Climate and Energy Plan & “Le Plan Climat de la Metropol de Lyon”

Climatic Zone [Köppen]: Cfb - Temperate oceanic climate | Temperate | Without dry season | Warm summer

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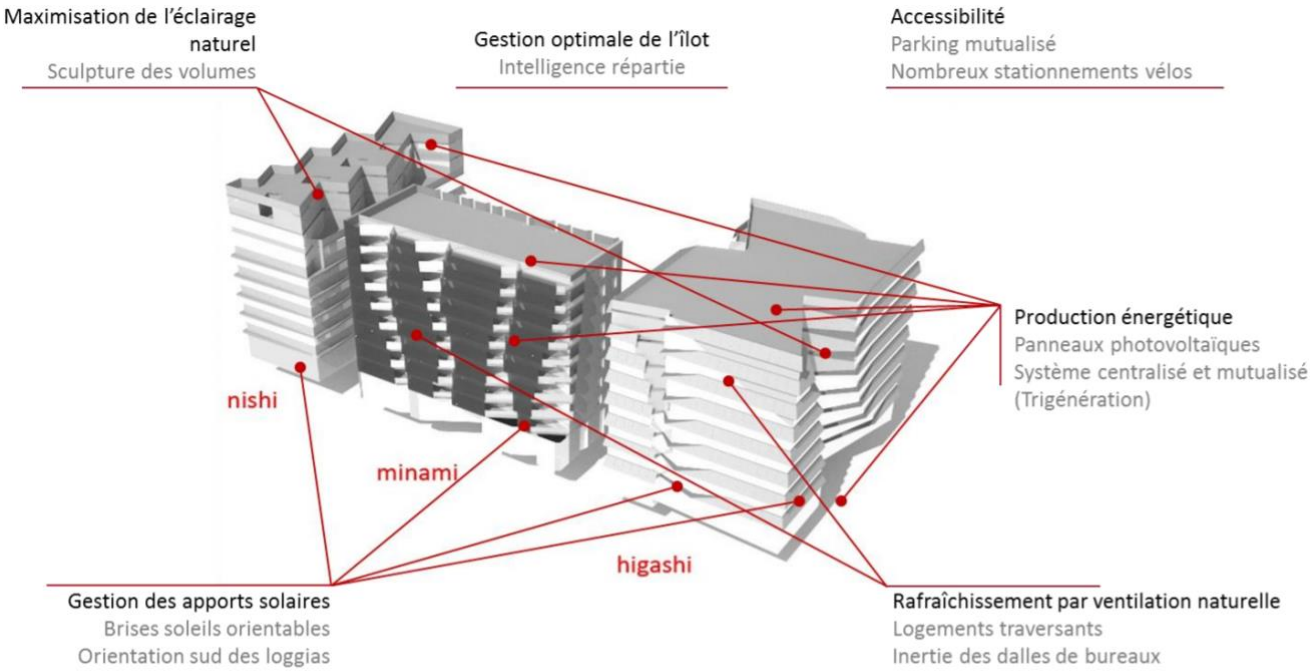
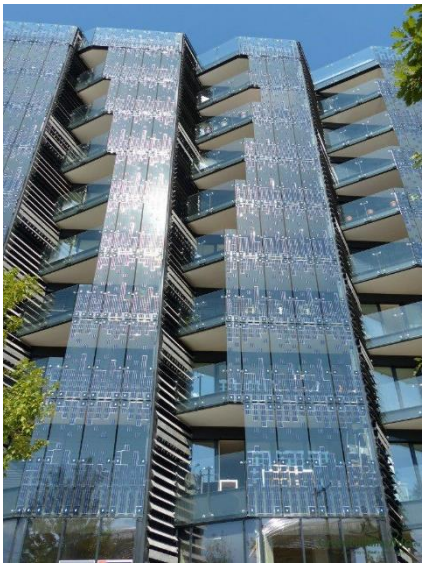
Image 5



Overview of PEB design and technology specifications [Source: https://www.construction21.org/data/sources/users/24246/ilot-hikari.pdf]

Image 6



PV façade of MINAMI building
[Source: SADEV_Architectural glass systems]

Image 7

Aerial view of La Confluence redevelopment area
[Source Background Image: https://www.lyon-confluence.fr/]

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