CASE STUDY 03: IZUBA ENERGIES BUILDING | FRANCE

GEOGRAPHICAL AND CLIMATE INFORMATION	
Location	34690 Fabrègues, France
Latitude; Longitude	43.56050216309316, 3.7915132981980086
Climate zone (Köppen–Geiger classification)	Csa: Warm temperate climate with dry and hot summer
BUILDING INFORMATION	
Building Type	Offices
Project Type	New construction
Completion Date	2015
Number of buildings	1
Number of storeys	2
Total Floor Area (m²)	-
Net Floor Area (m²)	424
Thermally conditioned space area (m²)	424
Spaces with Natural Ventilation (with or without Ceiling Fans) Only (m²)	0
Total cost (€)	934 000
Cost /m² (€/m²)	2 061,8
Performance Standards or Certification	None
Awards	None
STAKEHOLDERS	
Building Owner/ Representative	Izuba Energies / Eduardo Serodio - eduardo.serodio@izuba.fr - 0467186221
Architect	RIGASSI et Associés Architectes / Vincent RIGASSI vincent.rigassi@ra2.fr - 0476471172 -
Construction manager	RIGASSI et Associés Architectes
Environmental consultancy	Izuba Energies

ABC21 is funded by the EU's H2020 programme

Structural Engineer, Civil Engineer	Gaujard Technologie Scop (Wood structures) Soraetec (Concrete)
Energy Engineer	IZUBA énergies
Fluid Systems Engineer	Agence Des Fluides Cognin
Product Manufacturer	Jolie Terre entreprise (Earth plasters) Sud Est Charpente (Timber frame insulation straw)
Certification company	-

PROJECT DESCRIPTION [1] [2]

Figure 25 : Exterior view of the Izuba building

Izuba Energies Building is an office building located in France, more precisely near Montpellier, on the Fabrègues Ecoparc. The building construction is based on a bioclimatic architectural conception, using local bio-based materials so as to reduce environmental impacts. The building was built in order to adapt to the local Mediterranean climate, ensuring a comfortable working environment in summer and in winter, in terms of thermal and visual comfort. This building reflects what IZUBA Energies has supported since its creation in 2001, i.e a "negawatt" energy approach with its 3 components (sufficiency, efficiency and renewable energies). This includes: hygrothermal comfort, low impact components, user behaviour, waste management, indoor air quality, and so on.

Figure 26: Floor plan of the first floor

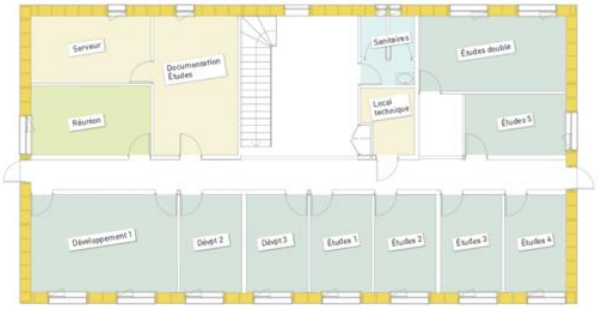


Figure 27: Floor plan of the second floor

SITE INTEGRATION

Figure 28 : Aerial view of the building in its surrounding environment

The building is located in the Eco-Parc Fabrègues, between a residential area and a rural area. A direct connection of the area from the centre of Montpellier will be possible through a future extension of the tramway line.

CLIMATE ANALYSIS

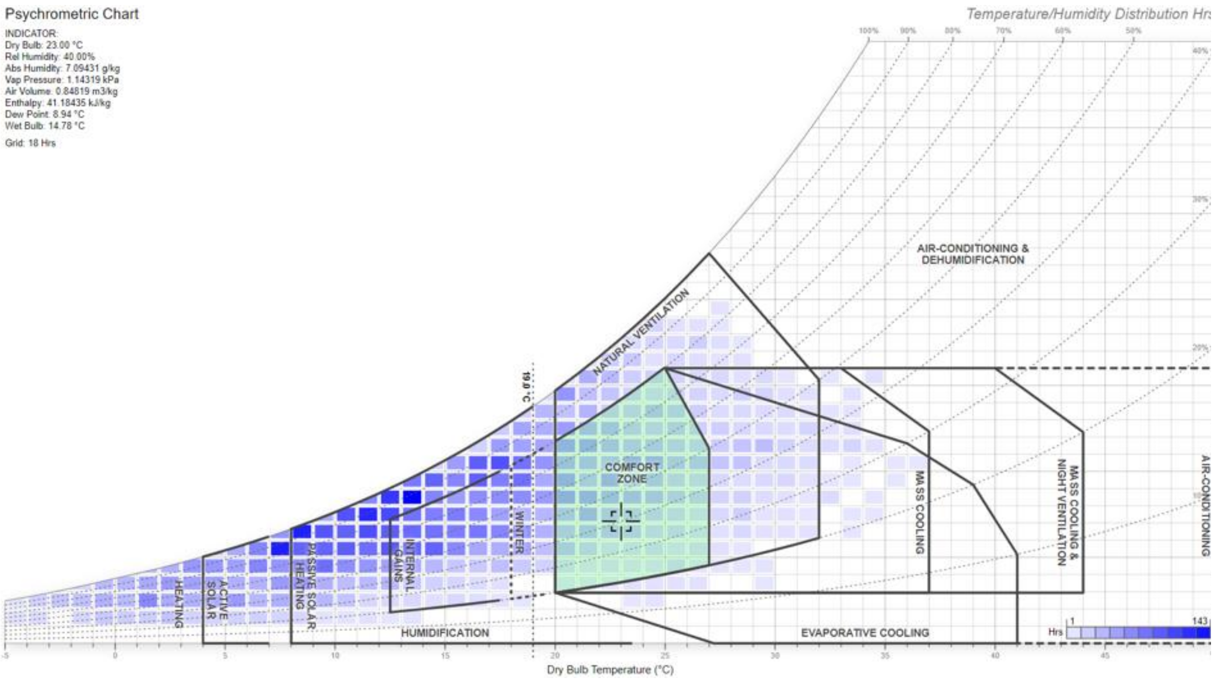


Figure 29: Givoni Bioclimatic chart for the climate of Montpellier using Andrew Marsh online tool. Climate data are extracted from https://energyplus.net/weather-region/europe_wmo_region_6/FRA%20%20 [3].

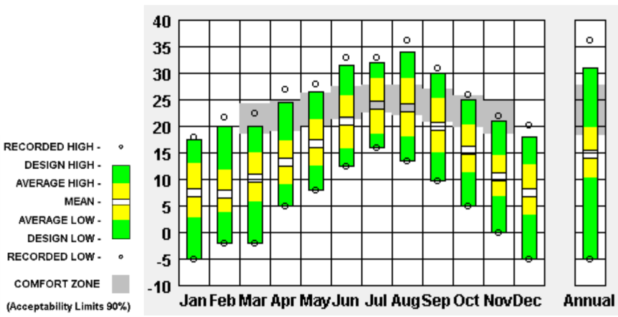


Figure 30: Temperature range by month for Montpellier - Adaptative Comfort model [4]

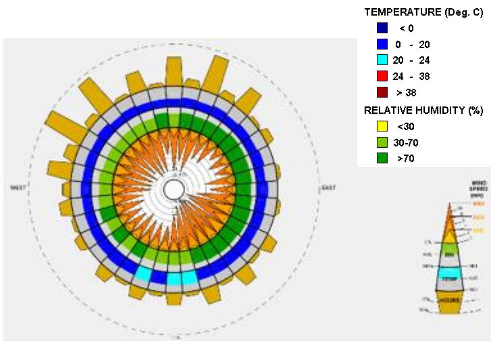
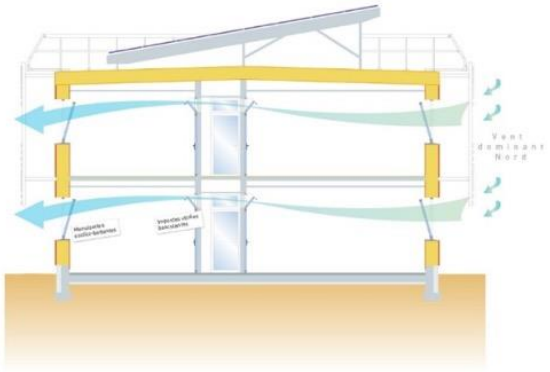


Figure 31: Wind rose for Montpellier [4]

Global horizontal radiation (Avg daily total) Min (month) / Max (month)	Min: **1 413** Wh/m² (Dec) Max: **6 746** Wh/m² (Jul) Mean: **4 004,17** Wh/m²
Annual Degree-Days for weather classification according to ASHRAE Standard 169-2020	HDD 18°C: **1 769** CDD 10°C: **2 181**
Annual Degree-Days for the Adaptive Comfort Base Temperature according to the ASHRAE 55-2017 for 80% of acceptability	HDD: **1 884** CDD: **20**
Annual Degree-Days for a static comfort temperature approach	HDD 18.6ºC: **1 918** CDD 26º: **65**
KEY BIOCLIMATIC DESIGN PRINCIPLES [1] [2]	
Passive cooling strategy	Nocturnal convective cooling (see  *Figure 32*) Thermal inertia (wood frame+ interior partitions of earth-straw and mud brick)
Passive heating strategy	High level of insulation of the walls and the roof Simple shape and good compactness of the building, limiting heat losses on surfaces. The main façade is south oriented so as to optimize solar gain in offices in the winter period.
Solar protection	Built-in fixed protection: - The building is completely surrounded by open-cut wood siding. - Motor drive external venetian blinds (see Figure 34). The building is equipped with fixed and mobile solar protection blocking direct sunlight while allowing solar gain in winter.
Building orientation	Main orientation south to take advantage of solar gain.
Insulation	The walls are composed of timber frame insulated with straw which provides a very high level of insulation. The high insulation levels, combined with perfect air tightness and strong solar inputs, reduce heating requirements.

Vegetation	Mediterranean plants, adapted to conserve water and survive summer drought, have been planted around the building. The different species have been chosen according to the solar exposition, i.e., linden trees for the shading of the parking areas, jasmine for the North and South façades. Also, a small common herb garden is provided.
Natural daylighting	The large openings on the main façades, as well as the fixed and mobile solar protection as been designed so as to allow natural daylighting in the building (see Figure 33).
Use of local and embedded materials	The earth used in the construction was extracted from a quarry near Uzes, composed of sand, clay and plant fibres (mostly straw).
Water saving and heat recovery on hot water drain	Flow controller fitted onto water tap in the bathroom to reduce water consumption. Hand wash basin with knee operation and with automatic shut-off.
Waste management	Sorting of recyclable waste and compost bin for kitchen waste.
Others features	**Eco-design material:** To limit the environmental impact of the manufacture of building materials and processing end of life, the design has largely favoured bio-sourced materials, minimally processed and recyclable: - Wooden frame insulated straw bale - earth plasters, clay walls and straw wall in mud brick - wood for exterior and interior joinery and furniture - anhydrite screed sanded and oiled finished floor The building includes a 19-seat parking lot, with shading structures designed to limit the use of air conditioning. There are also electric vehicle charging stations and local bicycle coverage.

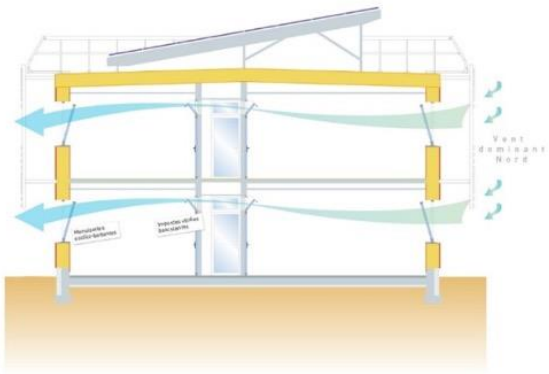


Figure 32: Nocturnal convective cooling principle

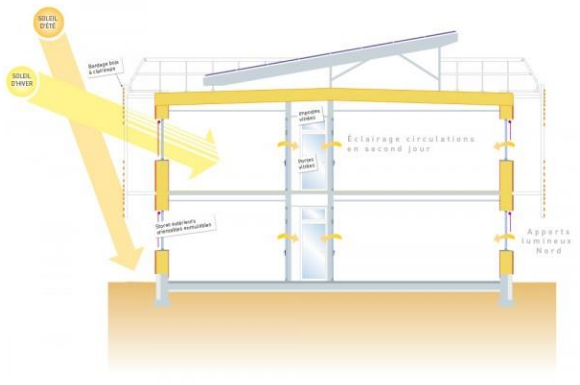


Figure 33 : Shading and natural daylighting principle

Figure 34: Motor drive external venetian blind. Type: Grinotex from Griesser.

Figure 35: Tilt and turn windows

INFRASTRUCTURES and REGULATIONS to enable SUFFICIENCY ACTION	
Dressing code	Informal dressing, adapted to the season, is welcome and promoted (e.g. short trousers and short leaves in hot periods): **Yes**
Protected bike parking and showers	Yes. **3 bike racks** and **2 showers** for 16 employees Ratio with number of users: **0.125**
Ceiling fans	In every room, even those conditioned: **Yes** Only in the offices, the kitchen and the meeting room. No ceiling fans in the large training room.
Lighting system fractioned to allow using light only in zones occupied and where daylighting insufficient	In every room, even those conditioned: **Yes**
Space and facilities for line drying clothes (especially important in residences, hotels, sport facilities…)	In every room, even those conditioned: **No**
Book of instruction for correct use of the passive features (windows, solar protections, water savings) and active (lighting…) in order to promote sufficiency and efficiency actions	Available through leaflets and posters at relevant places, online, etc.: **No** **T**he users work in the energy efficiency area and are aware of how to correctly use the building but this point could be improved.
BUILDING FABRIC AND MATERIALS [1] [2]	
Roof	The roof is structured as illustrated in (from outside to inside): ▪ thermoplastic polyolefin membrane ▪ OSB wood panel (1.8 cm) ▪ Straw bale (34cm) ▪ Vapour barrier ▪ Wooden batten (3 cm) ▪ Acoustical false ceiling in wood fiber
	U-value= 0.15 [W / m²K] Overall R-value: 6.67 [m^2K/W]

Windows	Type of materials: Wooden-framed double-glazed windows 4/16/4 with argon, low-E
	Window-to-wall ratio (WWR): -
	U-value: 1.5 [W / m²K]
	Visual transmittance: -
Walls	The **Exterior Walls** are structured as illustrated in

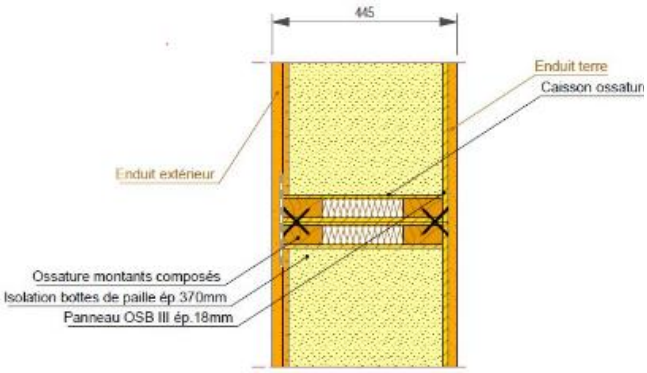


Figure 39 (from outside to inside):

- Raw earth outside coating
- Wooden box with thick straw bales (0.37m)
- OSB panel (0.018 m)
- Raw earth coating

U-value= 0.17 [W / m²K]

Overall R-value: 5.88 [m²K/W]

The **Interior Walls** are structured as illustrated in Figure 40 (from outside to inside)**:**

- Gypsum board (0.013m)
- Timber frame 45/120mm with 0.12m of wood wool
- OSB panel (0.012m)
- Gypsum board (0.013m)

Figure 36: Wood timber structure

Figure 37 Bunches of straw and wood fiber insulation in exterior walls

Figure 38 Mudbrick wall

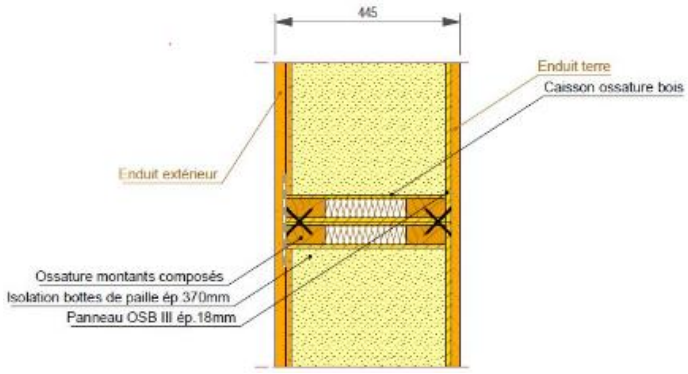


Figure 39: Exterior wall section

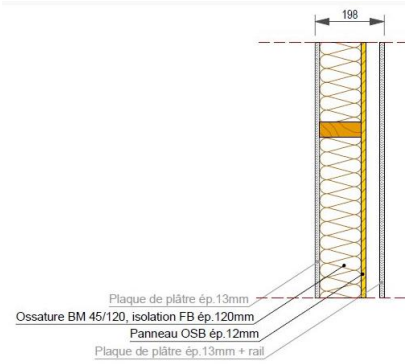


Figure 40: Interior wall section

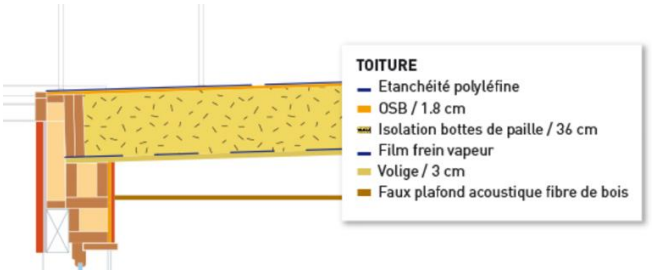


Figure 41: Roof section details

ABC21 is funded by the
EU's H2020 programme

ENERGY EFFICIENT BUILDING SYSTEMS [1] [2]	
Low-energy cooling systems	Comfort ventilation & Nocturnal convective cooling Geothermal heat pump Floor cooling Fan coil
Low-energy heating systems	Geothermal heat pump; Low temperature floor heating Fan coil
Ceiling fans	1 in each office and 1 in the meeting room. Ceiling fans with 3 blades and with integrated LED lighting and remote control from Shakespear brand.
Mechanical ventilation / air renewal	Dual flow ventilation system: Swegon Gold RX TOP Maximum flow= 1200 m^3/h Efficiency of the wheel exchanger= 81% Air tightness of the duct system= Class C
Domestic Hot Water	Solar Thermal ECS electro-solar water heater of 200 litres 1 solar thermal collector of 2 m^2
Artificial lighting	**Offices, training rooms and meeting rooms:** T5 light bulbs- 6 to 14 W / m^2c- equipped with presence sensors and daylight linked dimming systems. **Circulation areas and sanitary facility:** LED – 3 to 8 W/m^2 - equipped with presence sensors **Storage, server room:** compact fluorescent lamps - 13 W/m^2
Control and energy management	Building Management System: Trend 963 Supervisor Measurement of the energy consumption and the energy production with a 10 minutes timestep. Visualization and control of the heating, cooling and ventilation systems. Different energy savings features have been implemented such as presence sensors and daylight linked dimming systems, as well as multi-socket adaptors with a power switch.

Figure 42: The building is equipped with an under-floor heating/cooling system powered by a ground source heat pump

Figure 43 : Double flow mechanical ventilation system

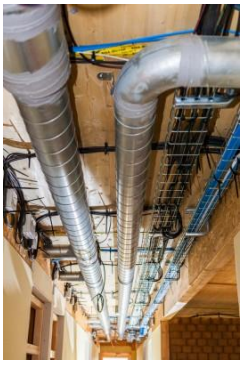


Figure 44 : Air distribution system of the building

ABC21 is funded by the EU's H2020 programme

Figure 45 : Lighting of the training room with presence sensors and daylight linked dimming systems

Figure 46 : Multi-socket adaptors with a power switch

RENEWABLE ENERGY [1] [2]	
PV	88 PV modules from the Sunpower brand - E20-327-COM **Total Power=** 28.8 kWp Solar Cell Efficiency= 20.4%
Solar thermal	ECS electro-solar water heater of 200 litres 1 solar thermal collector of 2 m²
Wind	None
Geothermal	Heat Pump on geothermal probes Heat pump Weishaupt WWP S 10 IBER - Heat: 9.5 kW, COP 4.2 - Cold: 14.6 kW, EER 9.1
Biomass	None

Figure 47: View of the PV panels installed on the rooftop of the building

Figure 48: Solar inverter and sensors of the PV system

BUILDING ANALYSIS AND KEY PERFORMANCE INDICATORS	
Thermal comfort indicators	1. Percentage of time outside an operative temperature range (Adaptive)
	2. Percentage of time outside an operative temperature range (Fanger)
	3. Degree-hours (Adaptive)
	4. Degree-hours (Fanger)
	5. Percentage of time inside the Givoni comfort zone of 1m/s
	6. Percentage of time inside the Givoni comfort zone of 0m/s
	7. Number of hours within a certain temperature range
	1. Energy needs for heating (kWh/y/m2) = **5.1**

ABC21 is funded by the EU's H2020 programme

Energy performance indicators	2. Energy needs for cooling (kWh/y/m2)= **2.0**
	3. Energy use for lighting (kWh/y/m2)= **7.1**
	4. Energy needs for Sanitary Hot water (kWh/y/m2)= **1.3**
	5. Total Primary energy use (kWh/y/m2)=
	6. Renewable Primary energy generated on-site (kWh/y/m2) =
	7. Renewable Primary energy generated on-site and self-consumed (kWh/y/m2)=
	8. Renewable Primary energy exported to the grid (kWh/y/m2)=
	9. Ratio of renewable primary energy over the total primary energy use (with and without compensation) (%)
	10. Delivered energy (kWh/y/m2) (from electricity bills)
Acoustic comfort indicators	1. Airborne sound insulation
	2. Equivalent continuous sound Level
	3. HVAC noise level
	4. Reverberation time
	5. Masking/barriers
Visual comfort indicators	1. Light level (illuminance)
	2. Useful Daylight Illuminance (UDI)
	3. Glare control
	4. Quality view
	5. Zoning control
Indoor Air Quality indicators	1. Organic compound
	2. VOCs
	3. Inorganic gases
	4. Particulates (filtration)
	5. Minimum outdoor air provision
	6. Moisture (humidity, leaks)
	7. Hazard material
Users' feedback	The occupant satisfaction is generally very positive. Thermal comfort is sometimes difficult to adjust due to the individual sensitivity of the occupants.

LESSONS LEARNED AND RECOMMENDATIONS

Lessons learned	-
Recommendations	-

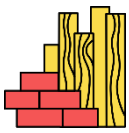
BUILDING STRENGTHS AND WEAKNESSES

Strengths

Passive Design

Energy Efficiency

Renewable Energy



Local Materials

ABC21 is funded by the EU's H2020 programme

Weaknesses
-

REFERENCES

[1] https://batiment.izuba.fr/

[2] https://www.construction21.org/case-studies/fr/izuba-energies-building.html

[3] PD: Psychrometric Chart n.d. https://drajmarsh.bitbucket.io/psychro-chart2d.html(accessed May 7, 2021).

[4] Milne (UCLA) M. Climate Consultant 6.0. n.d. http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php.