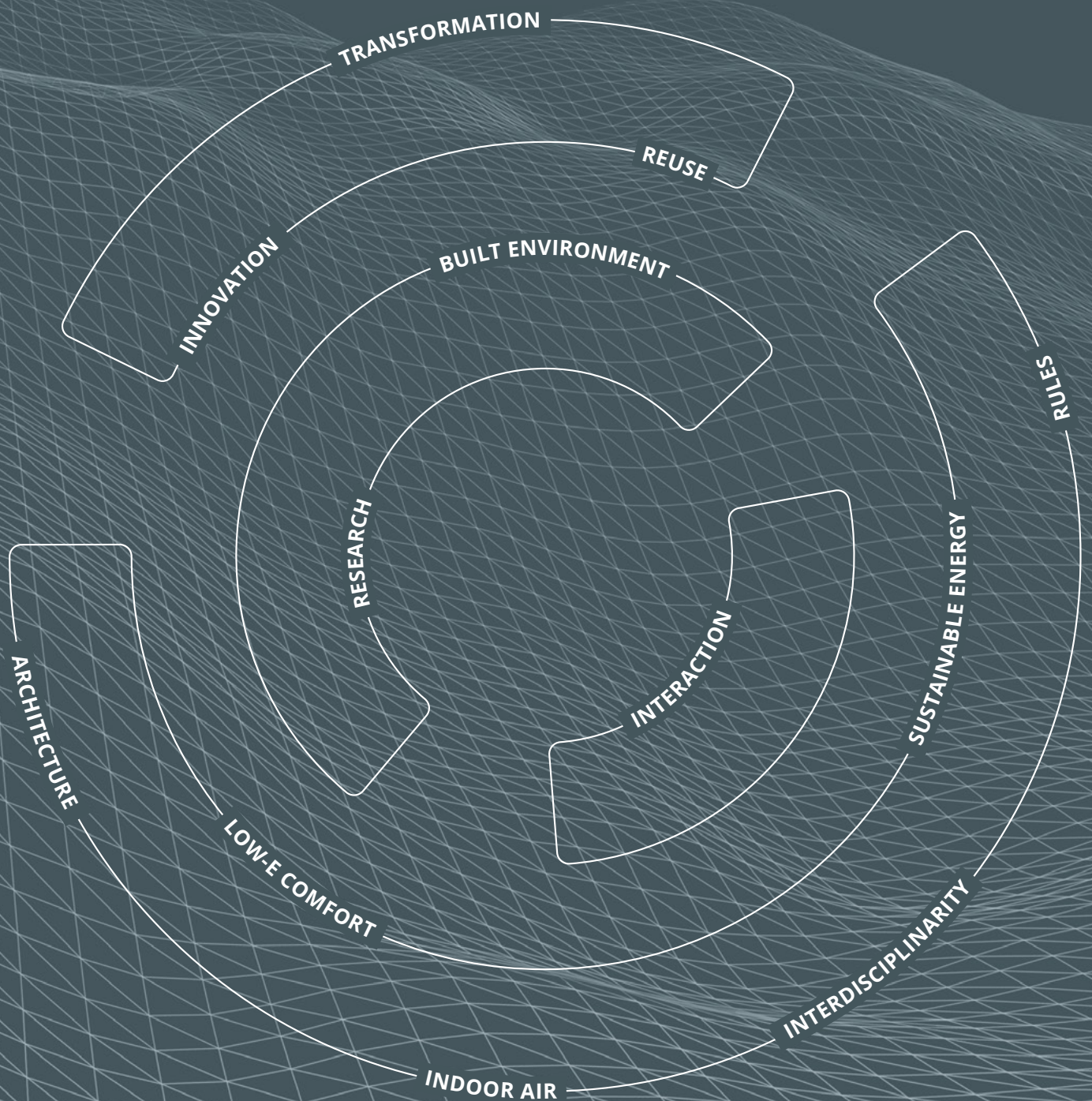


# 2021

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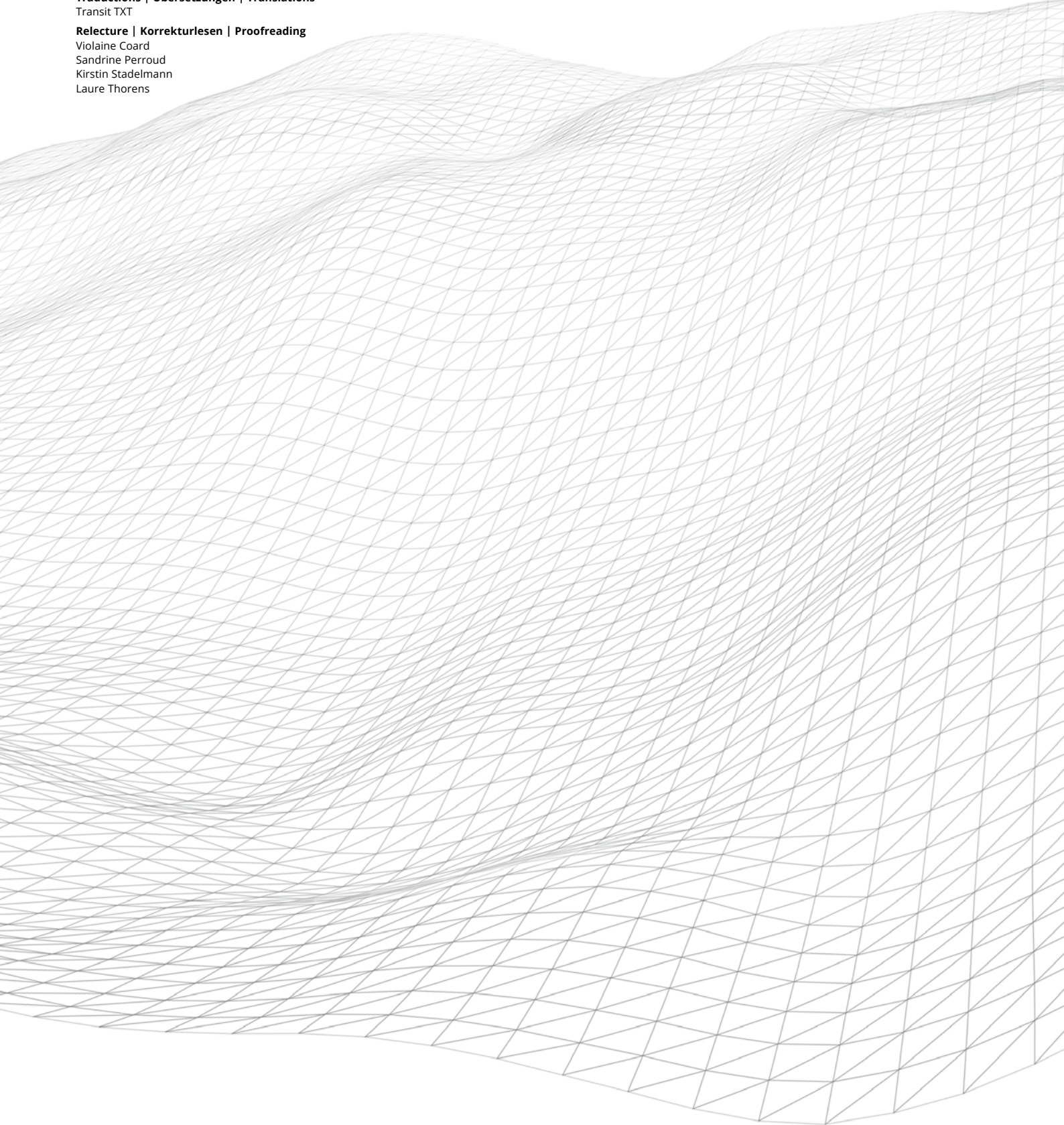
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# Avant-propos

## Editorial

## Foreword

FR

L'année 2021 a permis au Smart Living Lab d'effectuer d'importantes avancées dans toutes les dimensions de sa mission, en tant que centre de recherche fondamentale et appliquée. La construction de son bâtiment a été mise au concours et le marché a été remporté par JPF Entreprise Générale SA de Bulle, tandis que la procédure menée par BFF SA comme maître d'ouvrage a été accompagnée étroitement par les spécialistes du Smart Living Lab.

Il est particulièrement réjouissant de relever que le soutien populaire au développement du quartier d'innovation de bluefactory a été confirmé lors de la votation cantonale du 13 juin 2021. Tous les chantiers nécessaires à la transformation de l'ancienne friche industrielle, qui se conjuguent avec la réalisation du bâtiment du Smart Living Lab, ont ainsi reçu une impulsion décisive.

Le Smart Living Lab développe un jumeau numérique de son bâtiment sous forme de maquette BIM dynamique, qui permet d'effectuer des simulations et de produire des visualisations interactives en réalité augmentée. Ces développements ont été présentés à la communauté scientifique et à l'industrie lors de la conférence CISBAT 2021 et du Forum construction durable d'energissima.

Les échanges entre les scientifiques et le public ont aussi eu lieu autour des prototypes développés au Smart Living Lab : le pavillon visant à prévenir les îlots de chaleur urbains installés en ville de Fribourg et la passerelle construite en béton de réemploi présentée à la presse en première mondiale en sont des exemples. Des membres du Smart Living Lab à la pointe dans leur domaine sont intervenus à la Journée cantonale du développement durable, au Forum du logement, à RENT Switzerland, dans les conférences Salon Public sur l'avenir énergétique, et dans un contexte international aux Swiss-US Energy Innovation Days.

Le présent rapport donne un aperçu de la production scientifique du Smart Living Lab en listant les projets, publications et contributions aux conférences spécialisées. La force du Smart Living Lab réside en particulier dans la collaboration interdisciplinaire, illustrée en 2021 par l'initiative de répondre à l'appel d'offres du programme SWEET « Living & Working » de l'Office fédéral de l'énergie avec une dizaine de partenaires académiques de toute la Suisse, coordonnés par le Smart Living Lab. Remporté en 2022 par le Smart Living Lab, le projet de

recherche SWICE qui en découle vise à réduire la consommation d'énergie du pays sur la base de collaborations directes avec la population à travers des « living labs » sur huit ans.

Nous avons, en outre, le plaisir d'accueillir la professeure Séréna Vanbutsele en tant que nouvelle responsable de l'Institut TRANSFORM de la Haute école d'ingénierie et d'architecture de Fribourg, ainsi que plusieurs nouveaux membres du Comité de pilotage conjoint, à la suite de la réorganisation de la direction de l'EPFL.

2022 verra le début de la construction du bâtiment qui, une fois occupé, permettra au Smart Living Lab de réaliser véritablement ses ambitions de « living lab » et de développer encore davantage son rayonnement, en accueillant, sur une surface d'environ 5'000 mètres carrés, les équipes de recherche de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg.

**Marilyne Andersen, directrice académique, et Martin Gonzenbach, directeur opérationnel du Smart Living Lab**

DE

2021 konnte das Smart Living Lab im Rahmen seiner Mission als Zentrum für Grundlagen- und angewandte Forschung wichtige Fortschritte in sämtlichen Tätigkeitsbereichen erzielen. Die Ausschreibung der Generalunternehmung seines neuen Gebäudes wurde lanciert und der Auftrag an JPF Entreprise Générale SA in Bulle vergeben. Die Spezialistinnen und Spezialisten des Smart Living Lab waren stark in das von der BFF SA als Bauherrin geführte Verfahren eingebunden.

Besonderes erfreulich ist der starke Rückhalt, den die Entwicklung des Innovationsquartiers von bluefactory in der Bevölkerung genießt und der anlässlich der kantonalen Abstimmung vom 13. Juni 2021 bestätigt wurde. Damit haben alle für die Umwandlung der ehemaligen Industriebrache notwendigen Bauvorhaben im Zusammenhang mit der Realisierung des Gebäudes von Smart Living Lab einen entscheidenden Impuls erhalten.

Das Smart Living Lab entwickelt einen digitalen Zwilling seines Gebäudes in Form eines dynamischen BIM-Modells, das es erlaubt, Simulationen durchzuführen und interaktive Augmented-Reality-Visualisierungen zu erzeugen. Diese Entwicklungen wurden der wissenschaftlichen Gemeinschaft und der Industrie im Rahmen der Tagung CISBAT 2021 und des Forums Nachhaltiges Bauen der energissima präsentiert.

Ein Austausch zwischen den Wissenschaftlerinnen und Wissenschaftler und der Öffentlichkeit fand auch rund um die im Smart Living Lab entwickelten Prototypen statt: Beispiele dafür sind der in der Stadt Freiburg an verschiedenen Orten aufgebaute Klimapavillon zur Bekämpfung städtischer Hitzeinseln und die Fussgängerbrücke aus wiederverwendetem Beton, die der Presse als Weltpremiere vorgestellt wurde. Mitglieder des Smart Living Lab – Expertinnen und Experten in ihren jeweiligen Fachbereichen – haben aktiv am kantonalen Nachhaltigkeitstag, am Wohnforum, an RENT Switzerland, an den Foren von Salon Public über die Energiezukunft und an den internationalen Swiss-US Energy Innovation Days mitgewirkt.

Der vorliegende Bericht gibt einen Überblick über die wissenschaftlichen Projekte des Smart Living Lab, indem er die Projekte, Publikationen und Beiträge an Fachtagungen auflistet. Eine der Stärken von Smart Living Lab liegt in der interdisziplinären Zusammenarbeit. 2021 sticht in diesem Zusammenhang besonderes die Initiative hervor, mit einem Dutzend akademischer Partner aus der ganzen Schweiz und unter der Koordination des Smart Living Lab an der Ausschreibung des Programms SWEET «Living & Working» des Bundesamts für Energie teilzunehmen. 2022 gewann das Smart Living Lab die Ausschreibung mit dem Forschungsprojekt SWICE, das darauf abzielt, in den kommenden acht Jahren den Energieverbrauch des Landes mittels einer direkten Zusammenarbeit zwischen der Bevölkerung und «Living Labs» zu senken.

Wir freuen uns zudem, im Zuge einer Reorganisation der Schulleitung der EPFL Professorin Séréna Vanbutsele als neue Leiterin des Instituts TRANSFORM der Hochschule für Technik und Architektur Freiburg sowie mehrere neue Mitglieder des Lenkungsausschusses begrüßen zu dürfen.

2022 wird mit dem Bau des Gebäudes begonnen. Es wird dem Smart Living Lab nach seiner Fertigstellung erlauben, seine Ambitionen als «Living Lab» zu verwirklichen und seine Präsenz noch stärker auszubauen. Auf einer Fläche von circa 5'000 Quadratmetern wird es künftig Platz bieten für die Forschungsteams der EPFL, der Hochschule für Technik und Architektur Freiburg und der Universität Freiburg.

#### **Marilyne Andersen, akademische Leiterin, und Martin Gonzenbach, operativer Leiter des Smart Living Lab**

EN

For the Smart Living Lab, 2021 was a year of significant progress in all facets of its mission as a centre of basic and applied research. It successfully launched a call for tenders for the construction of its own dedicated building. A local company JPF Entreprise Générale SA in Bulle was the winning bidder. As project owner, BFF SA, oversaw every step of the process, ably assisted by Smart Living Lab specialists and their expert input.

We were also delighted at the strength of public support for the development of the bluefactory innovation district, which was further confirmed in the cantonal referendum held on

13 June 2021. The result is a major boost for the construction projects that will advance the redevelopment the brownfield site and the creation of a custom-built home for the Smart Living Lab.

The Smart Living Lab is currently developing a dynamic BIM model, which will serve as a digital twin of the new building. As a result, the team will be able to run simulations and benefit from interactive augmented reality visuals. They also presented their work to date to the scientific community and industry representatives at the CISBAT 2021 conference and the energissima Sustainable Construction Forum.

The general public also had the opportunity to learn more about and try out some of the prototypes developed by Smart Living Lab researchers. Two such examples are the life-size pavilion designed to mitigate the effect of urban heat islands which was set up at successive locations in the city of Fribourg, as well as the world's first footbridge built from reused concrete, which was unveiled at a special press conference. Also, members of the Smart Living Lab who are at the forefront of their field spoke at a range of national and international events, including the Cantonal Sustainable Development Day, the Housing Forum, RENT Switzerland, the 2021 Salon Public on the future of energy, and the Swiss-US Energy Innovation Days.

This report provides an overview of the scientific output of the Smart Living Lab over the past year and features a directory of the projects, publications and conference presentations carried out by our researchers in 2021. The Smart Living Lab has many strengths, but the most important is undoubtedly its interdisciplinary collaboration. This was on show in 2021 when the Swiss Federal Office of Energy launched a call for proposals for its SWEET "Living and Working" programme. The Smart Living Lab formed a consortium with 10 academic partners from across Switzerland and coordinated the bid submission. The resulting eight-year research project SWICE, won in 2022 by the Smart Living Lab, is designed to help Switzerland cut its energy use and engage with the public through Living Labs.

In 2021, we were delighted to welcome Professor Séréna Vanbutsele as the new head of the TRANSFORM Institute at the School of Engineering and Architecture of Fribourg. Following the restructuring of the EPFL direction, the past year also saw the arrival of several new members to the Joint Steering Committee of the Smart Living Lab.

Building work is set to begin on our new permanent 5,000m<sup>2</sup> facility in 2022. Once it is fully up and running, the Smart Living Lab will be in a position to realize its ambition of becoming a true living lab and expanding its reach even further by hosting research teams from the EPFL, the School of Engineering and Architecture of Fribourg and the University of Fribourg.

#### **Marilyne Andersen, Academic Director, and Martin Gonzenbach, Operational Director of the Smart Living Lab**

# Smart Living Lab

Centre de recherche pour le futur de l'environnement bâti  
Forschungszentrum für den zukünftigen Wohn- und Lebensraum  
Research centre for the future of the built environment





## FR

Implanté depuis 2014 à Fribourg, le Smart Living Lab est un centre de recherche et développement dédié au futur de l'environnement bâti. Ses activités sont motivées par le confort et les enjeux environnementaux du bâti. Il rassemble les compétences de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg dans les domaines des technologies de la construction, du bien-être et des comportements, des interactions et des processus de conception, ainsi que des systèmes énergétiques liés au bâtiment. Dans le quartier d'innovation de bluefactory, au sein du Switzerland Innovation Park Network West EPFL, il mène des projets de recherche interdisciplinaires impliquant des équipes de recherche et des entreprises. Un bâtiment pour le Smart Living Lab se destine à accueillir plus de 130 personnes au service de la recherche à l'horizon 2024. Ce bâtiment définit des objectifs environnementaux, qui répondent avec 30 ans d'avance à la stratégie énergétique 2050 de la Confédération suisse.

## DE

Das seit 2014 in Freiburg angesiedelte Smart Living Lab ist ein Forschungs- und Entwicklungszentrum, das sich der Zukunft des Wohnens widmet. Seine Aktivitäten konzentrieren sich auf den Komfort und die ökologischen Herausforderungen im Bauwesen. Das Smart Living Lab bündelt die Kompetenzen der EPFL, der Hochschule für Technik und Architektur Freiburg und der Universität Freiburg in den Bereichen Bautechnologien, Wohlbefinden und Verhaltensforschung, Interaktionen und Designprozesse sowie Energiesysteme. Im Innovationsquartier blueFACTORY, das zum Switzerland Innovation Park Network West EPFL gehört, führt es interdisziplinäre Forschungsprojekte, an denen Forschungsteams und Unternehmen beteiligt sind. Bis 2024 erhält das Smart Living Lab ein neues Gebäude, in dem mehr als 130 Personen in der Forschung tätig sein werden. Im Rahmen dieses Neubaus werden Umweltziele definiert, welche die Energiestrategie 2050 des Bundes um bis zu dreissig Jahre vorwegnehmen.

## EN

Established since 2014 in Fribourg, the Smart Living Lab is a research and development centre devoted to the future of the built environment. Its activities are focused on the comfort and challenges of the building. The Smart Living Lab reflects the combined expertise of the EPFL, the School of Engineering and Architecture of Fribourg, and the University of Fribourg in the areas of construction technologies, well-being and behaviours, interactions and design processes as well as energy systems for the built environment. In the bluefactory innovation district, which is part of the Switzerland Innovation Park Network West EPFL, the Smart Living Lab carries out interdisciplinary research projects in partnership with research groups and companies. Its new building, which is scheduled to open in 2024, will provide workspace for more than 130 researchers. It has also been designed to enable the Smart Living Lab to meet the goals of Switzerland's Energy Strategy 2050 thirty years ahead of schedule.

# Partenaires Partner Partners



Haute école d'ingénierie et d'architecture Fribourg  
Hochschule für Technik und Architektur Freiburg

FR

## Un important réseau de partenaires

L'EPFL est la plus cosmopolite des universités techniques européennes. Elle accueille des étudiant-e-s, professeur-e-s et collaborateurs-trices de plus de 120 nationalités. À vocation à la fois suisse et internationale, l'EPFL est centrée sur trois missions : l'enseignement, la recherche et l'innovation. L'EPFL collabore avec un important réseau de partenaires comprenant notamment d'autres universités et hautes écoles, des écoles secondaires et gymnases, des acteurs de l'industrie et de l'économie, des milieux politiques et du grand public, ceci dans le but d'avoir un véritable impact pour la société.

DE

## Umfassendes Partnernetzwerk

Die EPFL ist die weltoffenste technische Hochschule Europas. Mit rund 12'000 Studierenden und Doktorierenden aus über 120 Ländern und mehr als 370 Labors betreibt die EPFL Spitzenforschung in Bereichen wie erneuerbare Energien, Medizintechnik, Neurotechnologien, Materialwissenschaften und Informationstechnologien. Die EPFL arbeitet mit einem umfassenden Partnernetzwerk zusammen, dem insbesondere andere Universitäten und Hochschulen, Sekundarschulen und Gymnasien, Industrie und Wirtschaft, politische Einrichtungen und die allgemeine Öffentlichkeit angehören. Ihr Ziel ist es, echte Veränderungen in der Gesellschaft zu bewirken.

EN

## Important network of partners

EPFL is Europe's most cosmopolitan technical university. It welcomes students, professors and associates from more than 120 nationalities. EPFL has both a Swiss and international vocation and focuses on three missions: teaching, research and innovation. EPFL collaborates with an important network of partners, including other universities and colleges, secondary schools and gymnasiums, industry and the economy, political organisations and the general public, with the aim of having a real impact on society.

FR

## Recherche appliquée au service de l'économie, de la société et de la formation

En plus de sa vocation d'enseignement, la HEIA-FR chapeaute dix instituts de recherche appliquée qui œuvrent dans les trois domaines que sont les technologies de l'information et de la communication, les technologies industrielles, ainsi que la construction et l'environnement. Ils assurent le suivi de l'évolution technologique et développent des produits et procédés innovants et performants. Les instituts se positionnent comme un soutien pour les entreprises dans leur recherche de solutions novatrices.

DE

## Anwendungsorientierte Forschung im Dienst der Wirtschaft, der Gesellschaft und der Ausbildung

Ergänzend zu ihrem Lehrauftrag betreut die HTA-FR zehn Institute für angewandte Forschung, die in den drei Bereichen Informations- und Kommunikationstechnologien, Industrietechnologien sowie Bauen und Umwelt tätig sind. Sie verfolgen den technologischen Fortschritt und entwickeln innovative und leistungsstarke Produkte und Verfahren. Sie verstehen sich als Partner der Unternehmen, die sie bei der Erarbeitung neuartiger Lösungen unterstützen.

EN

## Applied research for the benefit of the economy, society and education

In addition to its teaching mission, HEIA-FR oversees ten applied research institutes working in the three fields of information and communication technologies, industrial technologies and construction and the environment. They monitor technological developments and develop innovative and high-performance products and processes. The institutes position themselves as a support for companies in their search for innovative solutions.





FR

### Centres de compétences & pôle de recherche

Le travail des chercheuses et des chercheurs, engagé·e·s dans des centres de compétences scientifiques et des projets de recherche de toutes les disciplines contribue à élargir en permanence l'horizon des connaissances. L'Université de Fribourg jouit également d'une excellente réputation internationale au niveau de la recherche. En plus d'un grand nombre de projets soutenus par le Fonds national suisse de la recherche scientifique (FNS), elle héberge aussi un Pôle de recherche national (PRN), ainsi que plusieurs centres de recherche interdisciplinaires.

DE

### Kompetenzzentren und Forschungszentren

Engagierte Forschende tragen mit ihrer Arbeit in wissenschaftlichen Kompetenzzentren und Forschungsprojekten in allen Disziplinen zur fortlaufenden Erweiterung des Wissenshorizonts bei. Im Fokus steht dabei stets die Lösung aktueller und künftiger Herausforderungen der Gesellschaft. Auch in der Forschung genießt die Universität Freiburg ein exzellentes internationales Renommee. Neben zahlreichen vom Schweizerischen Nationalfonds zur Förderung der wissenschaftlichen Forschung (SNF) geförderten Forschungsprojekten beherbergt die Universität einen Nationalen Forschungsschwerpunkt (NFS) sowie verschiedene interdisziplinäre Forschungszentren.

EN

### Centres of excellence

Through their work in the centres of excellence and on research projects, our committed researchers continually contribute to expanding the horizons of knowledge in all disciplines. In doing so, their attention is constantly focused on solving society's current and future challenges. The University of Fribourg also enjoys an excellent international reputation in research. In addition to numerous research projects funded by the SNSF, the University hosts a National Centre of Competence in Research (NCCR) as well as a variety of Interdisciplinary Centres of Research.



ETAT DE FRIBOURG  
STAAT FREIBURG

FR

### Canton de Fribourg

Le Canton de Fribourg investit dans la formation, la recherche et l'innovation dans le domaine de la construction. Il a voté en 2018 un crédit de 25 millions de francs pour la construction du bâtiment du Smart Living Lab, qui sera mis à disposition de la recherche pour une durée minimale de 20 ans. La société BFF SA en est le maître d'ouvrage.

DE

### Kanton Freiburg

Der Kanton Freiburg investiert in Bildung, Forschung und Innovation am Bau. 2018 bewilligte er einen Kredit in Höhe von 25 Millionen Franken für den Bau des neuen Smart Living Lab-Gebäudes, das für mindestens 20 Jahre der Forschung gewidmet sein wird. Bauherrin ist die BFF SA.

EN

### Canton of Fribourg

The Canton of Fribourg invests in education, research and innovation in the construction sector. Last year, its parliament approved a budget of CHF 25 million for construction of the Smart Living Lab building, which will host research activities for at least 20 years. BFF SA is the project owner.

# Organisation

FR

La conduite stratégique du Smart Living Lab est assurée par un **Comité de pilotage** conjoint aux institutions partenaires. Quant à la mise en œuvre, elle est l'affaire du **Comité directeur**. La **Commission scientifique** réunit les responsables académiques des groupes de recherche du Smart Living Lab.

DE

Die strategische Führung des Smart Living Lab wird vom **Lenkungsausschuss** der drei Partnerorganisationen wahrgenommen. Die Umsetzung erfolgt durch das **Leitungskomitee**. Mitglieder der **Wissenschaftlichen Kommission** sind die Leiterinnen und Leiter der Forschungsgruppen des Smart Living Lab.

EN

A **Joint Steering Committee** handles the strategic management of the Smart Living Lab on behalf of all partner institutions and an **Executive Committee** is in charge of implementation. The **Scientific Commission** brings together the academic heads of the Smart Living Lab's research groups.



Participants of the CISBAT International Conference visiting the building of the Smart Living Lab in virtual and augmented reality © Nicolas Brodard

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**COMITÉ DE PILOTAGE CONJOINT | LENKUNGSAUSSCHUSS | JOINT STEERING COMMITTEE**


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**Canton of Fribourg**


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**Olivier Curty**

State Councillor, Director of  
Economy and Employment

Co-Chair of the Joint Steering  
Committee


**Jean-Pierre Siggen**

State Councillor, Director of Public  
Education, Culture and Sport  
until 31.12.2021


**Sylvie Bonvin-Sansonens**

State Councillor, Director of Public  
Education, Culture and Sport  
as of 1.1.2022


**Olivier Allaman**

Fribourg Development Agency,  
Department of Economy and  
Employment

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**EPFL**


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**Matthias Gäumann**

Vice President for Operations

Co-Chair of the Joint Steering  
Committee


**Jan Hesthaven**

Vice President for Academic  
Affairs


**Ursula Oesterle**

Vice President for Innovation


**Claudia Binder**

Dean of the School of Architecture,  
Civil and Environmental  
Engineering (ENAC)

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**HEIA-FR**


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**Jean-Nicolas Aebischer**

Director

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**UNIFR**


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**Astrid Epiney**

Rector

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## COMITÉ DIRECTEUR | LEITUNGSKOMITEE | EXECUTIVE COMMITTEE

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### EPFL

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**Marilyne Andersen**

Academic Director of  
Smart Living Lab

Co-Chair of the Executive  
Committee



**Martin Gonzenbach**

Director of Operations EPFL Fribourg  
and Smart Living Lab

Co-Chair of the Executive  
Committee



**Corentin Fivet**

Head of Structural Xploration  
Lab (SXL)

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### HEIA-FR



**Jean-Philippe Bacher**

Head of ENERGY Institute  
Smart Living Lab HEIA-FR Manager

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### UNIFR



**Stephanie Teufel**

Head of international institute of  
management in technology (iimt)  
Smart Living Lab UNIFR Manager

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### Canton of Fribourg

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**Olivier Allaman**

Fribourg Development Agency,  
Department of Economy and  
Employment

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 COMMISSION SCIENTIFIQUE | WISSENSCHAFTLICHE KOMMISSION | SCIENTIFIC COMMISSION
 

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 EPFL
 

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**Marilyne Andersen**

Academic Director of  
Smart Living Lab

Chair of the Scientific Commission



**Corentin Fivet**

Head of Structural Xploration  
Lab (SXL)



**Paolo Tombesi**

Head of Laboratory of Construction  
and Architecture (FAR)



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Head of Laboratory of Integrated  
Comfort Engineering (ICE)



**Dusan Licina**

Head of Human-Oriented Built  
Environment Lab (HOBEL)



**Sergi Aguacil**

Head of Building2050 Group

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Head of Human-IST Institute



**Martin Beyeler**

Professor, Institute for Swiss and  
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# Financement Finanzierung Funding

FR

Le Smart Living Lab est un projet commun du Canton de Fribourg, de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg. Chacun des partenaires académiques y participe avec ses propres moyens et reçoit un soutien financier spécifique de la part du Canton.

En outre, le Canton de Fribourg met à disposition les locaux situés à bluefactory et finance la construction du bâtiment du Smart Living Lab. Le Smart Living Lab dispose d'un budget annuel pour la communication et les événements, alimenté par les quatre partenaires.

DE

Das Smart Living Lab ist ein gemeinsames Projekt des Kantons Freiburg, der EPFL, der Hochschule für Technik und Architektur Freiburg und der Universität Freiburg. Die akademischen Partner beteiligen sich jeweils mit eigenen Mitteln, wobei sie vom Kanton eine besondere finanzielle Unterstützung erhalten.

Darüber hinaus stellt der Kanton Freiburg die Räumlichkeiten auf dem bluefactory-Gelände zur Verfügung und finanziert den Bau des neuen Smart Living Lab-Gebäudes. Das Smart Living Lab verfügt über ein jährliches Budget für Kommunikation und Veranstaltungen, das von den vier Partnern gespeist wird.

EN

The Smart Living Lab is a joint project between the EPFL, the School of Engineering and Architecture of Fribourg and the University of Fribourg. Each academic partner contributes its own resources and receives funding contributions from the Canton of Fribourg.

In addition, the Canton de Fribourg provides the premises located on the bluefactory site as well as funding for construction of the Smart Living Lab building. The Smart Living Lab has an annual budget for events and communication, which is funded by all four partners.



# Domaines de recherche

## Forschungsgebiete

## Research domains



### Bien-être et comportements

Améliorer la santé et le confort humains en optimisant la qualité de l'environnement intérieur et en influençant positivement les comportements.

### Wohlbefinden und Verhalten

Verbesserung der Gesundheit und des Komforts des Menschen durch die Optimierung der Umgebungsqualität in Innenräumen und der positiven Beeinflussung von Verhaltensmustern.

### Well-being and behaviours

Improve human health and comfort by optimising indoor environmental quality and influencing behaviours in a positive way.



### Interactions et processus de conception

Comprendre et structurer le dialogue entre les parties prenantes du cycle de vie du bâtiment afin de développer les outils pour concevoir, modéliser et exploiter les bâtiments.

### Interaktionen und Designprozesse

Den Dialog zwischen allen Akteuren des Gebäude-Lebenszyklus verstehen, strukturieren und fördern, um Werkzeuge für das Design, die Modellierung und den Betrieb von Gebäuden zu entwickeln.

### Interactions and design processes

Understand and structure dialogue among stakeholders in the building lifecycle in order to develop the tools to design, model and operate buildings.



### Technologies de la construction

Évaluer l'efficacité de l'utilisation des ressources et accélérer les processus de changement dans la construction.

### Bautechnologien

Ressourceneffizienz evaluieren und Veränderungsprozesse im Bausektor beschleunigen.

### Construction technologies

Monitor resource effectiveness and accelerate processes of change in construction.



### Systèmes énergétiques

Développer des technologies et des systèmes intelligents à haut rendement énergétique, améliorer leur gestion et prévoir les impacts juridiques et économiques.

### Energiesysteme

Intelligente und energieeffiziente Systeme und Technologien entwickeln, das Management solcher Systeme optimieren sowie die rechtlichen und wirtschaftlichen Auswirkungen evaluieren.

### Energy systems

Develop smart energy-efficient systems and technologies, improve their management, and anticipate legal and economic impacts.

# Groupes de recherche Forschungsgruppen Research groups

## RESEARCH



Academic Director of Smart Living Lab  
Chair of Scientific Commission

Prof. Marilyne Andersen

## REUSE



Structural Xploration Lab (SXL)

Prof. Corentin Fivet

# EPFL

## ARCHITECTURE



Laboratory of Construction and Architecture (FAR)

Prof. Paolo Tombesi

## LOW-E COMFORT



Laboratory of Integrated Comfort Engineering (ICE)

Prof. Dolaana Khovalyg

## INDOOR AIR



Human-Oriented Built Environment Lab (HOBEL)

Prof. Dusan Licina

## INTERDISCIPLINARITY



Building Innovation Research and  
Integration Support Group (Building2050)

Dr. Sergi Aguacil





## TRANSFORMATION

Institute of Architecture: Heritage,  
Construction and Users (TRANSFORM)

Prof. Séréna Vanbutsele



## SUSTAINABLE ENERGY

Institute of Applied Research in Energy Systems (ENERGY)

Prof. Jean-Philippe Bacher



## BUILT ENVIRONMENT

Institute of Construction and Environmental Technologies (iTEC)

Prof. Daia Zwicky



## INNOVATION

international institute of management in technology (iimt)

Prof. Stephanie Teufel

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UNIVERSITÉ DE FRIBOURG  
UNIVERSITÄT FREIBURG



## INTERACTION

Human-IST Institute (Human Centered  
Interaction Science and Technology)

Prof. Denis Lalanne



## RULES

Institute for Swiss and International Construction Law

Prof. Jean-Baptiste Zufferey

# STAFF



**147 PEOPLE**  
(78 FTE)



**30 NATIONALITIES**

**EPFL**

**53 PEOPLE**  
(42,5 FTE)



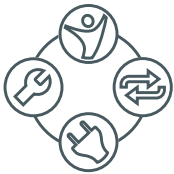
**HEIA-FR  
HTA-FR**

**77 PEOPLE**  
(23,5 FTE)



**UNI  
FR** **17 PEOPLE**  
(12 FTE)

# RESEARCH



**4**

DOMAINS



**11**

GROUPS



**8**

FACILITIES



**110**

PROJECTS



**120**

PUBLICATIONS

# WEB | SOCIAL MEDIA

**17,539**

WEBSITE USERS

**59,938**

PAGE VIEWS



**944**

FOLLOWERS



**2,180**

FOLLOWERS



**775**

FOLLOWERS

# EVENTS



27

REGIONAL EVENTS

34

INTERNATIONAL  
CONFERENCES\*

\*BASED ON CONFERENCE PAPERS

# SURFACE AREA

2,474 m<sup>2</sup>

OFFICES AND  
LABORATORIES

# COMMUNICATION | PRESS



x 42

NEWS ARTICLES



x 6

PRESS RELEASES



x 10

NEWSLETTERS

1,755 m<sup>2</sup>

ATELIER POPUP AND  
WORKSHOPS (INSIDE)

850 m<sup>2</sup>

ATELIER POPUP AND  
WORKSHOPS (OUTSIDE)

180 m<sup>2</sup>

NEIGHBORHUB

# FACTS & FIGURES 2021

EPFL

EPFL

www.epfl.ch



The GEO-GAMI pavilion made of reused skis © Sonia Villegas

FR

Les quatre laboratoires FAR, HOBEL, ICE et SXL, ainsi que le groupe de recherche Building2050 de la Faculté de l'environnement naturel, architectural et construit (ENAC) constituent le campus associé de l'EPFL à Fribourg et font partie intégrante du Smart Living Lab sur le site de bluefactory. Depuis 2014, ils développent leur activité scientifique autour des thèmes de l'économie circulaire, de la qualité de l'environnement intérieur, de la construction durable et de l'intelligence artificielle au service des performances énergétiques du bâtiment, en Suisse et dans le monde. Ils collaborent étroitement avec leurs homologues de l'EPFL à Lausanne et les équipes de recherche de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg, également membres du Smart Living Lab.

DE

Die vier Labore FAR, HOBEL, ICE und SXL sowie die Forschungsgruppe Building2050 der Faculté de l'environnement naturel, architectural et construit (ENAC) bilden den assoziierten Campus der EPFL in Freiburg. Sie sind integraler Bestandteil des Smart Living Lab auf dem bluefactory-Gelände. Seit 2014 beschäftigen sich Wissenschaftlerinnen und Wissenschaftler mit Themen wie Kreislaufwirtschaft, Luftqualität in Innenräumen, nachhaltiges Bauen und künstliche Intelligenz im Dienste der Energieeffizienz von Gebäuden, sowohl in der Schweiz als auch im Ausland. Sie arbeiten eng mit ihren Kolleginnen und Kollegen der EPFL in Lausanne und den Forschungsteams der Hochschule für Technik und Architektur Freiburg sowie der Universität Freiburg zusammen, die ebenfalls Mitglieder des Smart Living Lab sind.

EN

The Smart Living Lab, based in the bluefactory innovation district, is home to the EPFL's associated campus in Fribourg. The campus comprises four laboratories – FAR, HOBEL, ICE and SXL – as well as the Building2050 research group of the EPFL School of Architecture, Civil and Environmental Engineering (ENAC). Since 2014, they have ploughed their collective scientific expertise into a deeper exploration of the circular economy, indoor environmental quality, sustainable construction and artificial intelligence, with a view to maximizing the energy efficiency of buildings not only in Switzerland but also around the world. They also work closely with their EPFL colleagues in Lausanne, as well as with research teams from the School of Engineering and Architecture of Fribourg and the University of Fribourg based at the Smart Living Lab.



**Martin Gonzenbach**

Operational director of EPFL Fribourg  
and the Smart Living Lab

FR

En 2021, les bourses d'encouragement « ENAC Innovation Seed Grants », qui visent à faciliter le chemin de la recherche fondamentale à l'innovation, ont récompensé quatre projets de l'EPFL Fribourg dans les domaines de la qualité de l'air intérieur, la gestion des eaux dans le bâtiment et le réemploi de matériaux de construction. Une reconnaissance qui fait écho à la croissance du campus fribourgeois et ses opportunités d'expérimentation à large échelle et la construction de prototypes à taille réelle, dans l'Atelier PopUp de la Halle bleue de bluefactory. Plusieurs projets de recherche et d'enseignement y ont été menés avec succès, notamment le pavillon en skis de réemploi GEO-GAMI, présenté au Green Wave Festival, ou les cabines faites de matériaux mis en décharge, dans le cadre du programme interdisciplinaire « Projeter Ensemble » de l'ENAC, qui permet à la future génération d'architectes, d'ingénieurs et ingénieurs de travailler main dans la main.

Comme en témoigne Martin Gonzenbach, directeur opérationnel de l'EPFL Fribourg et du Smart Living Lab : « Le campus se développe dans un quartier en pleine mutation, marqué par un passé industriel. Aujourd'hui, il se transforme en quartier d'innovation doté d'une charte à faible empreinte carbone et est destiné à faire prospérer une mixité d'activités. » Une évolution en phase avec les objectifs d'expansion des campus associés de l'EPFL à Fribourg, Genève, Neuchâtel, Sion, ainsi qu'aux Émirats arabes unis, qui hébergeront prochainement près d'un sixième des chercheurs et chercheuses de l'École polytechnique fédérale de Lausanne.

« Le campus se développe dans un quartier en pleine mutation, marqué par un passé industriel. Aujourd'hui, il se transforme en quartier d'innovation doté d'une charte à faible empreinte carbone et est destiné à faire prospérer une mixité d'activités. »

« Der Campus entwickelt sich in einem industriell geprägten Umfeld im Wandel zu einem Innovationsquartier mit einer niedrigen CO<sub>2</sub>-Bilanz und einer fruchtbaren Mischung verschiedenster Aktivitäten. »

“Our growing campus is located in an old industrial district that is now changing rapidly. The neighbourhood is being transformed into an innovation hub with a low carbon footprint, destined to support activities of various kinds.”

DE

2021 wurden vier Projekte in den Bereichen Raumlufthklima, Wassermanagement in Gebäuden und Wiederverwendung von Baumaterialien mit einem Förderstipendium « ENAC Innovation Seed Grants » ausgezeichnet. Mit diesen Stipendien soll der Weg von der Grundlagenforschung zur Innovation erleichtert werden. Diese Anerkennung ist ein weiterer Beweis für das Wachstum des Freiburger Campus. In seiner Werkstatt PopUp in der Halle bleue auf dem bluefactory können Experimente im grossen Massstab durchgeführt sowie Prototypen in Originalgrösse gebaut werden. Mehrere Forschungs- und Lehrprojekte konnten hier erfolgreich durchgeführt werden, darunter der Pavillon aus wiederverwendeten Skiern GEO-GAMI, der beim Green Wave Festival vorgestellt wurde, oder die Kabinen aus deponierten Materialien im Rahmen des interdisziplinären Programms « Projeter Ensemble » der ENAC. In diesem Programm eignet sich die künftige Generation von ArchitektInnen und IngenieurInnen das nötige Wissen für die Bewältigung der komplexen Herausforderungen unserer heutigen Welt an.

Martin Gonzenbach, operativer Leiter der EPFL Freiburg und des Smart Living Lab: « Der Campus entwickelt sich in einem industriell geprägten Umfeld im Wandel zu einem Innovationsquartier mit einer niedrigen CO<sub>2</sub>-Bilanz und einer fruchtbaren Mischung verschiedenster Aktivitäten. » Diese Entwicklung steht im Einklang mit den Expansionszielen der assoziierten Campus der EPFL in Freiburg, Genf, Neuenburg, Sitten sowie in den Vereinigten Arabischen Emiraten, in denen demnächst fast ein Sechstel der Forscherinnen und Forscher der Eidgenössischen Technischen Hochschule Lausanne arbeiten werden.

EN

In 2021, four EPFL Fribourg projects were awarded an ENAC Innovation Seed Grant to support their work in the fields of indoor air quality, water management in buildings and the reuse of construction materials. The aim of these grants is to smooth the path from basic research to innovation. The ENAC's choice of recipients is a recognition of the growing standing of the EPFL associated campus in Fribourg and the opportunities it offers for large-scale experimentation and the construction of full-scale prototypes in the Atelier PopUp, which operates out of the Blue Hall in the bluefactory complex. Several research and teaching projects have been successfully carried out there. The list includes the GEO-GAMI reused ski pavilion, presented at the Green Wave Festival, or the cabins made from landfill materials, as part of the ENAC's interdisciplinary teaching programme “Design Together”, which enables the next generation of engineers and architects to integrate disciplinary knowledge to tackle complex challenges in a changing world.

As Martin Gonzenbach, operational director of EPFL Fribourg and the Smart Living Lab, explains, “Our growing campus is located in an old industrial district that is now changing rapidly. The neighbourhood is being transformed into an innovation hub with a low carbon footprint, destined to support activities of various kinds.” This development is in line with the expansion plans of the EPFL's associated campuses in Fribourg, Geneva, Neuchâtel, Sion and the United Arab Emirates, which together will soon be home to almost one-sixth of EPFL researchers.

# Haute école d'ingénierie et d'architecture de Fribourg Hochschule für Technik und Architektur Freiburg School of Engineering and Architecture of Fribourg



Haute école d'ingénierie et d'architecture Fribourg  
Hochschule für Technik und Architektur Freiburg

[www.heia-fr.ch](http://www.heia-fr.ch)



The DEMO-MI<sup>2</sup> climate pavilion on the bluefactory site © Sonia Villegas

FR

En 2021, une pandémie installée pour de longs mois a poussé les équipes de recherche de la Haute école d'ingénierie et d'architecture de Fribourg (HEIA-FR) à rester flexibles et créatives. Il a fallu composer avec le travail à distance, des mesures in situ à reporter, des expérimentations à remplacer par des modélisations, etc. Ces contraintes ont également révélé de nouvelles opportunités. Dans ce contexte, les besoins des utilisateur-trices ont inévitablement changé. Ceci engendre de nouvelles réflexions, des processus inédits, un besoin de collaboration accru et des questions inattendues.

DE

2021 zwang die bereits seit vielen Monaten andauernde Pandemie die Forschungsteams der Hochschule für Technik und Architektur Freiburg (HTA-FR) zu einem hohen Mass an Flexibilität und Kreativität. Sie mussten sich ans Homeoffice gewöhnen, Messungen vor Ort verschieben, Experimente durch Modellierungen ersetzen usw. Diese Einschränkungen haben aber auch neue Möglichkeiten aufgezeigt. Die Bedürfnisse der Nutzerinnen und Nutzer haben sich zwangsläufig geändert und neue Überlegungen und neue Prozesse angestoßen sowie zu einem verstärkten Bedürfnis nach Zusammenarbeit und zu unerwarteten Fragen geführt.

EN

In 2021, the protracted pandemic forced the School of Engineering and Architecture of Fribourg (HEIA-FR) research teams to stay flexible and creative. As well as getting used to working from home, they had to make lots more changes, such as postponing plans for in situ measurements and replacing experiments with modelling. Despite these limitations, the public health situation has also opened up new opportunities. The inevitable shift in user needs is prompting a rethink. At the same time, new processes are coming on stream, the need for collaboration is becoming more urgent, and unforeseen issues are emerging.



© Sonia Villegas



© Sonia Villegas

## FR

La pandémie a obligé la majorité d'entre nous à repenser notre mode de vie et à nous interroger sur nos besoins et envies. A-t-on encore besoin d'un bureau fixe auquel on se rend chaque jour ? Quel est l'impact sur la mobilité et la consommation énergétique ? La notion de confort a-t-elle évolué ? Allons-nous retourner à notre vie d'avant ? Qu'est-ce qui a définitivement changé ?

**Le monde de demain est à penser et à construire. Une aubaine pour les chercheur-euses et les usager-ères. Ensemble, ils et elles ont la possibilité de contribuer à la création de modes de vie plus durables et souhaitables.**

Avec le projet DEMO-MI<sup>2</sup> conçu au Smart Living Lab, les instituts de recherche TRANSFORM et ENERGY sont allées à la rencontre du public. Entre juin et septembre 2021, le pavillon climatique DEMO-MI<sup>2</sup> a été présenté successivement dans quatre lieux différents en ville de Fribourg. Pendant plusieurs semaines, les gens de passage ont pu profiter de la fraîcheur du lieu, tout en étant sensibilisés aux îlots de chaleur et aux différentes technologies permettant d'agir favorablement sur le microclimat urbain. Le projet s'inscrit plus largement dans la stratégie de développement durable de la Ville de Fribourg, adoptée en 2018.

De manière générale, en lien étroit avec les partenaires privés et publiques, les trois instituts de recherche ENERGY, TRANSFORM et ITEC de la HEIA-FR membres du Smart Living Lab contribuent activement au développement d'une société future durable et à la pointe de l'innovation.

## DE

Die Pandemie hat die meisten von uns genötigt, unseren Lebensstil zu überdenken und uns Fragen zu unseren Bedürfnissen und Wünschen zu stellen. Brauchen wir künftig noch ein fixes Büro, in dem wir jeden Tag arbeiten? Welches sind die Auswirkungen auf die Mobilität und den Energieverbrauch? Werden wir unser früheres Leben wieder aufnehmen? Was hat sich definitiv verändert?

**Die Welt von morgen muss entworfen und gebaut werden. Ein Glücksfall für die Forscherinnen und Forscher und die Nutzerinnen und Nutzer. Gemeinsam haben sie die Möglichkeit, an der Entwicklung von nachhaltigeren und wünschenswerteren Lebensmodellen mitzuwirken.**

Mit dem im Smart Living Lab konzipierten Projekt DEMO-MI<sup>2</sup> haben die Forschungsinstitute TRANSFORM und ENERGY die Begegnung mit der Öffentlichkeit gesucht. Zwischen Juni und September 2021 wurde der Klimapavillon DEMO-MI<sup>2</sup> nacheinander an vier verschiedenen Orten in der Stadt Freiburg aufgebaut. Mehrere Wochen lang konnten die Passantinnen und Passanten die Kühle des Ortes genießen und wurden gleichzeitig für die Problematik der Hitzeinseln und die verschiedenen Technologien sensibilisiert, mit denen das städtische Mikroklima günstig beeinflusst werden kann. Das Projekt ist Teil der 2018 verabschiedeten Strategie für eine nachhaltige Entwicklung der Stadt Freiburg.

Generell wirken die drei Forschungsinstitute der HTA-FR, ENERGY, TRANSFORM und ITEC, Mitglieder des Smart Living Lab, aktiv an der Entwicklung einer künftigen nachhaltigen und höchst innovativen Gesellschaft mit.

## EN

The pandemic has forced most of us to rethink our lifestyles and question what we actually need and want. Do we still need to commute every day to a permanent office? What is the impact on mobility and energy consumption? Do comfort and convenience mean something else to us now? Will we go back to the way we used to live? What has changed irrevocably?

**The world of tomorrow must be imagined and built. This is an opportunity for researchers and users to play their part in creating more sustainable and attractive ways of living.**

With the DEMO-MI<sup>2</sup> project developed at the Smart Living Lab, the TRANSFORM and ENERGY institutes went out to meet the public. Between June and September 2021, the DEMO-MI<sup>2</sup> climate pavilion was presented successively in four different locations in the city of Fribourg. For several weeks, passers-by were able to step in, cool down and find out more directly from the research teams about the heat island problem, and some of the technologies that can have a favourable effect on the urban microclimate. The project is part of the City of Fribourg's sustainable development strategy, which launched in 2018.

In close collaboration with private and public partners, the ENERGY, TRANSFORM, ITEC Institutes of the HEIA-FR and members of the Smart Living Lab, actively play their own particular part in creating a sustainable, innovative and future-oriented society.

Université de Fribourg  
Universität Freiburg  
University of Fribourg

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FR

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UNIVERSITÄT FREIBURG

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**17**   
Team members  
(12 FTE)

**15**   
Research projects

**20**   
Publications

**19**   
Teaching activities  
(online & onsite)

**3**   
Conferences  
(online & onsite)

FR

## Transfert de connaissances entre l'université et l'industrie

L'international institute of management in technology (iimt), l'Institut Human-IST et l'Institut pour le droit suisse et international de la construction sont les trois groupes de recherche de l'Université de Fribourg (UNIFR) actifs au sein du Smart Living Lab. Leurs activités de recherche visent non seulement à identifier les tendances mondiales, ainsi que les différents développements, mais aussi à avoir un impact décisif sur la société. Dans ce contexte, la collaboration et le transfert de connaissances entre l'université et l'industrie sont renforcés et encouragés au niveau national et international, afin de créer une valeur ajoutée.

### Projets phares

**iimt – international institute of management in technology**

#### Blockchain Énergie

Le projet examine la profonde transformation en cours du secteur de l'électricité vers une utilisation accrue de sources d'énergie alternatives et renouvelables, en allant au-delà d'une simple décentralisation du marché de l'électricité. Les technologies basées sur la blockchain (BC) ont le potentiel de jouer un rôle clé dans cette transition en offrant des interfaces et des systèmes décentralisés, ainsi que des configurations alternatives pour le marché de l'énergie. L'accent est mis sur l'applicabilité des technologies basées sur la BC dans le secteur de l'énergie, l'utilisation de la BC

DE

## Wissenstransfer zwischen der Universität und der Industrie

Das international institute of management in technology (iimt), das Institut Human-IST und das Institut für Schweizerisches und internationales Baurecht sind drei Forschungsgruppen der Universität Freiburg (UNIFR), welche im Smart Living Lab aktiv sind. Ihre Forschungsaktivitäten zielen nicht nur darauf ab globale Trends sowie verschiedene Entwicklungen zu erkennen, sondern auch einen entscheidenden Einfluss auf die Gesellschaft zu haben. Dabei wird die Zusammenarbeit und der Wissenstransfer zwischen der Universität und der Industrie auf nationaler und internationaler Ebene gestärkt und gefördert um einen integralen Mehrwert zu schaffen.

### Leuchtturm-Projekte

**iimt – international institute of management in technology**

#### Blockchain Energie

Das Projekt untersucht die laufende, weitreichende Transformation des Stromsektors hin zu einer verstärkten Nutzung alternativer, erneuerbarer Energiequellen, die über eine einfache Dezentralisierung des Strommarktes hinausgeht. Blockchain-basierte Technologien (BC) haben das Potenzial, bei diesem Wandel eine Schlüsselrolle zu spielen, indem sie dezentrale Schnittstellen und Systeme sowie alternative Konfigurationen für den Energiemarkt bieten. Der Schwerpunkt liegt auf der Anwendbarkeit von

EN

## Knowledge transfer between the university and industry

The international institute of management in technology (iimt), the Human-IST Institute (Human Centered Interaction Science and Technology) and the Institute for Swiss and international construction law are three research groups of the University of Fribourg (UNIFR) that are active in the Smart Living Lab. Their research activities aim not only to identify global trends and various developments, but also to have a decisive impact on society. In doing so, the cooperation and knowledge transfer between the university and industry is strengthened and promoted on a national and international level in order to create an integral added value.

### Flagship projects

**iimt – international institute of management in technology**

#### Blockchain Energy

The project examines the ongoing, far-reaching transformation of the electricity sector towards an increased use of alternative, renewable energy sources, going beyond a simple decentralization of the electricity market. Blockchain-based technologies (BC) have the potential to play a key role in this transition by offering decentralized interfaces and systems as well as alternative configurations for the energy market. The focus is on applicability of BC-based technologies in the energy sector, utilization of BC in various elements of the energy systems



dans diverses composantes des systèmes énergétiques, telles que le commerce, le stockage des informations, ainsi que l'augmentation de la transparence et de la démocratisation. Une perspective d'études de transition est utilisée pour examiner les obstacles potentiels, ainsi que pour tracer des trajectoires prospectives de transition.

#### **Institut Human-IST**

##### **Qualité de l'air dans les espaces de travail partagés**

L'exposition répétée à une mauvaise qualité de l'air dans des environnements intérieurs, tels que le bureau, la maison et la salle de classe peut avoir des effets négatifs importants sur notre santé et notre productivité. Le problème est particulièrement connu dans les espaces intérieurs fermés et partagés par plusieurs personnes. Human-IST a étudié l'évolution du niveau de dioxyde de carbone dans les salles de réunion des locaux professionnels, durant 1007 sessions de réunion. Les données collectées sont utilisées pour examiner des modèles d'apprentissage automatique visant à indiquer le modèle d'évolution du CO<sub>2</sub> et à prévoir le moment où de l'air frais doit être apporté. En outre, pour mieux comprendre les relations et les interdépendances des facteurs sociaux dans les réunions, qui peuvent influencer la perception des utilisateur·trices d'une solution interactive, Human-IST a mené une série d'enquêtes en ligne. Sur la base des résultats de ces deux études, il propose une solution qui prédit l'évolution de la qualité de l'air dans les salles de réunion à ventilation naturelle et incite les utilisateur·trices à prendre des mesures préventives lorsqu'un risque est prévu.

#### **Institut pour le droit suisse et international de la construction**

##### **Garantir la sécurité des bâtiments en assurant la sécurité des données**

L'équipe de recherche de l'Institut pour le droit suisse et international de la construction s'est particulièrement impliquée en 2021 dans le projet de recherche suivant: Sûreté et sécurité des travaux de construction au travers de la sûreté et de la sécurité des données. Analyse de la nouvelle norme internationale ISO 19650-5 et de ses implications d'un point de vue juridique.

BC-basierten Technologien im Energiesektor, der Nutzung von BC in verschiedenen Elementen des Energiesystems wie Handel, Informationsspeicherung und erhöhte Transparenz und Demokratisierung. Die Perspektive der Transition Studies wird genutzt, um potenzielle Hindernisse zu prüfen und mögliche Übergangswege zu skizzieren.

#### **Institut Human-IST**

##### **Luftqualität in gemeinsam genutzten Arbeitsräumen**

Ist man wiederholt schlechter Luftqualität in Innenräumen wie Büros, Wohnungen und Klassenzimmern ausgesetzt, kann dies erhebliche negative Auswirkungen auf unsere Gesundheit und Produktivität haben. Das Problem wird besonders in geschlossenen Räumen, welche von mehreren Personen gemeinsam genutzt werden, deutlich. Human-IST hat die Entwicklung des Kohlendioxidgehalts in Büro- und Besprechungsräumen während 1007 Sitzungen untersucht. Die gesammelten Daten werden verwendet, um Modelle des machine-learning zu untersuchen, die darauf abzielen, das CO<sub>2</sub>-Entwicklungsmuster anzuzeigen und vorherzusagen, wann Frischluft zugeführt werden sollte. Darüber hinaus hat Human-IST eine Reihe von Online-Umfragen durchgeführt, um Einblicke in die Beziehungen und Abhängigkeiten zwischen sozialen Faktoren in Besprechungen zu gewinnen, welche die Wahrnehmung einer interaktiven Lösung durch die NutzerInnen beeinflussen können. Aufbauend auf den Ergebnissen der beiden Studien wird eine Lösung vorgeschlagen, welche die Entwicklung der Luftqualität in natürlich belüfteten Besprechungsräumen vorhersagt und die NutzerInnen in präventive Massnahmen einbezieht, wenn ein Risiko prognostiziert wird.

#### **Institut für Schweizerisches und internationales Baurecht**

##### **Bauwerkssicherheit durch Datensicherheit**

Das Forschungsteam de Institut für Schweizerisches und internationales Baurecht hat sich im vergangenen Jahr auf folgendes Forschungsprojekt fokussiert: Sicherheit von Bauarbeiten durch Datensicherheit. Analyse der neuen internationalen Norm ISO 19650-5 und ihrer Auswirkungen aus rechtlicher Sicht.

such as trading, information storage and increased transparency and democratization. A Transition Studies perspective is utilized to review potential barriers, as well as to map out prospective transition trajectories.

#### **Human-IST Institute**

##### **Air Quality in Shared Work Spaces**

Repeated exposure to poor air quality in indoor environments such as office, home, and classroom can have substantial adverse effects on our health and productivity. The problem is especially recognized in closed indoor spaces shared by several people. Human-IST has studied the evolution of carbon dioxide level in office-meeting spaces, during 1007 meeting sessions. The collected data is employed to examine machine learning models aimed to indicate the CO<sub>2</sub> evolution pattern and to forecast when fresh air should be supplied. In addition, to gain insight into the relations and inter-dependencies of social factors in meetings that may influence the users' perception of an interactive solution, Human-IST has conducted a series of online surveys. Building on the results of the two studies, a solution is proposed that predicts the evolution of air quality in naturally ventilated meeting rooms and engages the users in preventive actions when risk is forecast.

#### **Institute for Swiss and International Construction Law**

##### **Building safety through data security**

The research team at the Institute for Swiss and International Construction Law focused on the following research project last year: Safety and security of construction works through data safety and security. Analysis of the new international standard ISO 19650-5 and its implications from a legal point of view.

# Bâtiment du Smart Living Lab

## Smart Living Lab-Gebäude

### Building of the Smart Living Lab

FR

#### Une entreprise fribourgeoise remporte l'appel d'offres pour la construction du bâtiment

Suite à l'appel d'offres public lancé en mars 2021, l'adjudication des travaux de construction sur le site de bluefactory du bâtiment pour le Smart Living Lab a été attribuée à JPF Entreprise Générale SA à Bulle. Les entreprises totales soumissionnaires ont été évaluées selon une méthode de notation basée sur le prix, les qualités techniques de l'offre et l'organisation spécifique du soumissionnaire et pour l'exécution du marché. Le lauréat s'est distingué par sa très bonne compréhension du projet et de ses contraintes, en particulier dans l'optimisation des coûts, qui respecte le crédit global de 25 millions de francs octroyé par le Canton de Fribourg. Le début des travaux est annoncé pour l'été 2022.

Mis en œuvre par le Canton de Fribourg, ce projet est le fruit d'une étroite collaboration entre BFF SA et le Smart Living Lab. Il s'est concrétisé, en 2018, par le lancement d'un Mandat d'Études Parallèles (MEP) participatif et innovant. Les étapes successives ont permis de répondre plus spécifiquement aux besoins des utilisateur-trices au travers d'un processus itératif et à l'aide d'outils de recherche de pointe. Elles ont

débouché sur une demande de permis de construire et un appel d'offres en entreprise totale.

#### Un laboratoire vivant

Sur une surface d'environ 5'000 mètres carrés, le bâtiment du Smart Living Lab accueillera dès 2024, 130 personnes issues de 11 groupes de recherche de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg. Conçu pour atteindre sur le long terme les objectifs de la Stratégie énergétique 2050 de la Confédération, ce bâtiment en bois local s'inscrit dans une démarche environnementale, qui repose sur les exigences de la Société à 2000 Watts à l'horizon 2050, définies sur l'ensemble de son cycle de vie, ainsi que sur le label énergétique Minergie-A-ECO et la certification selon le Standard de construction durable Suisse SNBS. En plus d'être un espace de travail confortable et performant, il a aussi pour objectif d'être l'outil d'expérimentation principal du Smart Living Lab. Pluridisciplinaire et catalyseur de progrès, ce « laboratoire vivant » de 4 étages sera un terrain propice aux travaux menés en conditions réelles.

« Sur une surface d'environ 5'000 mètres carrés, le bâtiment du Smart Living Lab accueillera dès 2024, 130 personnes issues de 11 groupes de recherche de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg et de l'Université de Fribourg. »



DE

## Ein Freiburger Unternehmen gewinnt die Ausschreibung für das Gebäude

Nach der letzten März 2021 erfolgten öffentlichen Ausschreibung wurde der Auftrag für den Bau des Smart Living Labs, Forschungszentrum für die Zukunft der gebauten Umgebung, auf dem Gelände der bluefactory der Firma JPF Entreprise Générale AG aus Bulle zugesprochen. Die Totalunternehmen, die sich beworben hatten, wurden auf der Basis einer Bewertungsmethode geprüft, die Preis, technische Qualität des Angebots und die spezifische Organisation des Anbieters sowie dessen Organisation im Hinblick auf die Ausführung des Auftrags gewichtete. Der Gewinner der Ausschreibung hob sich ab durch sein sehr gutes Verständnis für das Projekt und dessen Herausforderungen, insbesondere im Hinblick auf eine Optimierung der Kosten. Das Siegerprojekt hält sich an den vom Kanton Freiburg vorgegebenen Globalkredit in der Höhe von CHF 25 Millionen.

Das vom Kanton Freiburg realisierte Projekt ist das Ergebnis einer fortgesetzten Zusammenarbeit zwischen der BFF SA und dem Smart Living Lab. Konkretisiert wurde es 2018 mit der Lancierung eines partizipativen und innovativen Studienauftrags. Die darauffolgenden Schritte haben es ermöglicht, spezifischer auf die Bedürfnisse der Benutzer einzugehen. Dabei gelangten ein iteratives Verfahren und neuste Forschungstools zum Einsatz. Die Arbeiten mündeten schliesslich in ein Baugesuch und eine öffentliche Ausschreibung für ein Totalunternehmen.

### Ein lebendiges Labor

Ab 2024 wird das Smart Living Lab auf einer Fläche von circa 5'000 Quadratmetern 130 Personen aufnehmen, die aus 11 Forschungsgruppen der EPFL, der Hochschule für Technik und Architektur Freiburg und der Universität Freiburg stammen. Das Gebäude aus lokalem Holz, das im Hinblick auf das Erreichen der langfristigen Ziele der Energiestrategie 2050 des Bundes gebaut wird, verfolgt ökologische Ziele, die auf den Anforderungen einer 2000-Watt-Gesellschaft bis 2050 basieren. Die Ziele werden über den gesamten Lebenszyklus hinweg definiert. Das Gebäude hält sich zudem an die Vorgaben des Labels Minergie-A-ECO und an den Standard Nachhaltiges Bauen Schweiz SNBS. Das Gebäude soll nicht nur ein angenehmer und leistungsfähiger Arbeitsort sein, es soll auch das zentrale Experimentierfeld des Smart Living Labs sein. Das pluridisziplinäre und fortschrittliche «lebendige Labor» auf vier Stockwerken wird ein Raum sein, in dem unter realen Bedingungen gearbeitet und geforscht werden kann.

«Ab 2024 wird das Smart Living Lab auf einer Fläche von circa 5'000 Quadratmetern 130 Personen aufnehmen, die aus 11 Forschungsgruppen der EPFL, der Hochschule für Technik und Architektur Freiburg (HTA-FR) und der Universität Freiburg stammen.»

EN

## Fribourg general contractor wins tender for the building

Following a public call for tenders launched in March 2021, JPF Entreprise Générale SA, a general contractor based in Bulle, has been awarded the contract to build the new facility that will house the Smart Living Lab, a research and development centre devoted to the built environment of the future. All bids were scored on a set of award criteria that included the price, the technical merits of the bid, the organisational capacity of the bidder, and the proposed execution of the contract. JPF Entreprise Générale SA demonstrated an excellent understanding of the project and its constraints, particularly with regard to cost optimisation, since its winning bid falls within the CHF 25 million budget granted by the cantonal government. Construction is scheduled to begin in summer 2022.

The project is the result of a collaborative process between BFF SA and the Smart Living Lab; the Canton of Fribourg has overseen its implementation. In 2018, it took concrete shape with the launch of the participatory and innovative *Mandat d'Etudes Parallèles (MEP)*. With the help of advanced research tools and an iterative process, the original design has been successively refined to ensure that it meets the particular needs of the building's future users. At the end of this process, an application for planning permission was submitted and a call for tenders (general contractor) launched.

### A living laboratory

The Smart Living Lab building, which is scheduled to open in 2024 with around 5,000 m<sup>2</sup> of floor space, will provide workspace for the 130 members of 11 research teams from the EPFL, the School of Engineering and Architecture of Fribourg, and the University of Fribourg. The facility, which will be built from locally sourced timber, has been designed with the targets of Switzerland's Energy Strategy 2050. The design also reflects a wider environmental approach that is informed by the values set for 2050 by the 2000-watt society vision and applied during the whole lifecycle of its component parts, and meets the requirements of the Minergie-A-ECO energy label and Swiss Sustainable Building Standard (SNBS) certification. In addition to offering a comfortable and high-performance workspace, the primary purpose of the Smart Living Lab is to serve as a site of experimentation. The four-storey, multi-disciplinary living laboratory will be a catalyst of progress, providing fertile ground for conducting experiments under real-life conditions.

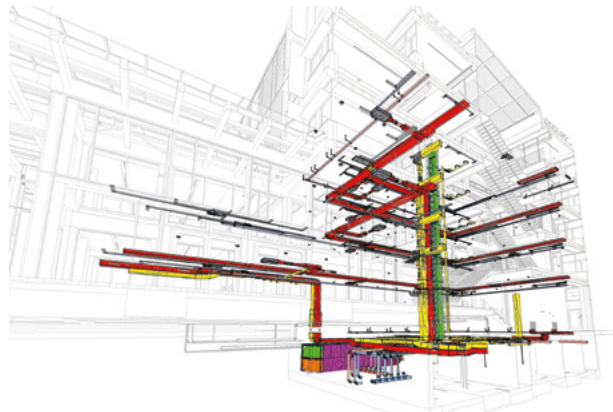
“The Smart Living Lab building, which is scheduled to open in 2024 with around 5,000 m<sup>2</sup> of floor space, will provide workspace for the 130 members of 11 research teams from the EPFL, the School of Engineering and Architecture of Fribourg, and the University of Fribourg.”

## KEY FEATURES OF THE SMART LIVING LAB BUILDING



### ENVIRONMENTAL PERFORMANCE

- » 2000 Watts Society - Horizon 2050
- » Minergie-A-ECO label
- » SNBS label
- » Carbon budget

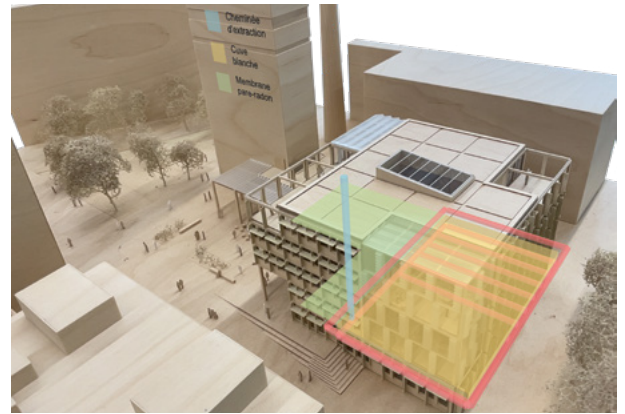


### BIM (Building Information Modeling)

- » 5 sets of digital models LOG 350 – LOI 450
- » 4 objectives: Monitoring, Facility Management, Communication, Life Cycle Analysis
- » Data collection for research
- » Demonstration of full size digital twin

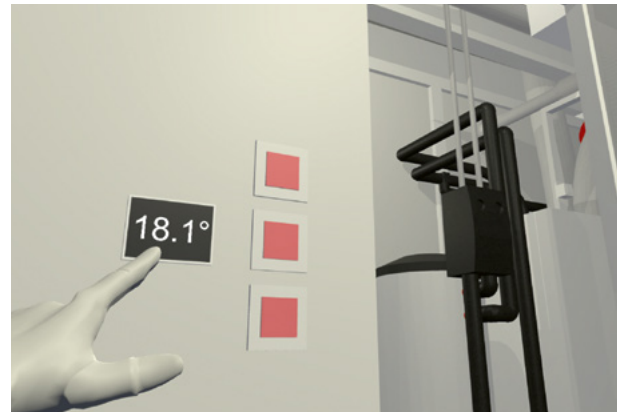


The information refers to the project phase resulting from the public tender in March 2021. Pictures © EPFL Building2050, BFF SA, Behnisch Architekten



## RADON

- » Radon free building ( $< 100$  Becquerel/m<sup>3</sup>)
- » Radon drainage
- » Radon barrier membrane
- » Radon monitoring:  
105 radon sensors (Interface Ground - Building)



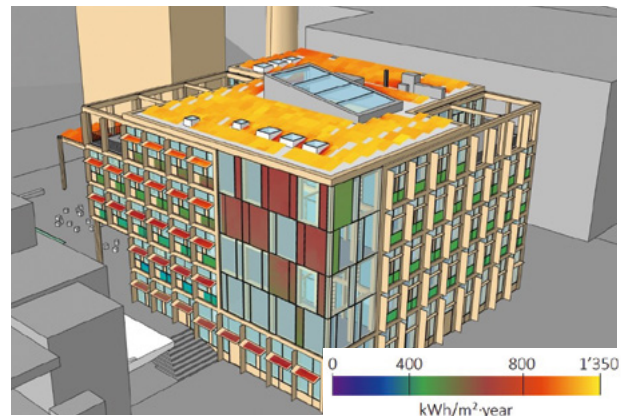
## MONITORING and CONTROL

- » 3 modes of Building Management System (automatic, manual, customized)
- » 160 temperature sensors, 64 humidity sensors
- » Indoor Environment Quality parameters and occupancy/usage monitoring



## BIPV (Building-Integrated Photovoltaics)

- » Surface = 1,015 m<sup>2</sup>
- » Installation size = 156 kWp (850 kWh/kWp)
- » Self-sufficiency = 52% (30kWh battery capacity)



- » Integration into various facade/roof elements
- » Different levels of integration using standard and innovative/customized products (appearance and shape).

# BFF SA

## Quartier d'innovation

## Innovationsquartier

## Innovation district

FR

Fondée en 2014, BFF SA a pour mission le développement, la construction, l'exploitation, la promotion et l'animation du quartier d'innovation bluefactory, dont l'intégration au Parc suisse d'innovation (Switzerland Innovation Park) en fait un acteur incontournable de l'habitat du futur. Pour relever les défis de demain, le site se positionne également dans la mobilité, l'agro-alimentaire et la santé. La formation et l'entrepreneuriat y jouent un rôle clé. Plus qu'un parc technologique, bluefactory s'inscrit comme un quartier d'innovation qui s'intègre parfaitement dans son environnement urbain, par sa mise en lumière de l'innovation sociale et de la vie culturelle. Orienté bas carbone, il adopte et promeut une démarche d'économie circulaire. Sa gestion innovante de l'eau lui permettra de devenir le premier « quartier éponge » de Suisse. Aujourd'hui, bluefactory compte plus de 340 personnes actives dans une cinquantaine d'entités (PME, start-up, innovation et recherche universitaire). Le nombre d'emplois devrait doubler d'ici 2023 avec l'inauguration d'un nouveau bâtiment.

DE

Die 2014 gegründete BFF SA ist für die Entwicklung, den Bau, den Betrieb, die Förderung und die Animation des Innovationsquartiers bluefactory zuständig. Dessen Integration in den Switzerland Innovation Park macht es zu einem unumgänglichen Akteur des Lebensraum der Zukunft. Um die Herausforderungen der Zukunft angehen zu können, positioniert sich bluefactory auch in den Bereichen Mobilität, Lebensmittelversorgung und Gesundheit. Ausbildung und Unternehmertum spielen dabei eine zentrale Rolle. bluefactory ist mehr als ein Innovationsquartier, sie passt sich dank der von ihr geförderten sozialen Innovationen und dem Kulturleben auch nahtlos in ihr städtisches Umfeld ein. Das Quartier ist emissionsarm ausgerichtet und fördert die Kreislaufwirtschaft. Das innovative Wassermanagement wird es der bluefactory ermöglichen, zu einem der ersten «Schwamm-Quartiere» der Schweiz zu werden. Heute sind auf dem Gelände der bluefactory gegen 340 Personen in 50 Einheiten (KMU, Startups, Innovation und universitäre Forschung) tätig. Bis 2023 soll die Anzahl der Arbeitsstellen mit der Einweihung eines neuen Gebäudes verdoppelt werden.

EN

Founded in 2014, BFF SA's mission is to develop, build, operate, promote and foster community life in the bluefactory innovation district. As an integral member of the Swiss Innovation Park, bluefactory is a key player in realizing the habitat of the future. To meet the challenges of tomorrow, the site is also involved in mobility, agri-food and health. Training and entrepreneurship play a vital role. More than a technology park, bluefactory is an innovation district that fits perfectly into its urban environment by highlighting social innovation and cultural life. With its low carbon orientation, it adopts and promotes a circular economy approach. Innovative water management will enable it to become the first "Sponge District" in Switzerland. Today, bluefactory has more than 340 people working in about fifty entities (SMEs, start-ups, innovation and university research). The number of jobs is expected to double by 2023 with the inauguration of a new building.





# Histoires de recherche Forschungsgeschichten Research stories



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CONSTRUIRE EN BÉTON... SANS COULER DE BÉTON  
 BAUEN AUS BETON – OHNE ZU BETONIEREN  
 BUILDING OUT OF CONCRETE, BUT WITHOUT POURING CONCRETE



© EPFL ENAC

Prof. Corentin Fivet, Structural Xploration Lab (SXL), EPFL



« Il y a de nombreuses craintes qui freinent le réemploi du béton. »

«Die Baubranche zögert, Beton wiederzuverwenden, weil sie einige Bedenken hat.»

“People are hesitant to reuse concrete due to a variety of concerns.”

FR

Des chercheuses et chercheurs de l'EPFL ont construit une passerelle piétonne à partir de murs d'un bâtiment en rénovation. Les blocs en béton armé ont été sciés un à un sur place puis réassemblés en un arc précontraint. Une première mondiale qui vise à réduire drastiquement l'impact environnemental de l'industrie de la construction en y appliquant les principes de l'économie circulaire.

DE

ForscherInnen der EPFL haben einen Prototypen für eine Fußgängerbrücke aus Stahlbetonblöcken gebaut, die aus den Wänden eines zu renovierenden Gebäudes stammen. Die Blöcke wurden vor Ort in einzelne Stücke gesägt und anschliessend zu einem vorgespannten Bogen zusammengesetzt. Dieses Projekt, bei dem zum ersten Mal Beton auf diese Weise wiederverwendet wurde, ist Teil einer Forschungsinitiative, die darauf abzielt, den CO<sub>2</sub>-Fussabdruck der Bauindustrie durch die Anwendung der Kreislaufwirtschaft erheblich zu verringern.

EN

EPFL researchers have built a footbridge prototype using reinforced-concrete blocks from walls of a building being renovated. The blocks were cut into individual pieces on site and assembled into a prestressed arch. This project, which marks the first time concrete has been reused in this way, is part of an initiative to substantially shrink the construction industry's carbon footprint by adopting a circular economy approach.

[Read the entire story on our website](#) ↗

## MIEUX CONNAÎTRE LA QUALITÉ DE L'AIR DANS LES ÉCOLES PRIMAIRES FRIBOURGEOISES MEHR ÜBER DIE LUFTQUALITÄT IN FREIBURGER PRIMARSCHULEN ERFAHREN AIR QUALITY MEASUREMENT CAMPAIGN IN FRIBOURG'S PRIMARY SCHOOLS



© Guillaume Perret

Prof. Joëlle Goyette Pernot, TRANSFORM Institute, HEIA-FR

« Avec la pandémie de Covid-19, la qualité de l'air intérieur est devenue un sujet d'intérêt qui a gagné en importance. »

« Im Zuge der Covid-19-Pandemie ist die Luftqualität in Innenräumen zu einem wichtigen Thema geworden. »

“The Covid-19 pandemic has raised awareness of the importance of good indoor air quality.”

FR

La qualité de l'air que l'on respire influence notre état de santé global. Les capacités cognitives des enfants peuvent être affectées par des niveaux élevés de CO<sub>2</sub> dans les salles de classe. Le projet de recherche Scol'air-FR, mené par le Centre romand de la qualité de l'air intérieur et du radon (croqAIR) de l'Institut TRANSFORM de la Haute école d'ingénierie et d'architecture de Fribourg (HEIA-FR) actif au sein du Smart living lab, ambitionne de mieux connaître la qualité de l'air dans les écoles primaires fribourgeoises. En dix-huit mois, il prévoit trois campagnes de mesures dans 48 salles de classe réparties dans 24 écoles.

DE

Die Qualität der Luft, die wir einatmen, hat Auswirkungen auf unseren allgemeinen Gesundheitszustand. Die kognitiven Fähigkeiten von Kindern können durch eine hohe CO<sub>2</sub>-Konzentration in Klassenzimmern beeinträchtigt werden. Das Forschungsprojekt Scol'air-FR wird vom Centre romand de la qualité de l'air intérieur et du radon (croqAIR) des innerhalb des Smart Living Lab tätigen Instituts TRANSFORM der Hochschule für Technik und Architektur Freiburg (HTA-FR) durchgeführt. Sein Ziel ist es, mehr über die Luftqualität in den Freiburger Primarschulen zu erfahren. Innerhalb von achtzehn Monaten sind drei Messkampagnen in 48 Schulklassen in 24 Schulen geplant.

EN

The quality of the air we breathe has a bearing on our general health. High levels of CO<sub>2</sub> in classrooms, for example, can affect children's cognitive performance. With this in mind, the Scol'air-FR research project was launched in order to gain a better understanding of air quality in primary schools across Fribourg. Over an 18-month period, the Radon and Indoor Air Quality Centre of Western Switzerland (croqAIR), the project lead, will carry out three measurement campaigns in 48 classrooms of 24 schools. croqAIR, part of the TRANSFORM Institute of the School of Engineering and Architecture of Fribourg (HEIA-FR), is based at the Smart Living Lab.

REPLACER L'HUMAIN AU CŒUR D'UNE GESTION INTELLIGENTE DE LA LUMIÈRE  
 DEN MENSCHEN INS ZENTRUM EINER INTELLIGENTEN STEUERUNG DES LICHTS STELLEN  
 BRINGING HUMAN-CENTRED DESIGN TO SMART LIGHT CONTROL SYSTEMS



© Guillaume Perret

Julien Nembrini, Senior researcher, Human-IST, UNIFR

« Les systèmes d'automatisation sont optimisés par rapport à l'efficacité énergétique et à des facteurs de confort modélisés, mais ils sont rarement testés par l'être humain qui va les utiliser. »

«Automatisierungssysteme werden im Hinblick auf ihre Energieeffizienz und auf modellierte Komfortfaktoren optimiert, jedoch nur selten von den Menschen getestet, die sie nutzen werden.»

"Generally speaking, system optimisation tends to focus on energy efficiency and modelled comfort factors. Rarely does this process consider the end user."

FR

Senseurs obturés par du ruban adhésif, fermetures automatiques de store entravées... l'automatisation des bâtiments se heurte régulièrement à la perception négative qu'en ont les utilisatrices et les utilisateurs. Or, pour atteindre ses objectifs d'amélioration du confort et d'économie d'énergie, l'automatisation a besoin de leur adhésion. Mené par l'Institut Human-IST de l'Université de Fribourg, le projet LUCIDELES vise à optimiser la gestion de la lumière en favorisant l'éclairage naturel et à tester les réactions face à un dispositif de contrôle intelligent. Le but : mieux comprendre les mécanismes d'appropriation de ce système.

DE

Mit Klebeband abgedeckte Sensoren, automatische Rollläden, die sich nicht schliessen lassen... die Gebäudeautomatisierung hat bei den Nutzerinnen und Nutzern häufig ein Imageproblem. Damit die Automatisierung ihre Ziele wie einen verbesserten Komfort und eine höhere Energieeinsparung erreichen kann, ist sie jedoch auf deren Akzeptanz angewiesen. Das vom Institut Human-IST der Universität Freiburg durchgeführte Projekt LUCIDELES hat zum Ziel, das Lichtmanagement durch eine Förderung des Tageslichts zu optimieren. Zudem sollen die Reaktionen auf ein intelligentes Kontrollsystem getestet werden. Das Ziel ist es, die Nutzungsmechanismen dieses Systems besser zu verstehen.

EN

Sensors covered with sticky tape and deliberately disabled smart blind motors... these are just a few examples of users' DIY solutions to troublesome everyday building automation systems. Yet, the user comfort and energy efficiency of these systems can only be improved if there is a decent level of user acceptance. The LUCIDELES project, led by the Human-IST Institute of the University of Fribourg, has two aims. The first is to optimise light management by leveraging natural daylight. The second is to carry out user testing on a smart control device in order to better understand user acceptance mechanisms.

Read the entire story on our website [➔](#)

# Promotion Öffentlichkeitsarbeit Outreach

## ÉVÉNEMENTS | VERANSTALTUNGEN | EVENTS

DATE	TITLE	SPEAKER
2021-01-26	INVITED TALK   Reinforcement Learning: Adapting to unknown environments	Dr. Zoltan Nagy, University of Texas at Austin
2021-02-10	SMART LIVING LUNCH   LUCIDELES: Leveraging User-Centric Intelligent Daylight and Electric Lighting for Energy Saving	Dr. Julien Nembrini, Human-IST, UNIFR
2021-02-23	SMART LIVING LUNCH   CarbonLight: An exploration-based life cycle assessment of daylighting strategies	Nazanin Rezaei Oghazi, ENERGY, HEIA-FR
2021-03-10	SMART LIVING LUNCH   Thermal performance of air-spaces behind claddings	Mohammad Rahiminejad, ICE, EPFL
2021-04-21	SMART LIVING LUNCH   The Complexity of Indoor Air Quality Forecasting and the Simplicity of Interacting with It	Sailin Zhong, Human-IST, UNIFR
2021-05-11	SMART LIVING LUNCH   Influence of ambient air pollution on natural ventilation potential in Europe	Evangelos Belias, HOBEL, EPFL
2021-05-25/26	Toitures végétalisées en mode démo	Prof. Joëlle Goyette-Pernot, Prof. Raphaël Compagnon, TRANSFORM, HEIA-FR
2021-05-26	SMART LIVING LUNCH   Probabilistic approaches applied to geotechnical finite element analyses	Prof. Stéphane Commend, iTEC, HEIA-FR
2021-06-01	Forum Construction durable   energissima	Prof. Thomas Jusselme, ENERGY, HEIA-FR, Dr. Sergi Aguacil & Dr. Sebastian Duque, Building2050, EPFL
2021-06-08	Smart Living Lunch   Interactions between energy use, COMfort, Behaviour, and INdoor Environment in office buildings	Dr. Verena M. Barthelmes, ICE, EPFL
2021-06-22	SMART LIVING LUNCH   Structural Design Space Exploration through the generation of variant networks of bars in static equilibrium, using grammar rules and interactive genetic algorithms	Ioannis Mirtsopoulos, SXL, EPFL
2021-06-26	Festival The Green Wave	Prof. Raphaël Compagnon, TRANSFORM, HEIA-FR Prof. Corentin Fivet, SXL, EPFL
2021-07-01	Vernissage musical   Pavillon GEO·GAMI	Nicolas Montagne, SXL, EPFL Prof. Corentin Fivet, SXL, EPFL



Presentation of the GEO-GAMI ski pavilion at the Green Wave Festival © Sonia Villegas

<b>2021-09-01/02</b>	RENT SWITZERLAND 2021	Martin Gonzenbach, Smart Living Lab Dr. Frédéric Dreyer, ENAC, EPFL Prof. Florinel Radu, TRANSFORM, HEIA-FR
<b>2021-09-10</b>	CISBAT 2021   Visit of the Smart Living Lab	Dr. Sergi Aguacil, Dr. Sebastian Duque, Justine Roman, Building2050, EPFL
<b>2021-10-04</b>	4 <sup>e</sup> Forum du logement	Prof. Florinel Radu & Nicole Jan, TRANSFORM, HEIA-FR
<b>2021-10-06</b>	Forum Habitat durable   energissima	Prof. Joëlle Goyette-Pernot, TRANSFORM, HEIA-FR Dr. Sergi Aguacil, Building2050, EPFL
<b>2021-10-11</b>	Vernissage de la passerelle en béton de réemploi RE:CRETE	Prof. Corentin Fivet, SXL, EPFL
<b>2021-10-13/15</b>	Semaine européenne du radon 2021	Prof. Joëlle Goyette-Pernot, TRANSFORM, HEIA-FR
<b>2021-10-20</b>	Smart Living Lunch   The Future of Green: Indoor Environmental Quality in Building Certifications	Prof. Dusan Licina, HOBEL, EPFL
<b>2021-11-02</b>	Smart Living Lab building Interactive Information Session	Dr. Sergi Aguacil, Dr. Sebastian Duque, Justine Roman, Building250, EPFL
<b>2021-11-03</b>	Smart Living Lunch   A toolbox to solve social dilemmas	Julia Cunha, iimt, UNIFR
<b>2021-11-04/30</b>	Cafés-conseils   Rénovation énergétique Beratungs-Café   Energetisch sanieren	Prof. Stefanie Schwab, TRANSFORM, HEIA-FR
<b>2021-11-15</b>	Journée cantonale du développement durable	Prof. Florinel Radu & Nicole Jan, TRANSFORM, HEIA-FR
<b>2021-11-17</b>	Journée de sensibilisation   Rénovation énergétique de l'enveloppe du bâtiment	Prof. Stefanie Schwab, TRANSFORM, HEIA-FR
<b>2021-11-23</b>	Smart Living Lunch   Exploring carbon targets for Swiss buildings in line with global carbon budgets	Yasmine Priore, ENERGY, HEIA-FR
<b>2021-12-15</b>	Smart Living Lunch   Should buildings learn our behavior? Case study of self-learning hot water systems	Amirreza Heidari, ICE and IPESE, EPFL

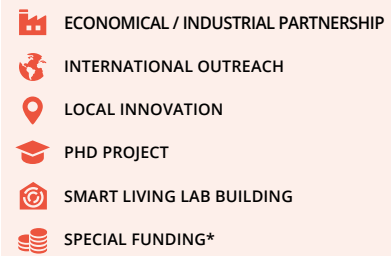
## MÉDIAS | MEDIEN | MEDIAS

DATE	TITLE	MEDIA
2021-02-10	Bluefactory sera bientôt rentable	La Liberté
2021-02-13	Fribourg veut toujours croire en Bluefactory	Le Temps
2021-02-17	Formations et environnement (3/5) - Comment intégrer la durabilité dans les hautes études ?	RTS La première
2021-02-21	Sobald mehr Kapital da ist, beginnen die Bauarbeiten bei der Blue Factory	Freiburger Nachrichten
2021-02-24	Recapitalisé, Bluefactory accueillera des centaines de chercheurs de l'EPFL	L'Agefi
2021-03-03	A Fribourg, le soutien à Bluefactory sera probablement tranché par les urnes	Le Temps
2021-03-03	Des débutés fribourgeois s'opposent à un crédit pour Bluefactory	RTS La première
2021-03-12	Le bâtiment du Smart living lab à l'enquête	La Liberté
2021-03-29	Les héros de Denver sur leur lancée	La Liberté
2021-03-31	Une approche circulaire de la construction	Le Nouvelliste
2021-04-03	Kontroverse Diskussion um die Rekapitalisierung der Blue Factory	Freiburger Nachrichten
2021-04-15	Comment les maisons de demain pourront-elles améliorer leur empreinte environnementale ?	Smart Média / 24Heures
2021-04-27	Le Conseil d'Etat fribourgeois uni derrière Bluefactory	Le Temps
2021-05-05	Quel avenir pour Bluefactory ? Débat contradictoire	La Liberté
2021-05-10	Le grand débat - Fribourg peut-il se passer de Bluefactory ?	RTS La première / Forum
2021-05-12	La Cafét - La collaboration entre les industries et les Hautes écoles	Radio Fribourg
2021-05-19	La Cafét - L'avenir de blueFACTORY et le Smart Living Lab	Radio Fribourg
2021-05-26	La face cachée du photovoltaïque intégré aux bâtiments. La chronique immobilière de l'EPFL	Le Nouvelliste
2021-06-02	L'avenir du quartier d'innovation Bluefactory se jouera le 13 juin	Le Temps
2021-06-04	Architecture circulaire - Form follows availability	Espazium
2021-06-07	Penser la ville jeune	La Liberté
2021-06-10	Chasse aux îlots de chaleur	La Liberté
2021-06-10	Un pavillon de bois pour mesurer le réchauffement climatique à Fribourg	Batimag
2021-06-14	Le canton de Fribourg peut continuer à développer Bluefactory	swissinfo
2021-07-02	L'immobilier face aux enjeux urgents du changement climatique	ATS/AWP
2021-07-06	La terre, matériau du futur	La Gruyère
2021-08-03	Habitat de demain : les toilettes, un soucis intime et mondial	La Gruyère
2021-08-18	Axelle Marchon - La ville en symbiose	Le Temps
2021-09-18	Rénovation « active » : une aubaine à saisir à tout prix !	Habitation
2021-10-11	L'EPFL a construit une passerelle en béton sans couler de béton	heidi.news
2021-10-12	Révolution au pays du béton	La Liberté
2021-10-12	Construire en béton sans couler de béton	RTS CQFD

<b>2021-10-13</b>	Une semaine contre le radon	RTS CQFD
<b>2021-10-26</b>	Baustart auf Gelände der BlueFACTORY	Freiburger Nachrichten
<b>2021-12-01</b>	L'ozone néfaste au contact de la peau	RTS CQFD
<b>2021-12-01</b>	L'impact de l'ozone sur la peau	La Liberté
<b>2021-12-01</b>	Ozone causes our skin to emit tiny airborne particles	Tech Explorist
<b>2021-12-17</b>	JPF construira le Smart Living Lab de BlueFactory	La Liberté
<b>2021-12-17</b>	Fribourg confie la construction de son laboratoire sur l'habitat en mains bulloises	Batimag
<b>2021-12-18</b>	JPF construira le Smart Living Lab	La Gruyère
<b>2021-12-21</b>	Bauwerkssicherheit durch Datensicherheit	Espazium
<b>2021-12-25</b>	Penser au-delà de l'énergie. La chronique immobilière de l'EPFL	Le Nouvelliste



# Projets de recherche Forschungsprojekte Research projects



\* Recognized competitive funding schemes:

- EU
- Federal offices SFOE, FOEN, etc.
- Foundations and similar grants
- Innosuisse
- NPR
- SNSF

DIRECTION   TEAM	SUMMARY	RESEARCH GROUP(S) AND PARTNER(S)	START END
<b>Adaptation to Extreme Temperatures   The Study of Physiology and Lifestyle of Nomadic Pastoralists in Tuva-Siberia</b>  			
Khovalyg, Dolaana; Chatterjee, Arnab; Sellers, Adam; van Marken Lichtenbelt, Wouter	Understanding of physiological and behavioural adaptation to environmental extremes through a field study of nomadic pastoralists living in yurts, frequently exposed to significant daily temperature variations.	EPFL ICE Thermophysiology & Metabolism group, Maastricht University (Netherlands)	2019 2021
<b>ADVENS</b>   			
Kane, Malick	Platform for modelling and simulating integrated multisource heating networks.	HEIA-FR ENERGY Groupe E SINEF PSE Energies Ville de Fribourg	2021 2022
<b>Affirming actions   Women in architecture</b>  			
Tombesi, Paolo; Xu Julia; Barnato, Ippolita; Garin, Raquel; Martin, Nora; Mateos, Ana; Perez, Marta; Bastianutti, Sophie; Legrand, Capucine; Radat, Philippine; Kieffer, Colin; Astaes, Charlotte; Thuring, Annabelle	Investigation into the challenges, opportunities and trajectories open to small-scale environmentally aware practices in specific parts of the world, with a particular focus on women-led firms.	EPFL FAR EPFL IA EPFL ARCHIZOOM	2020 2021
<b>Alaskan Layered Pollution And Chemical Analysis (ALPACA)</b>  			
Licina, Dusan; Wu, Tianren	Elucidation of sources and dynamics of air pollution in indoor and urban environments in Fairbanks, Alaska.	EPFL HOBEL John Hopkins University	2021 2024
<b>ARMO-Cure Innosuisse</b>   			
Zwicky, Daia; Chira, Alexandru	Development of a maintenance and reinforcement system for large steel pipes.	HEIA-FR ITEC S&P Clever Reinforcement AG Innosuisse	2020 2022



## ArraTex



Zwicky, Daia;	Experimental and analytical optimization of new anchorage types for externally bonded strengthening lamellas.	HEIA-FR ITEC	2021
Chira, Alexandru;		TEXUM SA	2022
Pathé, Julien;			
Schaller, Yanis			

## Assessing the Potential of Building Component Reuse



Fivet, Corentin;	Assessment of the reuse of building components as a key strategy in the circular economy.	EPFL SXL	2020
Bastien Masse,		SNSF	
Maléna; Lambec,			
Barbara; Wegmann, Raphaël			

## ASSIST BAT



Radu, Florinel;	Tools to understand and decide on a better quality of use and performance of new and old buildings.	HEIA-FR TRANSFORM	2019
Schwab, Stefanie;		EPFL Building2050	2020
Boumaref, Redouane;		Banque Raiffeisen	
Parrat, Jonathan;		Building Innovation Cluster	
Runser, Julie;		FEDER	
Jan, Nicole;		Interreg	
Gonzenbach, Martin;		Lutz Architectes	
Aguacil, Sergi		Service de l'énergie Fribourg	
		CAUE 74 Haute-Savoie	
		CMDL Manaslu Ing.	

## Atlas du logement



Frank, Frédéric	Online source of information on typo-morphological issues, the Housing Atlas initially used by HEIA-FR students, is being redesigned to target researchers and practitioners.	HEIA-FR TRANSFORM	2019 2020
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## BIM-AR | Exploring the Smart Living Lab building project using augmented reality



Aguacil, Sergi;	Using augmented reality (AR) based on the digital models of the Smart Living Lab to communicate the project design (BIM objective in the call for tenders).	EPFL Building2050	2019
Duque, Sebastian			2024

## BIM-FM | Digital twin and its application as facility management tool



Aguacil, Sergi;	Developing a digital twin prototype for the monitoring and maintenance management of the Smart Living Lab building (BIM objective of the call for tenders).	EPFL Building2050	2021
Duque, Sebastian			2024

## BIM-LCA | Data Collection for Life Cycle Assessment (LCA)



Aguacil, Sergi;	Defining a data collection methodology in connection with digital models for the Life-Cycle Analysis of the Smart Living Lab building (BIM objective of the call for tenders).	EPFL Building2050	2021
Duque, Sebastian			2024

**BIM-UP**

Boumaref, Redouane; Aguacil, Sergi; Duque, Sebastian	Building information modelling practices: study of support measures for the digital transition of building and facility management companies.	EPFL Building2050 HEIA-FR TRANSFORM Advent Antiglio BIC BFF SA Element AG Grisoni Zaugg Groupe E HEG-FR Objectif BIM UPCF	2020
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**Binaural audio for hybrid models of meeting**

Rosset, Loic; Zhong, Sailin; Lalanne, Denis; Alavi, Hamed	Could the direction of sound into the audio signal improve the experience of remote attendance at a physical meeting? Using binaural audio recording methods to create such a feature, researchers conducted an experiment that answers this question capitalising gaze data.	UNIFR Human-IST Logitech Innosuisse	2020 2021
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**Biodégrès**

Labieuse, Vincent; Frei, Benjamin; Breguet, Mercier Véronique; Dabros, Michal; Pollien, Jessy	Biocementation of excavated sandstone.	HEIA-FR iTEC HEIA-FR ChemTech	2021 2022
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**BIPV | Building-Integrated Photovoltaics of the Smart Living Lab building**

Aguacil, Sergi	Designing and monitoring of building-integrated photovoltaics (BIPV) that advance the achievement of environmental targets and meet the research requirements of the Smart Living Lab building.	EPFL Building2050	2019 2024
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**Blockchain Energy**

Teufel, Stephanie; Sentic, Anton; Barmet, Mathias; Niemer, Tim Tom	Exploration of the ongoing, far-reaching transformation of the electricity sector that goes beyond market decentralisation towards the increased use of alternative, renewable energy sources.	UNIFR iimt Chalmers University Göteborg	2020 2021
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**blueEnergy**

Pfister, Michael; Kane, Malick; Radu, Florinel	Focus on sustainability at district scale as well as on the energy potential of local waters and their regulation.	HEIA-FR iTEC HEIA-FR ENERGY HEIA-FR TRANSFORM BFF SA Sinef SA Groupe E	2019 2021
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## Building energy modeling with hourly time-step simulation for the Smart Living Lab building



Aguacil, Sergi	Development for environmental performance analysis applied to the Smart Living Lab building project, in relation to the objectives defined during the parallel studies mandate (MEP) phase.	EPFL Building2050	2019 2021
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## Building safety through data security



Beyeler, Martin	Safety and security of construction sites through data safety and security. Analysis of the new international standard ISO 19650-5 and its implications from a legal point of view.	UNIFR Institute for Swiss and International Construction Law	2021 2021
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## Building-integrated photovoltaic analysis for the Smart Living Lab building



Aguacil, Sergi	Building-integrated photovoltaic analysis to support the development of the Smart Living Lab building based on self-sufficiency and self-consumption filtering the annual irradiation threshold to identify the active surfaces.	EPFL Building2050	2019 2021
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## Cereva 0



Compagnon, Raphaël; Cesari, Matias	Developing evaporative cooling bricks.	HEIA-FR TRANSFORM	2021 2022
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## City Pulse SIM



Radu, Florinel; Ingram, Sandy; Parrat, Jonathan; Fénart, Marc-Antoine; Runser, Julie	Simulation of urban planning interactions: land use – density – mobility.	HEIA-FR TRANSFORM HEIA-FR iTEC HEIA-FR iSIS HEIA-FR iCOSYS	2020 2022
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## Clothing-induced particle resuspension in indoor environments



Licina, Dusan; Jiang, Han-Yun	Establishment of a new model for characterisation of particle resuspension from clothing.	EPFL HOBEL	2020 2024
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## Computational Design for Resilient Shelters



Estrella, Xavier; Ullal, André; Fivet, Corentin	Design and optimisation of low-tech solutions for flood-resistant shelters in South Sudan.	EPFL SXL EPFL FAR Medair NGO	2021 2023
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## Constituents of Human Particle, Microbial and Chemical Emissions, Dispersal Mechanisms and Exposures in Indoor Environments



Licina, Dusan; Merizak, Marouane	Examination of the processes by which humans shape the microbiology and chemistry of indoor air through emissions of particles and gases, their secondary transformation in indoor air and the resulting contribution to personal inhalation exposure.	EPFL HOBEL	2020 2024
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## Déconstruction Sélective / Construction Réversible



Fivet, Corentin; Küpfer, Célia	Production of a manual on reversible building design as a way to decrease demolition waste. Principles and techniques are reviewed.	EPFL SXL OFEV	2019 2020
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## DEMO-MI<sup>2</sup>



Vonlanthen, Marc; Compagnon, Raphaël; Rotzetta, André; Taillebois, Jean-Michel; Cesari, Matias	Design, implementation and experimentation of a mobile demonstrator operating as a microclimate for scientific, educational and awareness-raising purposes.	HEIA-FR ENERGY HEIA-FR TRANSFORM Ville de Fribourg	2020 2021
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## Digital monitoring of the construction process of Smart Living Lab building



Aguacil, Sergi; Duque, Sebastian;	Design and implementation of a digital monitoring system of the Smart Living Lab building.	EPFL Building2050	2021 2024
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## DIRE | Digital Infrastructure for Research Experiments of the Smart Living Lab building



Aguacil, Sergi; Duque, Sebastian	Developing a digital infrastructure to facilitate research experiments in the Smart Living Lab building.	EPFL Building2050	2021 2024
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## Direct awards under the 2012 Government Procurement Agreement (GPA 2012) and the 2019 Federal Act on Public Procurement (FAPP 2019)



Socchi, Caroline	Analysis of Art. XIII GPA 2012 and Art. 21 FAPP 2019.	UNIFR Institute for Swiss and International Construction Law	2020 2024
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## Dynamic Indoor Environment with Reinforcement Learning for HVAC energy savings and long-term health benefits.



Chatterjee, Arnab; Khovalyg, Dolaana	Development of a deep reinforcement learning (DRL) based controller that can help to create a healthy and energy-efficient dynamic indoor environment.	EPFL ICE	2019 2022
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## eCOMBINE | Interaction between energy use, COMfort, Behaviour, and INdoor Environment



Khovalyg, Dolaana; Licina, Dusan; Barthelmes, Verena; Andersen, Marilyne; Wienold, Jan; Karmann, Caroline; Gonzalez Serano, Maria Viviana	Predicting energy consumption of HVAC and lighting services in open plan offices by developing an integrated approach to study the cause-effect relationship between occupants and combined indoor environmental factors.	EPFL ICE EPFL HOBEL EPFL LIPID UNIFR Human-IST	2019 2021
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## ECon-BioLA | New Ecological CONcretes based on low-energy BIO-based artificial Lightweight Aggregates with multifunctional properties



Zwicky, Daia; Serpell, Ricardo; Pathé, Julien; Jusselme, Thomas; Marti, Roger; Robadey, Jacques	Development of new eco-friendly lightweight concretes: from the generation of novel, low-energy lightweight aggregates by cold bonding local by-products through to their optimisation to meet multifunctional building construction specifications.	HEIA-FR iTEC HEIA-FR ENERGY HEIA-FR ChemTech	2021 2022
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## Efficient and sustainable waste collection



Sentic, Anton; Bürgy, Reinhard; Ries, Bernhard; Pasquier, Virgile; Fischer, Vera; Wyss, Manuel; Teufel, Stephanie	Decision support tool for municipal waste management systems based on optimisation modeling and the deployment of innovative technologies.	UNIFR iimt UNIFR DS&OR Innosuisse Schwendimann AG	2019 2021
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## Epolé



Rime, Alain; Muresan, Alexandre	Use of cold-formed steel in building elevations.	HEIA-FR iTEC	2020 2021
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## Exergy Analysis of Geneva's District Heating Network



Khovalyg, Dolaana; Barre, Pierre; Richard, Pierre; Adihou, Yolaine; Kane, Malick	Exergy analysis of Geneva district heating network in search of losses and optimisation of future expansion of the network.	HEIA-FR ENERGY EPFL ICE Services Industriels de Genève (SIG)	2020 2021
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## Experimental module of a Smart Living Lab building façade prototype



Aguacil, Sergi; Duque, Sebastian; Roman, Justine	Design, construction, test and evaluation of an innovative, multifunctional experimental module using a Smart Living Lab façade prototype developed by the general contractor.	EPFL Building2050 HEIA-FR ENERGY Etat de Fribourg	2021 2024
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## Exploring the unintended consequences of air cleaning chemistry



Licina, Dusan; Wu, Tianren; Athanasios, Nenes	Investigation of the unintended consequences of the use of air cleaning devices on indoor air chemistry.	EPFL HOBEL EPFL LAPI	2021 2024
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## FACILITY 4.0



Hennebert, Jean; Bacher, Jean-Philippe; Montet, Frédéric; Marazzi, Sofia; Pongelli, Alessandro	Building Management 4.0 - innovative services for performance monitoring and facility management.	HEIA-FR ENERGY HEIA-FR iCoSys Amotech Plus BIC ESTIA GreenWatt Losinger So'Watt	2019 2021
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## Follow-up of the environmental aspects of the Smart Living Lab building



Aguacil, Sergi; Roman, Justine	Follow-up monitoring of environmental aspects of the Smart Living Lab building, both during the tender phase and in preparation for the construction phase.	EPFL Building2050	2019 2024
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## Food Living Lab Fribourg



Teufel, Stephanie; Sentic, Anton; Pasquier, Virgile	Methodological and planning support of the Swiss centre of excellence for agricultural research Agroscope and canton Fribourg in development of a Food Living Lab located partly at the BlueFACTORY site and partly at Agroscope's Posieux campus.	UNIFR iimt Smart Living Lab Canton de Fribourg Agroscope	2020 2021
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## Framework contracts under Swiss public procurement law



Fasnacht, Thierry; Beyeler, Martin	Analysis of Art. 25, Federal Act on Public Procurement (FAPP).	UNIFR Institute for Swiss and International Construction Law	2021
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## Fri-Loranet



Robadey, Jacques; Jourdan, Matthieu; Bapst, Nicolas	An intelligent Fribourg-based network based on LoRa (Long Range) technology to manage traffic.	HEIA-FR ENERGY HEIA-FR iCoSys HEIA-FR iSIS FRANIC SA Groupe e connect SA Gruyère Energie SA Softcom SA Ville de Bulle Ville de Fribourg WiFX	2019 2021
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## Generative Grammars for Structural Exploration



Fivet, Corentin; Mirtsopoulos, Ioannis	Approach that fosters a close collaboration between user and machine, ensuring that the design process benefits from the experience of both the former and the latter.	EPFL SXL	2018 2022
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## Hidden Genericity



Fivet, Corentin; Ye, Jingxian	Identifying hidden genericity and reversibility in load-bearing components for buildings as a way to improve reuse loops.	EPFL SXL	2018 2022
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## Hilo | well-being in office spaces through subjective sensing and predictive models of comfort



Lalanne, Denis; Zhong, Sailin; Alavi, Hamed	Advancing indoor environmental conditions in office spaces with a novel approach in which hazardous situations are prevented instead of being rectified after they are detected through sensing devices.	UNIFR Human-IST Logitech Innosuisse	2018 2020
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## Human emissions of particle and bioaerosols: Controlled chamber study



Licina, Dusan; Yang, Shen	Scientific-grade air quality instrumentation to characterize how human-associated emissions of particles and bioeffluents contribute to indoor air composition and to resulting inhalation exposures.	EPFL HOBEL	2018 2022
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## ICU\_FRIBOURG | Ilots de chaleurs urbains (ICU) en ville de Fribourg



Vonlanthen, Marc	Urban heat islands in the city of Fribourg: a decision-making and communication tool to anticipate and raise awareness of the consequences of global warming on urban comfort and human health.	HEIA-FR ENERGY Ville de Fribourg OFEN	2019 2021
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## Impact of the ventilated air-space on the thermal performance of traditional and modern building envelopes



Rahiminejad, Mohammad; Khovalyg, Dolaana	Understanding the impact of ventilated air gaps on the thermal performance of traditional passive and active BIPV façades.	EPFL ICE	2019 2022
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## Indoor environment and health: Exploration of multi-domain KPIs, HPIs and socio-economic evaluation models in open space offices



Berquand, Cecile; Becchio, Christina; Khovalyg, Dolaana	Quantitative analysis of health and productivity risks correlated with poor indoor environmental quality in open-plan office spaces in Switzerland and Italy.	EPFL ICE Politecnico di Torino, Technology Energy Building Environment Group	2021 2022
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## initiation to BIO-based Light Aggregate Pelletizing (i-BioLAP)



Zwicky, Daia; Serpell, Ricardo	Initiation to pelletising lightweight aggregates (LWA) from biomass and cement; initiation to bio-based lightweight aggregate pelletising.	HEIA-FR iTEC	2020 2021
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## Jura



Tombesi, Paolo	Technological review of approximately 200 factory buildings with specific typological traits across the Jura Valley, aiming at determining the degree of production-induced innovation in the building systems they used.	EPFL FAR	2017
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## Laboratory and field assessment on human microbial clouds



Licina, Dusan; Muthalagu, Akila	This project aims to improve our understanding of the release of human-associated microbes and gases, and how they impact the indoor air and our lungs.	EPFL HOBEL	2020 2024
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## LightBudget



Jusselme, Thomas	Integration of carbon budgets and natural light in building envelope design.	HEIA-FR ENERGY CSD Ingénieurs Losinger Marazzi Lutz architectes OVALE & Partenaires CMA Kleijer Annelore	2021 2023
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## Longitudinal assessment of human inhalation exposures



Licina, Dusan; Gonzalez Serrano, Maria Viviana	Assessment of individual level exposure to environmental pollutants, and its impact on human health and well-being.	EPFL HOBEL	2018 2022
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## LUCIDELES | Leveraging User-Centric Intelligent Daylight and Electric Lighting for Energy Saving



Nembrini, Julien; Kaempf, Jérôme; Papinutto, Michael; Colombo, Moreno; Lalanne, Denis	User-centric study of interaction with a state-of-the-art daylight/electric light control algorithm in an office setting.	UNIFR Human-IST EPFL Building2050 Idiap Research Insitute Regent Lighting OFEN	2020 2021
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## Mapping Geneva's embodied carbon legacy



Fivet, Corentin; De Wolf, Catherine; Vanbutsele, Sérena	New methodology to assess the embodied carbon over time and space in the canton of Geneva.	EPFL SXL EPFL Habitat Research Center EPFL DHLab Time Machine University of Geneva	2019 2021
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## Maximizing the potential for natural ventilation with regard to energy use and occupant well-being



Licina, Dusan; Belias, Evangelos	Maximizing the potential of natural ventilation in buildings with regard to multivariable set of relevant indoor-outdoor environmental quality factors and long-term energy saving potential.	EPFL HOBEL	2019 2023
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## mEAUbilité



Fénart, Marc-Antoine; Favre Boivin, Fabienne; Pfister, Michael	Infiltration of water runoff in mobility infrastructures.	HEIA-FR ITEC	2021 2021
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## MIP



Pfister, Michael; Favre, Boivin, Fabienne; Sandoval, Santiago	Deep infiltration modelling.	HEIA-FR ITEC	2021 2022
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## NextEarthBuild



Redaelli, Dario	Development of new approaches to the design and construction of buildings and outdoor facilities using excavated earth.	HEIA-FR iTEC HEIA-FR SeSi HEIG-VD	2019 2021
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## Occupant-Centric Hot Water Production based on Reinforcement Learning



Heidari, Amirreza; Maréchal, François; Khovalyg, Dolaana	Assessment of current challenges of domestic hot water production, accounting for individual preferences and occupant behaviour.	EPFL ICE EPFL IPESE DROOPLE SA	2019 2022
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## Occupant-centric HVAC control for optimal air quality, comfort and energy use



Licina, Dusan; Yun, Seoyeon	Research roadmap to extend the building-centred HVAC control strategy to tackle occupants' needs in an energy-efficient manner.	EPFL HOBEL	2019
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## OptiSoil



Commend, Stéphane; Jost, Colette	Optimisation of support system for urban deep excavations with machine learning techniques.	HEIA-FR iTEC HEIA-FR iCoSys EPFL Fondation Hasler	2019 2024
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## Performance of people at low-level activities in varying indoor temperatures



Khovalyg, Dolaana; Chatterjee, Arnab; Kwak, Jiyoun; Ravussin, Yan; Schutz, Yves; Montani, Jean-Pierre; Dulloo, Abdul	Understanding the effect of the indoor environment beyond thermoneutrality on thermoregulatory responses, thermal sensation and cognition during low level human activities.	University of Fribourg, Department of Endocrinology, Metabolism & Cardiovascular system	2020 2022
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## PopUp-CNC | 5-Axis Digital Manufacturing



Aguacil, Sergi; Duque, Sebastian; Jacot, Claude-Alain	Development of usage protocols of CAM (computer-aided manufacture) software and support for work to enable complex 5-axis machining on the Atelier PopUp CNC milling machine.	EPFL Building2050	2021 2022
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## Prediction of air quality in meeting rooms



Zhong, Sailin; Lalanne, Denis; Alavi, Hamed	Prediction and prevention of poor indoor air quality based on analysis of indoor air quality data collected during 1,007 meetings, and measures to ensure building user engagement.	UNIFR Human-IST Logitech Innosuisse	2019 2021
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## Predictive model of loading capacity for sustainable management



Tombesi, Paolo; Serpell, Ricardo	Development of an interactive graphic model capable of translating and representing the effect of population statistics and dynamics on built environment needs and requirements in a coastal region of Chile.	EPFL FAR Pontificia Universidad Católica de Chile Drexel University Municipalidad de El Quisco Ministerio del Medio Ambiente de Chile	2019 2021
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## PSBâti



Devaux, Mylène; Schwab, Stefanie; Jeanneret, Jérôme; Balestrieri, Leandro; Zahar, Skander	Analysis of the structural performance of building systems developed up to 1990 (Western Switzerland).	HEIA-FR iTEC HEIA-FR TRANSFORM	2020 2021
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## Public contracts, public concessions, public delegations: sorting things out in the light of art. 8 and 9 of the 2019 Federal Act on Public Procurement (FAPP 2019)



Beyeler, Martin	Analysis of Arts. 8 and 9 FAPP 2019 and Art. 2 para. 7 Internal Market Act.	UNIFR Institute for Swiss and International Construction Law	2020
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## Public procurement court decisions 2020/2021



Beyeler, Martin	Exhaustive analysis of public procurement case law (2020/2021).	UNIFR Institute for Swiss and International Construction Law	2021 2022
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## Publications database on Smart Living Lab website



Aguacil, Sergi; Roman, Justine; Thorens, Laure	Design of a searchable database of publications on the Smart Living Lab website using records from the databases of the parent institutions: infoscience (EPFL), ArODES (HEIA-FR) and Futura (UNIFR).	EPFL Building2050 EPFL Library HES-SO iZed Smart Living Lab UNIFR	2019 2021
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## QualiTEC



Commend, Stéphane; Jost, Colette; Favre, Fabienne; Bullinger, Géraldine; Froidevaux, Manuel; Pfister, Michael; Bénet, Loïc	In civil engineering, most of the measurements and parameters of calculation models are marred by imprecision. The aim of this project is thus to master error propagation techniques, and to improve the skills of in-situ measurement of parameters decisive in the performance and comfort of buildings.	HEIA-FR iTEC	2020 2021
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## Radon investigation in Swiss buildings



Licina, Dusan; Goyette Pernot, Joëlle; Rey, Joan	Collaborative effort between HEIA-FR TRANSFORM and EPFL HOBEL to advance the state of knowledge of indoor radon.	EPFL HOBEL HEIA-FR TRANSFORM	2020 2024
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## RAME | Radon Mitigation Efficiency



Goyette Pernot, Joëlle; de Potter-Longchamp, Céline; Pampuri, Luca	Testing long-term effectiveness of radon mitigation measures that have been used in residential buildings.	HEIA-FR TRANSFORM croqAIR SUPSI FHNW	2019 2021
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## Rapa Nui



Tombesi, Paolo; Beovic, Carolina	Long-term analysis, assessment and re-imagination of the socio-technical ecology that defines Rapa Nui and its built form.	EPFL FAR Pontificia Universidad Catolica de Santiago de Chile Municipality and Provincial Government of the Isla de Pascua Sociedad Agrícola y Servicios Isla de Pascua	2017 2021
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## RCB



Zwicky, Daia; Macchi, Niccolò; Serpell, Ricardo	Ecological optimisation of concrete made with recycled aggregates (RC) and basalt fibres.	HEIA-FR iTEC STRABAG AG	2020 2021
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## RE:CRETE



Brütting, Jan; Bastien-Masse, Maléna; Devènes, Julie; Küpfer, Célia; Fivet, Corentin	Design and construction of a post-tensioned arch footbridge that reuses cut blocks of cast-in-place concrete walls.	EPFL SXL Bridgology SA Diamantbohr AG Freyssinet	2021 2021
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## Regulations on cybersecurity of critical infrastructures (namely power grids)



Simon, Clea; Beyeler, Martin	Analysis of federal and cantonal regulations on the cybersecurity and cybersafety of critical infrastructures in general and power grids specifically.	UNIFR Institute for Swiss and International Construction Law	2021 2025
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## Reinforcement Learning for occupant-centric operation of building energy systems



Heidari, Amirreza; Maréchal, François; Khovalyg, Dolaana	Assessment of current challenges of domestic hot water production, accounting for individual preferences and occupant behaviour.	EPFL ICE EPFL IPESE DROOPLE SA	2019 2022
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## RenoBAT-FR



Schwab, Stefanie; Boggian, Stefania; Rime, Jean Luc; Devaux, Mylène; Balestrieri, Léandro; Jusselme, Thomas; Pasquier, Marilyne	Tools for the comprehensive upgrade of Fribourg's built environment.	HEIA-FR TRANSFORM HEIA-FR iTEC HEIA-FR ENERGY HEG CCRB Service de l'énergie Fribourg	2021 2022
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## Research infrastructure for advanced studies on Radon in buildings



Goyette Pernot Joëlle; Cesari, Matias; Aguacil, Sergi; Roman, Justine	Support for the implementation of a radon protection and monitoring plan in the Smart Living Lab building.	HEIA-FR TRANSFORM EPFL Building2050	2020 2024
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## Resource Assessment of Concrete Structures



Devènes, Julie; Bastien-Masse, Maléna; Küpfer, Célia; Fivet, Corentin	Development and application of assessments to identify the component reuse potential of concrete building systems.	EPFL SXL City of Zürich	2021 2022
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## Reuse potential of reinforced concrete building structures



Fivet, Corentin; Küpfer, Célia	This doctoral project reevaluates current construction practices of reinforced concrete buildings in the context of the circular economy, and more precisely their reuse potential.	EPFL SXL Doc.CH	2020 2024
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## ReuSlab



Redaelli, Dario; Fivet, Corentin; Buri, Hans; Bourquin, Vincent; Albertoni, Loran	Adaptation of a new reusable load-bearing system concept in order to manage the construction environmental impact.	EPFL SXL HEIA-FR iTEC HEIA-FR TRANSFORM HEIA-FR SeSi Stephan SA JPF Ducret SA Ancotech SA Holcim Suisse SA	2019 2021
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## SAR | Sociology and architecture



Radu, Florinel; Jan, Nicole	A method to identify the evolution of the residential mobility of different types of inhabitants over the course of their lives and the adequacy of their current habitat.	HEIA-FR TRANSFORM	2020 2021
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## Scol'Air-FR



Goyette, Pernot, Joëlle; Cesari, Matias; Jorin Hager, Corinne; Rey, Joan Frédéric	Improvement of air quality in Fribourg primary schools.	HEIA-FR TRANSFORM EPFL HOBEL EPFL LESO Etat de Genève, SABRA Etat de Fribourg, SEN Minergie OFSP QualiVentil SUPSI TOXpro Unisanté	2021 2022
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## SETUP Pro



Jusselme, Thomas; Radu, Florinel; Rezaei Oghazi, Nazanin; Priore, Yasmin	Decline of the objective of neutrality to a smaller scale, and provision of specifications in order to adapt SETUP to the reality of those involved in the urban planning process.	HEIA-FR TRANSFORM HEIA-FR ENERGY BFF SA Climate Services SA CSD Ingénieur SA Implenia Suisse SA Urbaplan	2020 2021
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## Shelter | Humanitarian Tents



Ullal, André; Vannucci, Riccardo; Tombesi, Paolo; Licina, Dusan; Aguacil, Sergi; Goyette Pernot, Joëlle	Assessment of thermal performances and indoor air quality of standard humanitarian tents on the blueFACTORY site in Fribourg.	EPFL FAR EPFL Building2050 EPFL HOBEL HEIA-FR TRANSFORM croqAIR	2019 2020
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## Smart Living Lab Application to the European Network of Living Labs



Sentic, Anton; Pasquier, Virgile; Cunha, Julia; Teufel, Stephanie	Preparation and implementation of the Smart Living Lab's formal membership application to the European Network of Living Labs (ENoLL).	UNIFR iimt Smart Living Lab Direction	2020 2021
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## SPOT ON



Ingram, Sandy; Chabi, Houdda; Radu, Florinel; Jan, Nicole; Fringeli, Samuel ; Nwachukwu, Uchendu	Proactive and adaptive system for workplace comfort management.	HEIA-FR TRANSFORM HEIA-FR iSIS HEIA-FR iCoSyS Raiffeisen	2021 2022
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## Stock-Based Structural Form-Finding



Fivet, Corentin; Brütting, Jan; Senatore, Gennaro	Algorithms development to identify structural system geometries that make optimal use of existing component inventories.	EPFL SXL	2017
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## Student Incubator: Development of an IoT device for monitoring and elimination of Legionella risk at the water point-of-use in buildings



Heidari, Amirreza; Khovalyg, Dolaana	Prototyping and testing an IoT device and an UVC-LED disinfection reactor to monitor and eliminate the risk of Legionella growth in water end-use points.	EPFL ICE	2021 2021
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## Support for the coordination and implementation of research projects



Aguacil, Sergi; Duque, Sebastian; Roman, Justine; Pastore, Luisa	Providing assistance for the formulation and coordination of multilateral research projects.	EPFL Building2050	2019
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## Sustainable construction in humanitarian action



Ullal, André	The goal of this project is to improve the sustainability of ICRC construction projects, particularly in terms of their impact on water and local habitat, through development of a digital platform that supports the sustainable design, operation and maintenance of humanitarian buildings and infrastructure.	EPFL FAR EPFL Building2050 EPFL EssentialTech Centre ETHZ Sustainable Construction D-BAUG ICRC	2020 2023
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## Technical support for the design and the call for tenders for the Smart Living Lab building



Aguacil, Sergi; Duque, Sebastian; Roman, Justine	Contracting authority support of blueFACTORY (owner of the Smart Living Lab building). Technical support for the entire project from the design to the tender phase for the Smart Living Lab building.	EPFL Building2050	2019 2022
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## Texture mapping and IFC material retrieval for VR and BSM uses



Aguacil, Sergi; Duque, Sebastian; Deschamps, Laurent	Application programme that aligns retrieved IFC model data to a set of image/pattern files, in order to control texture mapping in virtual reality navigation using IFC models.	EPFL Building2050	2020 2022
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## The Future of Green | Indoor Environmental Quality in Building Certifications



Licina, Dusan	Research and practice roadmap for future development of green building certification schemes.	EPFL HOBEL	2020
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## The Future of Indoor Aerosol Measurement



Licina, Dusan	This project aims to summarise the latest advances in indoor aerosol measurements and highlights the key research requirements in this field.	EPFL HOBEL	2020
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## Thermal Environments and Architecture for Cooling and Heating with Radiant Systems (TEACH-RS)



Khovalyg, Dolaana; Chatterjee, Arnab; Teitelbaum, Eric; Meggers, Forrest; Hou, Miaomiao; Aviv, Dorit	Advanced characterisation of the indoor thermal environment created by radiant systems, and the development of tools to predict the effect of radiant systems on the thermal experience of people.	EPFL ICE University of Pennsylvania Princeton University	2020 2021
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## TISLA 2D-Fx



Zwicky, Daia; Macchi, Niccolò; Niederhäuser, Elena-Lavinia; Buri, Hani	Proof of the technical feasibility of a flooring system made of wood and alternative lightweight concrete ('WooCon' wood-based concrete) as a substitute to concrete pre-slabs.	HEIA-FR iTEC HEIA-FR ENERGY HEIA-FR TRANSFORM	2019 2021
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## TRAB



Favre Boivin, Fabienne	Analysis and benchmarking of treatment solutions for roof runoff water. Treatment optimisation recommendations.	HEIA-FR ITEC	2021 2021
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## TypoRENO-VD



Schwab, Stefanie; Gaudard, Jean-François; Sciboz, Yanaelle	Development of roadmaps for the energy renovation of representative protected buildings in the canton of Vaud in collaboration with the Directorate of Energy and the General Directorate of Buildings and Heritage.	HEIA-FR TRANSFORM Etat de Vaud	2021 2023
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## Using virtual reality to explore and communicate the Smart Living Lab's research facilities



Aguacil, Sergi; Duque, Sebastian; Roman, Justine	Interoperability tests for 3D model exchange, including different levels of detail and construction modes, using a visualisation and 'conflict' treatment platform during the design phase.	EPFL Building2050	2019 2023
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## Viadotto Fornaci



Redaelli, Dario; Schaller, Yanis; Moix, Jonathan	Experimental studies on the bond between ultra-high performance concrete (UHPC) and ordinary concrete.	HEIA-FR ITEC OFROU GEOTEST SA	2017 2021
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## Vi-Vid: Valeurs Intrinsèques des Vides urbains



Vanbutsele, Séréna; Brahimllari, Estela	The Vi-Vid project maps and identifies urban empty spaces to reveal their potential in the Fribourg context.	HEIA-FR TRANSFORM	2021 2022
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## VR-enabled building-data management integrating BIMs and IoT - Case study CELLS



Aguacil, Sergi; Duque, Sebastian; Deschamps, Laurent	Integration of Building Information Models (BIMs), an Internet of Things (IoT) inventory and building data management to enable a double-way control of objects and data within a virtual reality (VR) environment.	EPFL Building2050	2020 2022
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## Waste Reclamation | Elastic Gridshell



Montagne, Nicolas; Fivet, Corentin; Baverel, Olivier; Douthe, Cyril	Design and construction of an elastic gridshell from reclaimed material.	EPFL SXL ENPC	2019 2021
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# Publications

# Publikationen

# Publications

## RESEARCH PUBLICATIONS 2021

TO BE FOUND ON [WWW.SMARTLIVINGLAB.CH/PUBLICATIONS](http://WWW.SMARTLIVINGLAB.CH/PUBLICATIONS)

Adihou, Yolaine; Kane, Malick; Ramousse, Julien; Souyri, Bernard. (2021). [Temperature level optimization for low-grade thermal networks using the exergy method. Journal of Physics: Conference Series, vol. 20142](#), article no. 012029. DOI: 10.1088/1742-6596/2042/1/012029.

Adihou, Yolaine; Kane, Malick; Ramousse, Julien; Souyri, Bernard. (2021). [An exergy-based methodology to determine thermal network's optimal temperature level](#). Proceedings of Ecos 2021, 34th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, 28 June - 2 July 2021, Taormina, Italy.

Adihou, Yolaine; Kane, Malick; Rime, Simon; Ramousse, Julien; Souyri, Julien. (2021). [Méthodologie d'étude des performances exergétiques d'un réseau énergie : application au réseau d'Estavayer-le-lac \(Suisse\)](#). Actes du 29ème Congrès français de thermique (SFT 2021), 1er-3 juin 2021, Belfort, France. DOI: 10.25855/SFT2021-027.

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Barthelmes, Verena M.; Karmann, Caroline; Serrano, Viviana Gonzalez; Chatterjee, Arnab; Andersen, Marilyne; Wienold, Jan; Licina, Dusan; Khovalyg, Dolaana. (2021). [Global Environmental Stimuli and Human-Building Interaction in Open Space Offices: A Swiss Case Study](#). Ashrae Transactions 2021, Vol 127, Pt 1, 127, 434-442. DOI: 000725205700050.

Barthelmes, Verena M.; Karmann, Caroline; Gonzalez, S. Viviana; Chatterjee, Arnab; Wienold, Jan; Andersen, Marilyne; Licina, Dusan; Khovalyg, Dolaana. (2021). [Environmental preferences of occupants: A multi-domain approach in the Swiss open office case study](#). [Proceedings of] CISBAT 2021 Carbon-neutral cities - energy efficiency and renewables in the digital era 8-10 September 2021, EPFL Lausanne, Switzerland. DOI: 10.1088/1742-6596/2042/1/012131.

Barthelmes, Verena Marie; Chatterjee, Arnab; Karmann, Caroline; Wienold, Jan; Licina, Dusan; Gonzalez Serrano, Maria Viviana; Andersen, Marilyne; Khovalyg, Dolaana. (2021). [eCOMBINE – Interaction between energy use, COMfort, Behaviour, and INdoor Environment in Office Buildings](#).

Basurto C.; Colombo, M.; Papinutto, M.; Nembrini, J.; Kämpf, J. (2021). [Implementation of Machine Learning Techniques for the Quasi Real-Time Blind and Electric Lighting Optimization in a Controlled Experimental Facility](#). Journal of Physics: Conference Series, Volume 2042, CISBAT 2021 Carbon-neutral cities - energy efficiency and renewables in the digital era 8-10 September 2021, EPFL Lausanne, Switzerland.



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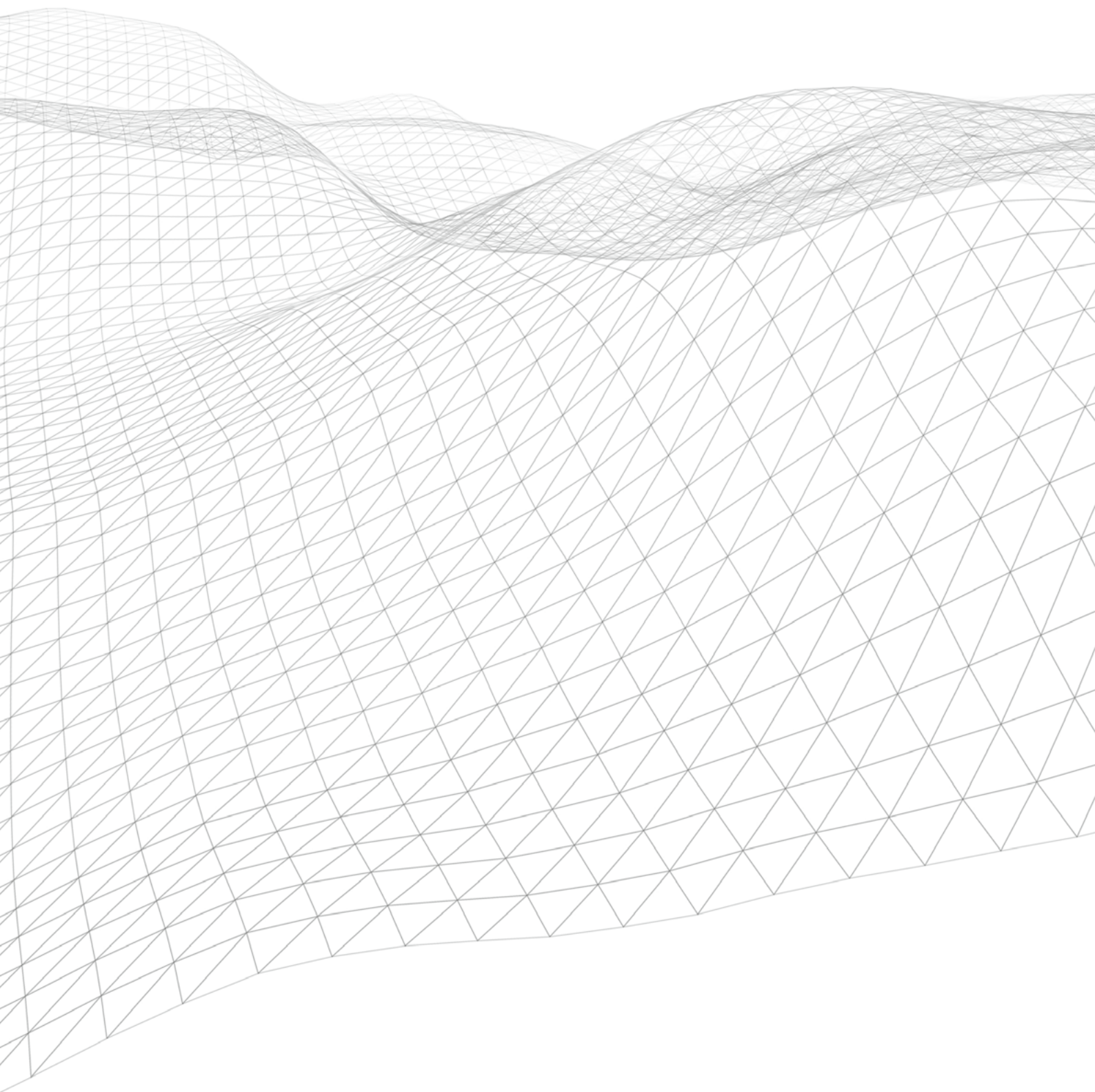
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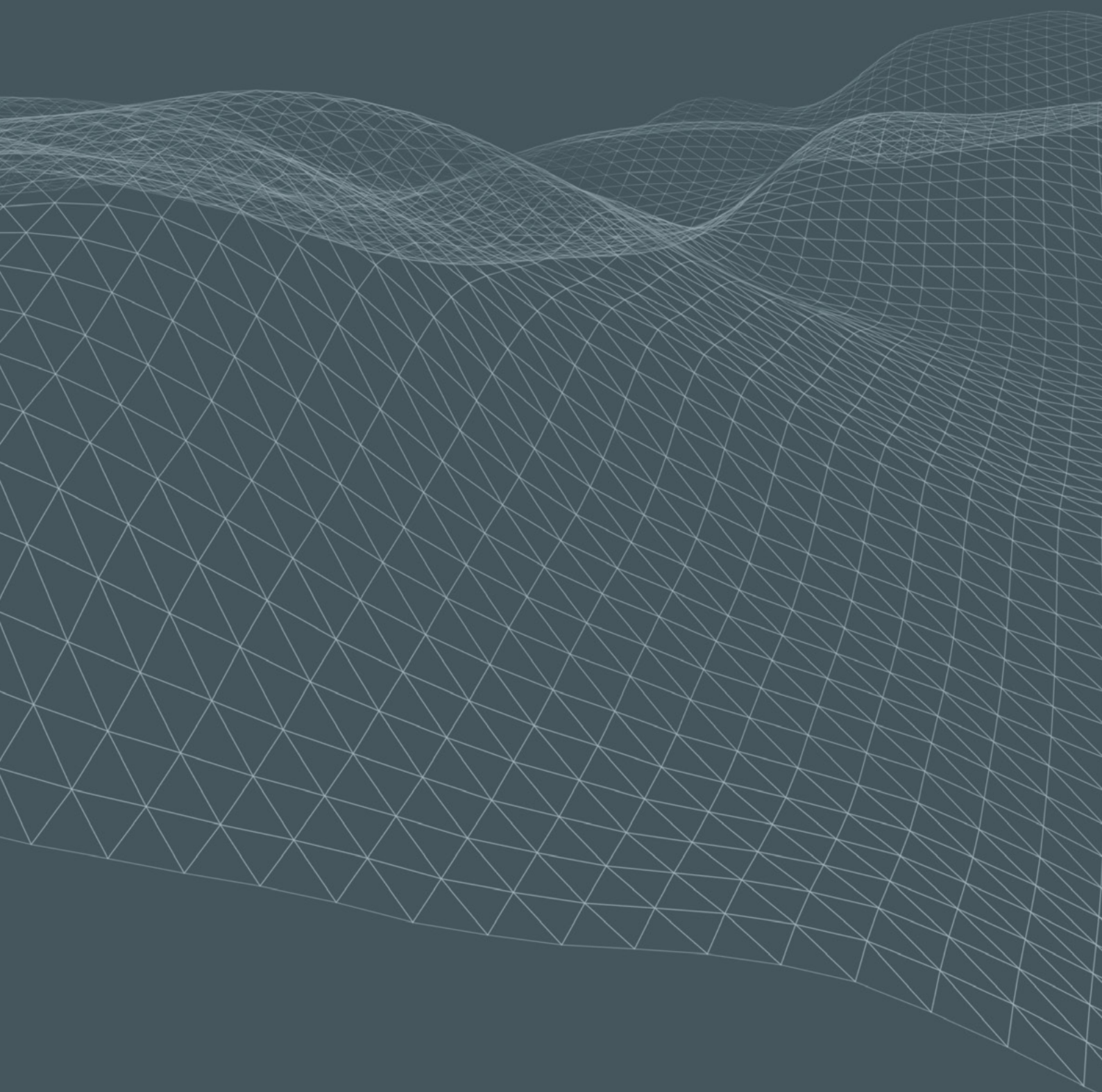
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