- SYNTHESIS -

Friday, july 6th 2018

2018 BATI' Marseille FRAIS

4ÈME COLLOQUE CONFORT D'ÉTÉ

LES SOLUTIONS CONCRÈTES POUR MIEUX CONSTRUIRE EN CLIMAT MÉDITERRANÉEN

Un événement organisé par

envirobatbdm

Avec le soutien de

Région Provence-Alpes-Côte d'Azur

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SOUCHIER GESTION DES ÉNERGIES NATURELLES

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LE MONITEUR

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This synthesis is done for BÂTI'FRAIS - Summer Comfort Symposium.

BÂTI'FRAIS is :
- an inventory of concrete ways to adapt our spaces to the new climate conditions,
- proven and verifiable feedbacks,
- testimonies from the most exposed French regions as well as overseas territories,
- foreign guests from a hot region.

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OPENING

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EnvirobatBDM

Daniel FAURE
Engineer et founding member
EnvirobatBDM

"For the 4th consecutive year, the Bâtifrais Summer Comfort Symposium will provide the opportunity to share experience and tangible solutions from across France and even other countries," said **Florence Rosa, President of EnvirobatBDM**, in her introduction, adding that this new edition was being held in July in order to better tie in with issues surrounding sustainable construction and rising summer temperatures.

To prepare for climate change and limit its impacts on comfort and health in the building construction sector, EnvirobatBDM created assessment committees and collective intelligence groups whose work was to be presented at this day of meetings and discussion. The aim is to develop greater cooperation between institutional, industrial and non-profit partners by analysing success stories, problems and setbacks in order to achieve progress. Collegial work is the foundation for success and developing a network that promotes sustainable buildings. In 2019, EnvirobatBDM will create partnerships with several regional stakeholders in a continuing effort to pool collective intelligence and build better buildings.

Since the concept of summer comfort reflects the huge challenge of adapting to climate change, **Fanny Viot, Deputy Regional Director of ADEME PACA**, underlined that Marseille and the surrounding region's location in the Mediterranean Basin make it one of the world's 25 climate change hot spots. According to the most recent projections, by 2100, the climate in Marseille could be similar to the Apulia region in Southern Italy, with temperatures rising by over 5°C and even greater effects in urban areas. 91% of the population in the Sud Region (PACA region) live in urban environments, so identifying the vulnerabilities of these environments, pinpointing the risks and adapting are of crucial importance.

In May 2018, the International Energy Agency (IEA) published a report on the energy issues associated with rising demand for air-conditioning, which already accounts for 10% of the world's energy consumption. Without major efforts in the building construction sector, the existing fleet of 1.6 billion air-conditioners is poised to triple by 2030. While constructions in the Mediterranean have traditionally been adapted to the region's distinctive climate characteristics, this building ingenuity has somewhat taken a back seat as a result of changing lifestyles. The solutions required to adapt to climate change need to keep regional specificities in mind. That's why the French Environment and Energy Management Agency (ADEME) supports energy efficiency experiments targeting particular regions, such as new buildings that comply with E+/C- standards which are setting the stage for future environmental regulations.

The agency also promotes the idea of taking users' and their activities into consideration in building performance. ADEME is therefore keen to offer support and expertise to project owners and organisations in charge of experimental projects participating at the 4th Bâtifrais Symposium.

Rémi Costantino, Secretary General at Euroméditerranée presented the approach being implemented by the EcoCité-certified public institution since 2009. This urban renewal project is based on the concept of a sustainable Mediterranean city and is designed as an applied research laboratory where high-performance and high added value projects are developed. It also places residents and the people of Marseille at the heart of this new urban area and the associated housing stock, as the involvement of users in their day-to-day comfort is crucial for making construction performance policies successful.

This type of local approach created a need for support, which was met by EnvirobatBDM along with its expertise during discussions with project owners. A partnership was created in 2014 with a focus on four strategies:

- action, with 15 projects and 80,000 m2 of Mediterranean Sustainable Buildings-certified space to date,
- the ability to think and put things into perspective, with a focus on comfort and cost-management issues,
- innovation, through diverse experimental projects and implementation of the "innovation permit" specific to projects of national interest, which allows current regulations to be circumvented,
- the ability to disseminate knowledge and drive change.

Rémi Costantino praised the collective intelligence provided by EnvirobatBDM and the Bâtifrais initiative, which offers a wonderful opportunity to work together more closely.

CONFERENCE

CLIMATE CHANGE IN THE PACA REGION: FROM REGIONAL TO LOCAL IMPACTS

Changes in global temperatures have experienced a statistically significant rise since the 1980s, recalled **Elodie Briche, from the Group of Experts on Climate in the PACA Region (GREC PACA)**. The past decade was the hottest on record since the middle of the 19th century, with a succession of increasingly extreme and severe heat waves.

In terms of regional trends, temperatures are expected to rise until the end of the century, but with some spatial and time-related variabilities. Fluctuating on average annually from 1.9 to 4.6°C depending on the place and greenhouse gas emissions scenario, this increase will be more pronounced in the summer, particularly when it comes to minimum temperatures, with a significant increase in the number of "tropical nights". This limits the possibilities of night-time cooling, with potential impacts on thermal comfort.

The number of days with frost is also expected to be cut in half, which would have a major impact on some plant species.

When it comes to precipitation, levels are expected to drop, with longer dry periods and water shortage complications. However, severe weather events in the Mediterranean stand to intensify at the end of the 21st century, with a greater risk of urban floods caused by runoff from increasingly impervious surfaces.

The results of different models sometimes appear to contradict each other, but they all point to increased annual precipitation on the Queyras and Ubaye mountains, lower precipitation in Haute Provence, and generally less summer precipitation for a large part of the Sud Region. In any event, precipitation will be characterised by interannual variability and differences between various places.

Without a climate policy, as summer temperatures rise, normal values will be similar to the peak values recorded in 2003, with daytime temperatures above 35°C and heat waves above 40°C according to the most pessimistic scenario. This would have both economic and health impacts, with increased urban heat islands and air pollution. Heat waves will evolve into hotter and longer events and an increase in the number of "tropical nights" with temperatures above 20°C. Mediterranean cities will ultimately create their own climate due to high urban density, an environment damaged by coastal developments and increased air-conditioning use. They have thus become laboratories for analysing climate change, where the real challenge is to quantify the effects of urban heat islands in order to work towards developing sustainable cities in terms of morphology, energy policy, material use, green space planning, etc.

Elodie Briche and her colleagues established INTI Urban Climate in line with this research. The startup's goal is to create an early warning prototype in Marseille, in order to manage urban heatwaves and their health, economic, social and environmental impacts. Using a platform with several layers of information including a medium-range weather forecast, urban morphology and social and health data, INTI is able to address all the issues related to urban heatwaves on a small scale.

Elodie BRICHE
Groupe d'experts sur le climat en PACA (GREC PACA) - INTI Urban Climate

CASE STUDY

PROJECTS FOR NEW COLLECTIVE HOUSING (>2 YEARS):

THE ESSENTIAL ROLE OF DTS IN CLIMATE ADAPTATION

"Thermal comfort will be a big issue for the building sector in the years to come," said **Frédéric Bœuf, Surya Consultants**. If this aspect and the users are not taken into account in the design phase, buildings may have high technical and economic performance in the design phase, but will end up with energy consumption problems when they are actually used (change to the pre-set temperature, addition of privately-owned or low quality air-conditioners, addition of privately-owned portable radiators, etc.). The performance gap can vary by a factor of 2 to 10, depending on user behaviour. "If we leave comfort out of the equation, the operating performance won't be up to par," insisted Frédéric Bœuf.

That is why Dynamic Thermal Simulation (DTS) tools have been developed. They are increasingly effective and are able to simulate real usage conditions as long as they use assumptions that are consistent with reality. By modelling both energy and comfort issues, they help define the best design compromises. That said, design tools are not meant to (and should not) replace the designer, whose ideas should guide simulations.

DTS is used in the preliminary design phase in order to:
- define the envelope, and the project's goals and constraints,
- qualify the bioclimatic quality of the design,
- evaluate the summer and winter indoor comfort level,
- optimise technical and architectural solutions,
- evaluate the building's needs and estimate the energy use of technical equipment (HVAC, lighting, etc.)..

This initial modelling work provides architects with the information required to come up with the right design so that comfort and energy performance achieve the desired results. To illustrate the benefits of using DTS tools to design buildings that are comfortable in the summer, Frédéric Bœuf presented feedback from two buildings built and operated using the Mediterranean Sustainable Buildings approach (BDM) – the MasCobado in Montpellier and the Château d'Eau residence in Miramas. In terms of methodology, the engineering firm was involved from the preliminary design phase right through to the construction drawings for the first building, whereas dynamic thermal simulation was carried out in the detailed design phase for the second building for almost the exact same construction principle. The scenarios for the two projects were developed using an approach similar to the one used in thermal regulations, based on variable and differentiated occupancy per room, and significant internal sources. The occupancy density is much lower for the passive certification scenario, recognised for the quality of its assumptions and more physics-based approach. The ventilation assumptions are higher than the regulation, with free-cooling at around 2 to 5 ACPH depending on the project, but difficult to quantify with current technology. The various simulations did not take any heatwaves into account. It would therefore be interesting to incorporate this factor in order to see how buildings respond to this constraint and define any corrective strategies that would be required.

In terms of results, all the MasCobado units achieve good summer comfort targets (less than 60 hours at more than 28°C), except for one unit, which had a total of 225 hours of discomfort. However, this risk was identified during the design phase, mainly due to the direction in which the building faces, the lack of solar protection and the inability to implement proper free cooling, as the unit faces one direction.

For the Château d'Eau residence, no targets were defined, but the occupants' comfort was taken into consideration. Significant differences in values were observed during uncomfortable (hot) days, depending on the type of shutters that had been installed.

After one year of use, the engineering firm's forecasts were confirmed at the MasCobado. In the case of the Château d'Eau residence, free-cooling proved to be less effective than expected. The free-cooling assumption was also overestimated for both projects, as the actual use of the openings did not correspond to the ideal scenario used in the preliminary design phase.

Furthermore, although the MasCobado had good results in the preliminary and design phase, feedback on comfort from users was generally that they were hot, even though they said they were less hot than in previous residences. The same applied for the Château d'Eau.
In terms of communication between stakeholders, warnings from engineering firms could not be taken into account, which led to corrective work in one of the MasCobado units.

Furthermore, since both projects were studied after the architects had signed off overall approval, the engineering firms were only involved to a limited extent in the overall design of the envelope, the design of the solar protections, and other elements. These findings raise some questions as to the role of these stakeholders and DTS tools in the design phase, their use earlier in projects, joint-design of architectural forms and the façade, etc.

In conclusion, Frédéric Bœuf underlined that DTS is an essential tool for analysing comfort although it is still difficult to qualify the output of night flushing and air speeds. In any case, it requires common specifications and realistic and shared assumptions, and for results to be better shared and promoted.

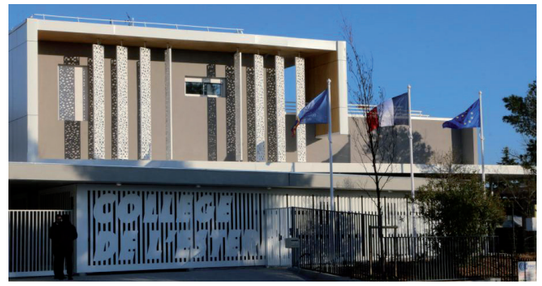
Frédéric BŒUF
Surya &
Ecole des Mines

WORKSHOP

WORKSHOP 1: summer comfort and tertiary buildings

José Coelho, Oasiis engineering firm, presented initial feedback on summer comfort from three middle schools in the Var, built through a public/private partnership. These three projects had high environmental objectives in terms of comfort (thermal, visual and indoor air quality), energy management, and the use of bio-based materials. These efforts were rewarded with BDM, Effinergie+ and BBC Effinergie Rénovation certifications.

L'Herminier middle school in La-Seyne-sur-Mer was completed in February 2018 and used the basic principles of bioclimatic design, including exterior insulation, overhangs, vertical solar protections with indoor blinds, etc. for both the renovated buildings and the extensions. Thermal summer comfort is provided by a dual-flow air handling unit (AHU), with adiabatic cooling for the administrative area and natural ventilation openings connected to heat sensors that take advantage of E/W crosswinds. A BMS system has been installed to manage the buildings' various functions. Backed up by DTS, the summer comfort strategy mainly uses passive principles and relies on the behaviour of users, who have been informed about the need for ventilation. The school's other strong points include the use of renewable energies, its aesthetics, indoor air quality, the use of wood, a well-managed schedule and budget, and 25-year operational monitoring.



The brand new L'Estérel middle school in Saint-Raphaël was completed in February 2018. It features exterior wood fibre insulation and solar protections adapted to the direction of the various facades (vertical fins, overhangs and solar films). The summer comfort strategy is also managed by a BMS. It includes a dual-flow AHU with adiabatic cooling for the administration area, natural ventilation openings connected to thermal chimneys and fans for the offices. DTS and CFD modelling backed up these choices. Just like L'Herminier middle school, Estérel boasts the use of renewable energies, appealing aesthetics, operational monitoring, etc. and especially an effort to communicate with students and staff.

Geneviève De Gaulle-Anthonioz middle school in Carcès was completed in July 2017 and used the same bioclimatic principles as the other schools (exterior insulation, solar protections adapted to sun exposure, etc.). Summer thermal comfort is provided by a dual-flow AHU and natural ventilation openings for the windows of the main teaching building and gymnasium, and a geothermal cooling system.

Pending results from the La Seyne and Saint-Raphaël schools in 2019, the initial feedback on measures implemented between March and June 2018 at Geneviève De Gaulle-Anthonioz middle school is promising. No mid-season or summer discomfort problems have been reported at this point for the main teaching building thanks to the solar protections. Temperatures remained below 26°C on the ground floor and first floor, although DTS predicted over 100 hrs above this level. On the second floor, sun shades were effective and windows could be opened to expel hot air. Geothermal cooling was not needed, which allowed the frigories levels in winter to be maintained longer.

In conclusion, attention should be drawn to the team effort between the various stakeholders from the schematic design phase, including the contractors and the facilities manager, who adopted a sustainable environmental approach beyond just focusing on summer comfort. The projects implemented effective and passive solutions focused on a bioclimatic approach backed by CFD and dynamic thermal simulations. Finally, these three high-quality projects were undertaken simultaneously with a well-managed budget and schedule.

AUDIENCE DISCUSSION

In response to a question on the advantages of PPPs as a vector for teamwork, José Coelho emphasised the desire to bring together design, construction and maintenance teams around the same table in order to provide projects with better insight, regardless of the contractual framework.

With regard to energy use, José Coelho confirmed that it is being tracked but that he has not yet had the opportunity to analyse the data.

For the CO2 rate, José Coelho stated that this indicator is not being specifically monitored. However, particular attention was paid to air quality: air change rate at 25 m^3/hr (beyond the minimum regulatory rate of 18 m^3/hr); choice of indoor coverings and low VOC and formaldehyde emission furnishings, confirmed by measurements at the completion of each of the schools.

In another example from the public tertiary and educational sector, **Gabrielle Raynal, DOMENE engineering firm**, presented feedback from the 400 middle school in Koné, New Caledonia. The school is located in a thalweg and uses a bioclimatic and energy approach inspired by Ecocal recommendations. It is part of a Kanak environmental quality initiative, with Melanesian architecture that promotes innovative and ecological local materials (wood, mudbrick, etc.).


Collège 400 de Païamboué (Koné, Nouvelle-Calédonie)

Due to the environmental profile and climate (tropical ocean climate), the decision was made to build the school on the upper part of the thalweg slopes, parallel to water runoff, with buildings connected by walkways. In-depth reflection on building insulation and natural ventilation was carried out for the project. The prevailing trade winds determined the direction in which the buildings would face.

For the NW-SE facing structures, the decision was made to build stabilised rammed earth constructions featuring closed spaces with three types of comfort management (air-conditioning, fans or dual-aspect spaces that create an effective cross-breeze).
For the E-W facing structures, wood was the predominant building material. Comfort is provided by indoor blinds and fans. The dual-aspect classrooms are connected by walkways.

In terms of user feedback, the following should be noted:
- a striking architectural form (middle schools have diverse architectural approaches that are rarely bioclimatic and usually made of concrete),
- architecture that allows users to take ownership of the space (installation of shade sails in addition to school yard shelters, etc.),
- dissatisfaction with the architectural structure and walkway, which teachers and some students consider too long,
- distance of the infirmary from the classrooms.

In terms of energy use, the load profile projected by DTS studies was 16 kWh/m2 per year, which is lower than actual use at 29 kWh/m2 per year. Electricity use increases significantly during the hot season, stemming from air-conditioning and fan use.

The differences observed between the energy use projections and measured data can be explained by:
- the fact that kitchen and office equipment were not taken into account in calculations,
- a lack of shade (from trees), particularly along the rammed earth walls, which are constantly in direct sunlight,
- increasingly rare trade winds during the assessment period due to climate change, and natural ventilation affected by the blinds in the classrooms, which also increased lighting needs,
- the absence of roof pavers on pedestals, which increases exposure to sunlight on the fifth façade, to compensate for the abandonment of green roofs,
- an unused BMS due to a lack of technical and financial resources, despite the fact that this tool could detect and remediate abnormal use and energy-intensive systems.

Finally, a survey conducted with users identified a work environment that is slightly too hot, confirmed by significant local climate changes (fewer trade winds, higher average temperatures compared to normal seasonal temperatures).

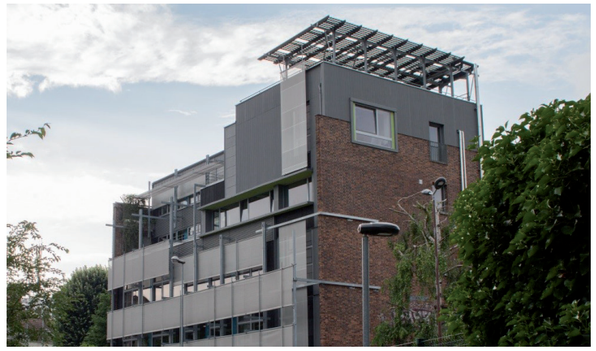
AUDIENCE DISCUSSION

With regard to the performance of rammed earth buildings compared to wood-framed structures, Gabrielle Raynal confirmed the advantages of this material as long as the facades and roof (preferably green roof) feature solar protection.

As far as the budget envelope was concerned, Gabrielle Raynal mentioned the higher cost resulting from the use of rammed earth, which is an uncommon material, however they managed to stay on budget. In addition, the project received a Terra Award, allowing the local project owner to be asked to launch an operational monitoring mission that benefited feedback.

With regard to the use of the Ecocal approach for a tertiary building, Gabrielle Raynal explained that some of the planned materials were not used.

After a brief presentation by the engineering firm about the original building selected, **Eric Hutter, Director of INEX**, explained that the goal was to design a building with a low environmental impact that reflected the company's image and acted as a "laboratory" for ideas and solutions. This project won the 1st prize of the 4th Tertiary Building Sustainable Renovation plan (Rénovation Durable Bâtiment) for the Île-de-France (Paris) region.



With questionable aesthetic appeal and a poor energy balance of 450 kWhep/m² per year, the architectural solution was to add two additional levels to the existing building and completely redo the facades by installing natural wood fibre insulation and solar protections. In terms of comfort, the challenge was to organise a suitable solution for the few cold and hot weeks during the year. The decision was therefore made to use free cooling, fans and adiabatic cooling rather than install air-conditioning. The idea was to prevent the building from heating, which requires the involvement of the occupants.

Mechanical ventilation is provided by two dual-flow air handling units (AHU) (winter and summer) with energy recovery ventilation and low-energy motors, and output adapted to the building occupancy. In terms of natural ventilation, occupants can open the windows according to their needs. Thanks to dual-aspect spaces, they are ventilated effectively and counter mid-season discomfort. Fans installed above each work station are activated according to daytime heat.
The building is equipped with numerous measuring devices, with results displayed on a dashboard that allows users to control energy consumption on the premises. In the event of an anomaly, problems can be quickly identified and fixed from a workstation.

In addition, in order to obtain the BEPOS certification, 100 m² of solar panels were installed along with a dual glass panel pergola. Seasonal thermal energy storage was also installed. This hybrid solution is designed to cover up to 20% of energy needs. The project also features vegetation, and resources such as rainwater are recycled.

Feedback from an internal survey of the occupants is positive, with 92% of respondents stating they were satisfied with the summer thermal comfort. 12% even kept their warm clothing. When occupied, the temperature fluctuates between 24.5 and 28°C depending on the level. When the summer AHU is on, the indoor temperatures stop changing and stagnate. Finally, when the rooms are empty, the temperature drops down to 20°C when the windows are open.

With energy use at 43.7 kWhep/m² per year for 46.8 kWhep/m² per year of energy production, conditions under the BEPOS certification have been met. Just as for 2017, the RT2012 assessment should be positive in 2018.

AUDIENCE DISCUSSION

In response to a question about the possible use of free cooling supplemented by the summer AHU at night, Eric Hutter explained that only the first tool was used, except during the 2016 heatwave, where adiabatic cooling was also used when the building was unoccupied.

With regard to the risk of intrusion, Eric Hutter indicated that openings are located on the top part of windows and prevent any intrusion.

Concerning the cost of the renovation project, Eric Hutter answered that it was around €2,500/m², furnishings included. The Region and ADEME provided €140/m² in funding for the project.

Concerning the use of the BMS and automated windows, Eric Hutter confirmed that the system is effective, but explained that there have been associated cost and maintenance problems, particularly in educational institutions, where maintenance budgets are increasingly being cut back. The key is to ensure that the user is involved in thermal comfort.

Still on the same topic of comfort and the use of automated systems in schools, one participant underlined the need for them with regard to observed use disparities, sometimes within the same building. Another participant pointed out the need for assistance and even for users to be educated so that they become aware of the impact of their behaviour. Lastly, a final participant underlined that automated systems do not necessarily mean that occupants are subordinate as they can still override these systems. In any case, information from the user is fundamental and essential.

Hervé Carloz considered that the success of a project depends on the right balance between user autonomy and correcting their errors. The BMS needs to be user-friendly and involve the user in making them run properly, confirmed Eric Hutter.


José COELHO
Oasiis


Gabrielle RAYNAL
DOMENE


Eric HUTTER
INEX


Daniel FAURE
Moderator

WORKSHOP 2: Summer comfort and ventilation

"In the context of summer comfort, ventilation is the visible part of the iceberg," said **Robert Célaire, Energy & Environment Engineer** in his introduction. Ventilation is essential, but summer comfort requires an overall approach that includes many other elements and design issues such as management of the urban heat island (UHI), the design of outdoor spaces, including vegetation, the implementation of an overall solar protection strategy, inertia design, management of heat sources inside the building, and the use of low-energy cooling technologies, all carried out using the right simulation tools.

User behaviour, how they appropriate the building and how their expectations are met in terms of overall comfort are also essential. For example, on completion of the entirely bioclimatic building for the head office of the Guadeloupe National Park, the occupants were informed during the design phase that dynamic simulations showed that they would experience slight discomfort 12% to 15% of the time spent in the building, but that by not installing air-conditioning, they would be able to finance other high-quality features (wood construction, vegetation, indoor fountain, etc.). This led to an extremely high level of satisfaction (confirmed by a survey) after one year of using the building. It is therefore important to work on the overall comfort (aesthetics, smell, acoustics, etc.), which can partially counterbalance slight thermal discomfort and encourage the use of amenities that are more environmentally friendly.

Finally, Robert Célaire encouraged projects to be developed with a bioclimatic approach that focuses on equality for all users in terms of overall comfort.

Nicolas Piot, SEGE Montpellier, presented feedback on free-cooling used in the Freevent project financed by ADEME, which led to the publication of a design guide.

To provide as much comfort as possible in the summer without using air-conditioning, particularly in new or renovated buildings, free-cooling, and night flushing in particular, is a summer comfort strategy that should be promoted for its potential to expel thermal energy that accumulates during the day. The effectiveness of this strategy was assessed for several projects.

- For offices located in Labège (31), free-cooling using motorised openings brings the temperature down by 2°C, in line with initial basic designs (worst-case scenario). After two years of configuration, users are happy with this performance level, knowing that temperatures rarely exceed 26°C at the end of the day in this high-inertia bioclimatic building.

- For offices in Valence (26), free-cooling uses an extractor that runs from 10pm to 7am and the occupants are asked to open the windows when they leave. The system is effective but can generate cold discomfort, causing users not to open their windows. The potential gains are therefore not achieved due to the closed windows. It is recommended that temperature probes be installed in order to stop free-cooling when the desired temperature is achieved and that users be informed about the importance of opening the windows.

- For a childcare centre in Vitrolles, when the building was designed, the designers underestimated the heat produced by sunlight and internal sources during the day and over-estimated potential natural ventilation. Night-time cooling is therefore not used to its full potential. Air-conditioning was therefore installed in addition. However, it would have been better to supplement the system with ECM fans and improve solar protection.

- For a dojo (martial arts centre) in the Ain not initially designed for free-cooling, work was carried out on several occasions in an attempt to create free-cooling with the existing equipment, output and regulation. Comfort was improved to the detriment of the EER. These results demonstrate the importance of having a good initial design.

- For a private home in the Haute-Garonne, despite an excellent EER, cooling provided by the dual-flow ventilation was insufficient. Much more effective free-cooling is therefore required, particularly in the bedrooms.

The general assessment of this feedback shows that free-cooling needs to be worked into the initial design, and that in most cases, it will not offset deficiencies in the bioclimatic optimisation of the building. In the Mediterranean climate it will only be a viable solution for truly bioclimatic buildings where external and internal heat loads have been optimised.

A series of conference sessions organised under the Freevent project also provided feedback from professionals on free-cooling.

Mohamed Abdesselam, President of the SOLENER engineering firm, Frédéric Nicolas, Architect, and Eric François, CEA Cadarache/LITEN presented feedback on the head office of INES (National Solar Energy Institute), which was the result of real teamwork. Helios is an emblematic zero fossil fuel, zero CO2 emissions and zero refrigeration fluid tertiary building that was the subject of a European architecture competition launched in 2007. The bioclimatic building features a compact heliotrope architectural design with distinct dynamic facades and a central atrium that serves as the thermal heart of the project. The huge south-facing wing is tilted at a 30° angle and is equipped with thermal sensors.

The building is home to highly technical research and includes several laboratories and areas with high internal thermal loads, requiring appropriate ventilation and cooling. To do so, the architects based their design on the basic energy requirements – annual consumption below 27 kWhEP/m² per year and at least 40% of energy provided by solar power. The walls are therefore hyper-insulated and to optimise energy sources, the facades were each designed differently, acting as a filter between the outdoor and indoor atmosphere. On the north side, the world's largest sundial adorns the technical rooms at the entrance of the building. On the west side, the façade changes according to what time of day it is. The motorised silk-screen printed glass provides shade and


Hélios building
(Chambéry, Savoie)

is connected to a clock so that the protections always face the sun. The south-facing facade features a large overhang. Finally, the facade includes a system of light shelves and each window is equipped with adjustable blinds.

The central atrium provides a relaxed gathering area enhanced by optimised natural light. It reduces energy loss and facilitates natural ventilation with wood/metal cladding.

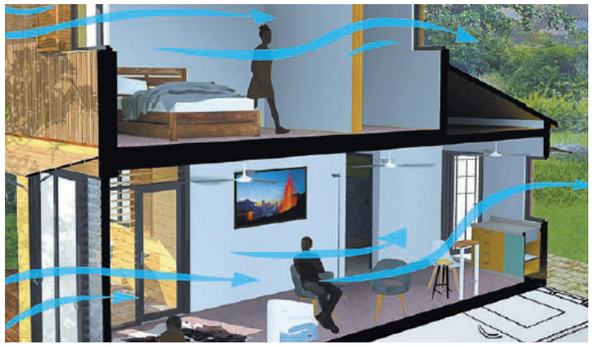
Cooling is provided by natural ventilation with night flushing. The facades feature windows between the offices and indoor passageways, and the atrium. The BMS (Building Management System) manages the vents, but users can open windows in the offices. Finally, the building has a high level of thermal inertia that absorbs peak temperatures in the summer months.

Measurements taken in the atrium have confirmed that in the summer, there is a 5 to 6°C temperature difference between the outdoors and the lower part of the space, and a 4 to 5°C difference in the mid-portion. The same generally applies for the offices, even during heatwaves. The air change rate is over 30 ACH (air changes per hour) in the atrium when all the windows are open. In any case, the building's operation and management have met expectations.

Catherine Morel, Réunion CAUE (Architecture, Urban Planning and Environment Council), presented the work conducted in collaboration with the Construction Quality Agency (AQC) regarding feedback gathered from the "REX Bâtiments performants" (High-performance Building Feedback) initiative designed and developed by the AQC concerning natural ventilation on Reunion Island. The goal of the study was to select 12 key lessons concerning natural ventilation, in order to identify obstacles and best practices, whether in terms of design, construction, or the behaviour of building users. "What makes users open windows to feel comfortable?"

These key lessons varied, from the issue of density, which can cause real discomfort (direct views, privacy, noise, insecurity, etc.) resulting from the balance between the project specifications and design, to building elements which can seem trivial, such as accessibility for opening windows. To create tangible results, dynamic thermal simulations (STD) need to include continuous and accurate information from users.

Feedback was collected from 46 exemplary high-performance buildings through audits and interviews with primary stakeholders and users. From this, 12 key lessons were identified for facilitating natural ventilation.



- Take into account the risk of intrusion right from the design phase, by giving priority to secure systems that allow air to circulate.
- Include easy-to-use and suitably sized windows and doors.
- Design with occupant privacy needs in mind, for example with architectural features on the facades such as sliding louvre shutters.Integrate solutions to specific acoustic problems into walkways by opting for passageways with access to one or two housing units or by using low-resonance materials on floor landings.
- Incorporate solutions for general noise problems caused by the external environment by installing buffer areas.
- Ensure that fans are well-placed and that sufficient space is kept below the fan blades.
- Choose high-quality fans adapted to the housing unit and that have a speed control.
- Include access to and maintenance for green spaces.
- Choose plants according to the environment, giving priority to plants that are native to the region.
- Integrate the need for both rain protection and natural ventilation.
- Take into account the type and colour of materials located near openings so that they do not heat the ventilated air.
- Keep occupants well-informed in order to optimise natural ventilation.

"'A passive building needs active occupants' is what needs to be constantly repeated," concluded Robert Célaire.

AUDIENCE DISCUSSION

With regard to managing the acoustics between the offices and walkways in the Helios building, Frédéric Nicolas explained that the ventilation screen was lined with a panel to attenuate resonance.

In response to a question on the slight change in the position of the building compared to a N/S-facing direction, Frédéric Nicolas explained that it was based on an optimum compromise between urban planning alignment requirements and optimum heliotropic design, without a significant impact on energy use and thermal comfort.

In response to a question on managing the atrium, Frédéric Nicolas pointed out the ventilation solutions installed north and south of the glass roof, and shading canopies. This equipment is put to use based on information from the temperature probes and measured solar energy. The vegetation, which contributes to the atmosphere, helps cool the air and provides a general sense of well-being, is also effective.

Robert CELAIRE
Animateur

Nicolas PIOT
SEGE Montpellier

Mohamed ABDESSELAM
Bureau d'études SOLENER

Frédéric NICOLAS
Architecte

Eric FRANÇOIS
CEA Cadarache/LITEN

Catherine MOREL
CAUE de La Réunion

WORKSHOP

WORKSHOP 3: Summer comfort and homes

Before presenting feedback on two private homes without air-conditioning that remain below 25°C in the summer, **Pascale Birotteau, A4 Architecture**, underlined the work done to educate the occupants, allowing them to take real ownership of the buildings and their passive design.

- The first home, located in Luynes, has a wood frame, concrete floors and wood fibre insulation. It features dual-flow ventilation, a thermodynamic water heater and a wood-burning stove. The architect worked closely with the residents on optimising the solar protections (roller tilt shutters), which at the owner's request, were automated so that the shutter slats tilt according to the sun. Total annual cost of utilities, including wood pellets - €960 including VAT.

- The second home, located in Aix-en-Provence, has crushed lavender straw insulation for the exterior walls and roof. Other than a rarely used wood-burning stove, all the installations are electric. The building's inertia has a positive impact on energy performance. Ventilation is provided by a single-flow system with recovery for hot water, and heating is provided by an air-to-air heat pump. Total annual cost of utilities, including cooking gas - €1,000 including VAT.

AUDIENCE DISCUSSION

Regarding the use of straw, Pascale Birotteau explained that the internal wall structure was crossed in order to optimise insulation, the drawback being the heavy weight. The use of this material added an extra €30,000 to the building cost.

Concerning the management of the home, Pascale Birotteau explained that because the occupant is legally blind, the home automation system was simplified as much as possible. The owner also adapted to the use of adjustable sun shades and the solar protection has always been efficient.

Regarding the crawl space in the first home, Pascale Birotteau said surface insulation was used.

For the heating of each of the homes, Pascale Birotteau explained that little heating was required since the sun provides more than enough passive heat. The aim was to recover the heat and distribute it as well as possible. The dual-flow distributes hot air and two towel heaters set at 21°C also provide heat.


Maison individuelle (Aix-en-Provence, Bouches-du-Rhône)

Courtois Energies Conseil develops building monitoring solutions that use different measuring technologies adapted to the local context, with personalised customer support, explained **Jean-Marie Courtois, Courtois Energies Conseil engineering firm**. With the Specrt@ solutions application, which includes the installation of energy meters, probes, and real-time monitoring tools, etc., the joint aim is to reduce energy consumption while improving the comfort of residents.

As part of its strategy to improve energy performance and support sustainable development, the social landlord UNICIL tasked Bureau Courtois Energie Conseil with overseeing a renovation project in Digne-les-Bains. The housing estate in question (Champourcin) has 44 three- and four-bedroom villas, each of which had insulation installed on the exterior and in the attics, new double-glazed PVC doors and windows, new individual air-to-water heat pumps, and Type B hygro-adjustable mechanical ventilation units, etc. The villas were also equipped with 6 electricity meters and 2 thermal energy meters.

As for assessments from the instruments, initial monitoring of indoor vs. outdoor temperatures is in place. Thermal energy data for heating needs to be validated with precision. Heat pump COP monitoring remains to be integrated, the influence of hygrometry needs to be characterised and accurate outdoor temperature monitoring adapted to the housing estate needs to be put in place. Then performance can be characterised by examining energy use in kWh (excluding for hot water) compared to the change in degree day in the winter, in order to define operating anomaly alerts.

The total cost of the renovations was €2 million excl. VAT for the entire housing estate, including €1 million for the exterior insulation. This cut the electricity bill by around 25% for each villa, and improved winter and summer comfort, especially upstairs, thanks to the loft/attic insulation. The energy performance level after the renovation for each housing unit was 96 Kwh in primary energy consumption per m2 per year. The project was been met with full satisfaction by the residents and it did not increase their rent.

To identify the advantages and drawbacks of the new thermal regulations for construction in Morocco, a call for projects was launched as part of financial support from the European Union for the National Energy Efficiency Programme for buildings. 9 projects were selected, including the housing pilot project Fal El Hanaa, in which **Zakaria**

AUDIENCE DISCUSSION

With regard to temperature regulation, Jean-Marie Courtois explained that each villa has inside thermostats connected via Bluetooth.

Concerning heating for the villas, Jean-Marie Courtois underlined that additional work is required to analyse the thermal data in detail. Furthermore, besides the energy performance assessment, he recommended implementing accurate monitoring of performance and electricity consumption to be characterised with respect to the local degree day.

With regard to interaction with users, Jean-Marie Courtois explained that each occupant will eventually have access to data on their villa and they should be informed about the proper behaviour to adopt. One participant felt that this point should become part of a communication policy to be defined with the social landlord and validated with the tenants.

Sadik, from the Alto Eko engineering firm was involved. Supported by the Moroccan Agency for Energy Efficiency (AMEE) and ADEME, 80% of the project's extra costs for investment in energy-efficient solutions were funded. It also has a strong social element as it provided housing to relocate over 400 families previously living in slums.

The bioclimatic design chosen for the programme helps reduce energy needs for heating, air-conditioning and lighting. Different types of insulation were selected, combined with double-glazed windows, for an additional cost of around €10/m2. Hot water is produced by solar panels, which offsets the cost of thermal energy produced for the tenants.

Follow-up identified feedback on winter and summer thermal comfort, problems, constraints, operational savings, etc. For instance, when the outside temperature is 38°C, the indoor temperatures remain below 28°C, except for west-facing rooms.

Thirty-two of the seventy-seven buildings in the property development have air-conditioning, due to the fact that they were built before funding was secured for energy efficiency. Furthermore, with current uses and practices in Morocco, families tend to install an air-conditioner as soon as they move in. It is therefore essential that they be well-informed to ensure optimised use of the homes and to influence urban aesthetics and mitigate the urban heat island effect.

The energy bill was also reduced by 60%, i.e. approximately €18 per month for an apartment of around 65 m^2.

AUDIENCE DISCUSSION

Regarding the compliance of property development projects with the new Moroccan thermal regulations, Zakaria Sadik explained that AMEE uses calculation software to issue compliance certificates and construction permits. However, on-site monitoring is still lacking.

Concerning the use of insulation, Zakaria Sadik indicated that Morocco produces cork. However, current regulations limit its use.

In response to a question about whether renovation incentives exist, Zakaria Sadik cited several programmes to encourage the installation of solar panels, the rehabilitation of office buildings and energy-performance contract initiatives.

Pascale BIROTTEAU
A4 Architecture

Jean-Marie COURTOIS
Courtois Energie Conseil

Zakaria SADIQ
Alto Eko

Sophie GENTIL
Moderator

GUESTS

SUSTAINABLE BUILDINGS IN MOROCCO

BIOCLIMATIC RENOVATION OF A HOUSE IN THE MEDINA OF RABAT AND FAL EL HANAA HOUSING

In Morocco, the last decade has seen a number of major infrastructure and housing projects come to life, explained **Zakaria Sadik, Alto Eko engineering firm**. The Kingdom has also become engaged in a policy of energy efficiency and promoting renewable energies, in line with COP22. To address the country's energy expenditure, an energy-efficiency approach is required to reduce the source of consumption, particularly in the industry and building construction sectors. Act 47-09 therefore seeks to increase energy efficiency in the use of energy sources, prevent waste and contribute to sustainable development, etc. Its implementation primarily relies on energy efficiency requirements, with the integration of bioclimatic design, energy impact studies, mandatory audits and technical inspections.

The Thermal Regulations for Construction in Morocco (RTCM) therefore includes characteristics required for new building projects for the various components of the building envelope for different climate zones, and the number of picture windows. Its implementation has drawn on pilot projects supported by the European Union and AMEE, with full or partial funding for the extra cost of energy-saving measures used on the pilot buildings. Among these projects, the residential property development project Fal El Hana, which receives support from ADEME, plans to cut energy needs for each home by half, or even two-thirds, by installing:

- roof insulation (extruded polystyrene),
- wall insulation (perlite, fibreglass),
- double-glazed windows (PVC sliding glass),
- solar water heaters (semi-collective and thermodynamic collective heaters).

In terms of summer comfort, for an outside temperature of 38°C, the indoor temperature varies from 26°C in the bedrooms, to 27.2°C in the lounge, depending on the direction in which they face. Natural ventilation can therefore be used instead of air-conditioning. Unfortunately, this is not the case for the project's first homes, which did not benefit from funding.

Finally, according to Zakaria Sadik, *"Moroccan regulations are still lacking when it comes to comfort and energy-dependency reduction objectives, which are not addressed."* However, actual implementation of the energy-efficiency strategy continues to diminish the impact of external heat sources and improve indoor comfort. Natural ventilation, the stack effect and suitable façade colours are strategies that need to be developed for bioclimatic plans for zero air conditioning in Morocco.

Myriam Soussan and Laurent Moulin, Archibionic, presented a project involving the renovation of a riad in the medina of Rabat, via video. Transformed into a completely self-sufficient 207 m^2 modular three-storey loft, the riad is part of an innovative sustainable development approach that led to the design of an urban home that does not rely on public utilities. The full scale of the home, with its different levels can be seen as soon as people walk in the door. The occupants can move about in several different spaces that open on to each other, but that can also be closed off and transformed for different uses. On the top floor, all the rooms can be transformed and are connected by suspended walkways. The appointed roof-top terrace features photovoltaic panels that also provide shade for the outdoor eating area. A vegetable garden and potted fruit trees are planted around the edges. The garden includes a greywater treatment system and access to the well and rainwater collection tank.

The bioclimatic processes that make the riad self-sufficient include two double-glazed skylights, high thermal inertia walls (earth/stone), photovoltaic power, cork roof insulation, double-glazing, and a greywater filtration system.

In terms of thermal comfort, the two large double-glazed retractable skylights provide natural heat in the winter thanks to the greenhouse effect they create when they are closed. When open, the courtyard regains its function with natural ventilation. In summer, indoor temperatures are at around 25°C. There is no need for artificial air-conditioning as the use of blinds, combined with plants and windows that are kept open at night create efficient ventilation. During heatwaves, the inertia of the building is fully optimised, which keeps the indoor temperature at around 27°C when it is 40 to 45°C outside for 4 to 5 days.

Riad rénové dans la Medina
(Rabat, Maroc)

AUDIENCE DISCUSSION

Concerning the cost of equipment for the riad, Bernard Cornut, ADEME, indicated that it cost around €20,000 to achieve complete self-sufficiency.

In response to a question about the occurrence of extended heatwaves, Laurent Moulin answered that it would be unnecessary to design a home for this type of relatively rare risk in Morocco. The existing passive solutions have proved their effectiveness over several days. The problem would be more relevant to Asia and humid regions.

Regarding Moroccan thermal regulations, one participant underlined the flaws of a text based on old Tunisian and French legislation. For example, the RTCM does not take into account condensation and thermal inertia issues. Zakaria Sadik explained a desire for energy-efficiency requirements to better promote local solutions adapted to Morocco, such as the use of cork.

Zakaria SADIK
Alto Eko

Myriam SOUSSAN
Archibionic

Laurent MOULIN
Archibionic

REPORT

141 LOW-ENERGY PILOT BUILDINGS:
LESSONS ON THERMAL COMFORT

After a brief presentation of the PREBAT "pilot building" programme, **Jean-Alain Bouchet, CEREMA** looked back at the assessment of summer thermal comfort to remind participants that "it cannot be measured, but is assessed through indicators such as the number of hours where the temperature is above 28°C or the level of comfort according to French standard EN NF 15251 on adaptive comfort." Thermal comfort also depends on the climate region and how hot the summers are. The user's activities, way of dressing, experience and habits also determine their perception.

With respect to the number of hours where the temperature is above 28°C, this limit is not exceeded in half of low-energy buildings. However, 20% of projects encounter real difficulties, more so for collective housing than private homes.

According to French Standard EN NF 15251, which provides for more detailed assessment of thermal comfort in the summer, discomfort is not specifically correlated to the climate region.

The DIES indicator (Statistical summer duration of discomfort) provides a weighted measurement of the intensity of discomfort with respect to the satisfaction of the occupants, and only reveals situations of extreme discomfort, which are relatively rare.

Surveys on summer comfort were also conducted with occupants. They revealed that one quarter of the occupants are dissatisfied, in correlation with the measurements taken. They were unsatisfied with the difficulty of managing solar heat, the windows and shades. This can be explained by systems poorly-suited to the context of future use, unwanted work by the occupants or a lack of active cooperation, and a lack of consideration for the external environment, (intrusion, privacy), etc.

Jean-Alain Bouchet explained that low-energy buildings are more sensitive to the quality of thermal management in the summer. They are designed to capture solar heat in the winter and confine it with internal sources, thus requiring involvement on the part of the occupants. Thermal management practices have more impacts than in traditional buildings. They require technical skills and cultural knowledge, even though some practices are well-established in the Mediterranean (close windows during the day, ventilate at night, etc.). Opening windows at night provides particularly effective and essential natural ventilation for counteracting thermal confinement. However, problems exist around the effective opening area of windows (manoeuvrability, porosity, etc.), external noise, safety, bad weather, etc. The Freevent design guide was developed as the result of a multi-partner project and identifies recommendations for designing and implementing efficient free cooling systems in new and renovated buildings.

In conclusion, Jean-Alain Bouchet insisted on the fact that due to its socio-cultural nature, thermal management in the summer needs to be extended across the entire region.

AUDIENCE DISCUSSION

Concerning the proper use of low-energy buildings, one participant called for simpler recommendations and assessment for both building professionals and occupants. Jean-Alain Bouchet agreed with this point of view, underlining that current legislation does not regulate the use of buildings. Another participant reminded the group that as things stand, regulations and associated instructions are extremely difficult, if not impossible to apply. As passive buildings are more difficult to manage, they require the active involvement of the occupants, underlined Jean-Alain Bouchet.

With regard to the complexity of the DIES indicator, Jean-Alain Bouchet acknowledged that the method used to calculate it makes it hard to understand.

One participant reiterated the subjective nature of summer comfort, which should be taken into account in the precision of assessments and simulations. The essence of bioclimatic architecture is to take into account sensibilities via quality calculations and tools.

Robert Célaire encouraged people to think in terms of overall comfort, and not just thermal comfort ("happiness exists below 19°C and above 28°C). This helps generate effective energy solutions, because while gaining a few degrees may be very costly from a financial and ecological standpoint, creating an acoustically, olfactory, visually or psychologically pleasing environment will significantly increase overall comfort in the long run. It would be interesting to bring together and compare a variety of diverse expertise at the 2019 symposium.

Jean-Alain BOUCHET
CEREMA

URBAN COOLING: WHAT DO WE NEED TO KNOW?

2017 ADEME STUDY

Karine Lapray, Tribu engineering firm, presented the Landscape and Environment Plan (PPE) for Villeurbanne, developed after an extensive investigation on urban cooling.
Adopted in 2012, the Villeurbanne PPE aims to promote the landscaped environment and nature in the city. It includes four major strategies, guidelines for each landscape entity and eight priority action programmes, which were mapped out in 2013. A study carried out in 2015-2016 was then used to assess the plan with regard to urban climatology.
To work on urban cooling and develop action plans, a distinction needs to be made between urban overheating and urban heat islands (UHI). The first is a multi-faceted problem that occurs during the day and at night, with impacts on entire cities and individuals, in outdoor spaces and buildings. It is also a health issue during heatwaves.
UHI on the other hand, is caused by high localised temperatures, and particularly night-time highs, recorded in the urban environment as opposed to neighbouring rural or forest areas.
In this context, options available to municipalities concern surface factors (evaporation, thermal storage, etc.) anthropic factors (pollution, heat emission, etc.) and morphological factors (wind erosion, radiation trapping effect, etc.). Through a cross-analysis of data, Tribu developed a map showing the contribution of the urban fabric to urban overheating. Based on this, the engineering firm worked with the city to define tools to improve the climate and urban microclimate, such as the local urban planning and housing strategy (PLU-H), urban projects, the management of public spaces and incentives/partnerships with the city's other stakeholders (industry, social landlords, etc.).
A second study carried out in 2017-2018 further developed these tools and applied them to five major focuses: exemplary urban planning projects, climate component of the PPE, overlapping urban overheating/air quality issues, PLU-H (future modifications) and public space planning. The City of Villeurbanne project was organised around a steering committee, overseen by two elected officials, and a technical committee involving all the municipal services, in order to implement green and blue cooling solutions (trees, low-growing plants, green walls, ponds/water elements, fountains, etc.).
To assess the actions of the PPE, Karine Lapray and her team used urban overheating and apparent temperature indicators to compare the effectiveness of the various green and blue solutions, and their impact through a map of wind corridors. This makes it possible to visualise the impact of municipal initiatives on urban cooling over the course of each term of office and set targets for the years to come.
At the same time, work was also done on the benefit-cost ratio for the various cooling techniques and on the environmental co-benefits (improved biodiversity, air quality, etc.).
Using this information and in consistency with the PPE, an environmental action plan was developed with cross-cutting actions ("tree" plan, "shade" plan and "water» plan) and one-off initiatives adapted to different uses and types of spaces, etc. Educational sheets were also created for the technical services.

In terms of the future, Karine Lapray mentioned the development of a "municipal equipment" plan, the definition of a cool environment in private spaces with crucial importance in the economic sectors, and communication initiatives on cool oases.

AUDIENCE DISCUSSION

Concerning the mobilisation of stakeholders and dealing with opposition, Karine Lapray emphasised the engagement of elected officials and municipal services. Work to inform people and familiarise them with vocabulary was also carried out in advance.

Regarding the partnership with the City of Villeurbanne, Karine Lapray explained that the method was developed gradually in conjunction with the PPE.

Concerning the cost of the study, Karine Lapray said that it cost around 25,000, and that support is essential.

Regarding the possibility of heat transfer via the Rhône River, Karine Lapray said that the river has a different behaviour as it cools during the day but heats at night.

Karine LAPRAY
Tribu

SUMMARY OF THE DAY AND CLOSING

The 2018 edition of Bâti'Frais invited participants to explore initiatives implemented on both sides of the Mediterranean, according to Daniel Fauré. The 2019 edition will open up to other regions and concepts, such as climate change, and other professionals, including insurance companies and reinsurers.

Florence Rosa congratulated the participants for the quality of presentations and feedback, which confirmed the importance and relevance of the bioclimatic approach promoted by EnvirobatBDM. It is clear that work needs to be done on sociological and cultural factors. "We need to raise better awareness to lay the proper groundwork for existing and future solutions." It is therefore important to pursue efforts to share and gather collective intelligence because an all-encompassing solution is needed.

ACRONYMS

HVAC: Heating ventilation and air-conditioning
PPE: Landscape and Environment Plan
BMS: Building Management System
AHU: Air Handling Unit
DTS: Dynamic Thermal Simulation
CFD: Computational Fluid Dynamics
VOC: Volatile Organic Compound

2018 BÂTI' Marseille FRAIS

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ENGIE Axima

KNAUF INSULATION

NILAN OUTSTANDING INDOOR CLIMATE

siniat

Partenaires presse

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LE MONITEUR DES TRAVAUX PUBLICS ET DU BÂTIMENT

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