

# 2020

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ANNUAL REPORT



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Personnes travaillant au Smart Living Lab en 2020, employées par l'EPFL, la HEIA-FR et l'UNIFR.  
People working at the Smart Living Lab in 2020, employed by EPFL, HEIA-FR and UNIFR.  
Mitarbeitende, die im Smart Living Lab im Jahr 2020 tätig waren, angestellt von der EPFL, der HEIA-FR und der UNIFR.

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# Avant-propos Editorial Foreword

FR

Vous allez découvrir le rapport d'activités du Smart Living Lab de 2020, l'année qui a vu nos vies bouleversées par l'apparition de la pandémie de Covid-19. Cette crise historique a révélé nos vulnérabilités et notre résilience, et redéfini soudainement nos formes d'interactions, nos modes de vie et de travail. D'une part, elle nous a fait repenser nos lieux d'activité professionnelle dans un contexte où le télétravail a été pratiqué à large échelle. D'autre part, elle a attiré l'attention sur l'importance de la ventilation et de la qualité de l'air dans les bâtiments. Ce sont deux des domaines de recherche du Smart Living Lab qui se sont retrouvés sur le devant de la scène.

Nous avons eu la chance de pouvoir réaliser l'académie d'hiver ARC-HEST avec trois universités de Séoul, juste avant l'impact de la pandémie. 30 étudiantes et étudiants de Suisse et de Corée du Sud, réparti-e-s en équipes interdisciplinaires, ont effectué une étude des espaces de co-working à Fribourg, à Berne et à Lausanne. Quant à « Perspectives », la manifestation professionnelle qui s'est tenue à la Halle bleue au mois de septembre, elle a permis d'inviter les entreprises fribourgeoises à découvrir les travaux du Smart Living Lab, en présentant des exemples concrets de collaborations avec l'industrie.

Enfin, le développement du bâtiment du Smart Living Lab constitue un projet phare, non seulement pour les chercheuses et chercheurs qui y travailleront, mais aussi pour tout le quartier de blueFACTORY. Ce sera l'une des trois nouvelles constructions du site qui doivent démarrer prochainement. En 2020, le projet détaillé a été élaboré dans le cadre d'une collaboration entre les mandataires, Bluefactory Fribourg-Freiburg SA et les équipes du Smart Living Lab. Le bâtiment comportera de nombreuses spécificités qui en feront un véritable instrument pour la recherche. Il servira à la fois de laboratoire vivant, faisant l'objet d'un intérêt scientifique à l'international, et de démonstrateur pour les innovations. En bref, une plateforme de premier ordre pour la collaboration avec les partenaires industriels.

**Nous vous souhaitons une excellente lecture.**

**Le Comité directeur du Smart Living Lab**

DE

Vor Ihnen liegt der Jahresbericht des Smart Living Lab für das Jahr 2020 – dem Jahr, das durch den Ausbruch der Corona-pandemie das Leben von uns allen auf den Kopf gestellt hat. Diese historische Krise hat uns gezeigt, wie verwundbar, aber auch wie widerstandsfähig wir sind, und sie hat von einem Tag auf den anderen unseren Umgang miteinander sowie unsere Lebens- und Arbeitsweise neu definiert. Auf der einen Seite brachte sie uns dazu, unsere Arbeitsplatzkonzepte zu überdenken – mit Homeoffice, das plötzlich weit verbreitet war. Auf der anderen Seite lenkte sie die Aufmerksamkeit auf die Bedeutung von Belüftung und Luftqualität in Gebäuden. Damit rückten zwei Forschungsbereiche des Smart Living Lab ins Rampenlicht.

Wir hatten das Glück, die ARC-HEST-Winterakademie mit drei Universitäten aus Seoul abhalten zu können, kurz bevor die Pandemie die Welt lahmlegte. Dreissig Studierende aus der Schweiz und Südkorea, aufgeteilt in interdisziplinäre Teams, führten eine Studie über Co-Working Spaces in Freiburg, Bern und Lausanne durch. An der Fachveranstaltung «Perspectives», die im September in der Halle bleue stattfand, konnten Freiburger Unternehmen die Arbeit des Smart Living Lab anhand konkreter Beispiele der Zusammenarbeit mit der Industrie kennenlernen.

Und schliesslich ist die Entwicklung des Smart Living Lab-Gebäudes ein Leuchtturmprojekt – nicht nur für die ForscherInnen, die dort arbeiten werden, sondern auch für das gesamte blueFACTORY-Quartier. Es wird eines von drei neuen Gebäuden an dem Standort sein, deren Bau demnächst beginnen soll. Im Jahr 2020 arbeiteten die Bluefactory Fribourg-Freiburg AG und die Teams des Smart Living Lab gemeinsam die Detailplanung aus. Das Gebäude wird über zahlreiche Besonderheiten verfügen, die es zu einem echten Forschungsinstrument werden lassen. Es wird zugleich als lebendiges Labor, das Gegenstand internationalen wissenschaftlichen Interesses ist, und als Vorzeigeobjekt für Innovationen dienen. Kurz gesagt, eine Plattform erster Klasse für die Zusammenarbeit mit industriellen Partnern.

**Wir wünschen Ihnen eine spannende Lektüre.**

**Das Leitungskomitee des Smart Living Lab**

« Le développement du bâtiment du Smart Living Lab constitue un projet phare, non seulement pour les chercheuses et chercheurs qui y travailleront, mais aussi pour tout le quartier de blueFACTORY. »

«Die Entwicklung des Smart Living Lab-Gebäudes ist ein Leuchtturmprojekt – nicht nur für die ForscherInnen, die dort arbeiten werden, sondern auch für das gesamte blueFACTORY-Quartier.»

“The development of the Smart Living Lab building constitutes a flagship project, not only for the researchers who work there, but also for the entire blueFACTORY area.”

EN

Welcome to Smart Living Lab's annual report for 2020, a year that saw our lives turned upside down by the onset of the COVID-19 pandemic. This history-making crisis revealed our vulnerabilities as well as our resilience and suddenly redefined the way we live, work and interact. On the one hand, it forced us to rethink our professional workspaces, in a context where remote working has been widely practiced. On the other hand, it shined a light on the importance of ventilation and air quality inside buildings. These are two of the Smart Living Lab research areas that were brought to the forefront during this time.

We were lucky enough to be able to complete the Winter School ARC-HEST with three universities from Seoul, just prior to the pandemic's impact being felt across the globe. Thirty students from Switzerland and South Korea, split up into interdisciplinary teams, and conducted a study of different coworking spaces in Fribourg, Bern and Lausanne. As for 'Perspectives', the professional event held at the Blue Hall in September, it provided the opportunity to invite Fribourg companies to discover the Smart Living Lab's accomplishments through concrete examples of collaborations within the industry.

Finally, the development of the Smart Living Lab building constitutes a flagship project, not only for the researchers who work there, but also for the entire blueFACTORY area. This will be one of the site's three new buildings, due to start soon. In 2020, the detailed project was developed as part of a collaboration between the architects and engineering firms, Bluefactory Fribourg-Freiburg SA and the Smart Living Lab teams. The building will include a number of specific features that will make of it a true research tool. It will also serve as a living lab of international scientific interest and an innovation demonstrator. In short, it's a top-notch platform for collaboration with our industrial partners.

**Happy reading!**

**The Smart Living Lab Executive Committee**

# Smart Living Lab

Centre de recherche pour le futur de l'environnement bâti

Forschungszentrum für den Lebensraum der Zukunft

Research centre for the built environment of the future



FR

Le Smart Living Lab est un centre de recherche et développement dédié au futur de l'environnement bâti. Ses activités sont motivées par le bien-être des utilisateurs-trices, l'efficacité énergétique et la transformation numérique. Il rassemble les compétences de l'EPFL, de la Haute école d'ingénierie et d'architecture de Fribourg (HEIA-FR) et de l'Université de Fribourg (UNIFR) 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 à l'habitat. Dans le quartier d'innovation de blueFACTORY, au sein du Switzerland Innovation Park Network West EPFL, il abrite des projets de recherche interdisciplinaires impliquant des chercheurs-cheuses, des utilisateurs-trices et des entreprises. La construction d'un bâtiment expérimental pour le Smart Living Lab est prévue ces prochaines années sur ce site.

DE

Das Smart Living Lab ist ein Forschungs- und Entwicklungszentrum, das sich dem Wohn- und Lebensraum der Zukunft widmet. Seine Aktivitäten konzentrieren sich auf das Wohlbefinden der Nutzerinnen und Nutzer, die Energieeffizienz sowie auf die digitale Transformation. Das Smart Living Lab bündelt die Kompetenzen der EPFL, der Hochschule für Technik und Architektur Freiburg (HTA-FR) und der Universität Freiburg (UNIFR) in den Bereichen Bautechnologien, Wohlbefinden und Verhaltensforschung, Interaktionen und Designprozesse sowie Energiesysteme. Im Innovationsquartier blueFACTORY, das zum Switzerland Innovation Park Network West EPFL gehört, werden interdisziplinäre Forschungsprojekte durchgeführt, an denen Forscherinnen und Forscher, Nutzerinnen und Nutzer sowie Unternehmen beteiligt sind. In den kommenden Jahren ist der Bau eines experimentellen Gebäudes für das Smart Living Lab geplant.

EN

The Smart Living Lab is a research and development centre devoted to the built environment of the future. Its activities are focused on the well-being of its users, energy efficiency and the digital transformation. The Smart Living Lab reflects the combined expertise of the EPFL, the School of Engineering and Architecture of Fribourg (HEIA-FR), and the University of Fribourg (UNIFR) in the areas of construction technologies, well-being and behaviours, interactions and design processes as well as energy systems for the built environment. The Smart Living Lab hosts interdisciplinary research projects involving researchers, users and companies. It is located in the blueFACTORY innovation site at the heart of the Switzerland Innovation Park (SIP) Network West EPFL. The construction of an experimental building for the Smart Living Lab on this site is scheduled for next year.

# Bluefactory Fribourg-Freiburg SA

Habitat du futur et innovation

Lebensraum der Zukunft und Innovation

Habitat of the future and innovation



FR

Fondée en 2014, Bluefactory Fribourg-Freiburg SA a pour mission le développement, la construction, l'exploitation, la promotion et l'animation du quartier d'innovation en devenir blueFACTORY. Situé au cœur de Fribourg, blueFACTORY fait partie du Parc suisse d'innovation (Switzerland Innovation Park).

À ce titre, il est reconnu pour sa compétence dans le domaine de l'habitat du futur. Le quartier compte aujourd'hui plus de 340 personnes actives dans une cinquantaine d'entités (PME, start-up, innovation et recherche universitaire). Il promeut les principes du développement durable, ainsi que ceux de l'économie circulaire.

DE

Die 2014 gegründete Bluefactory Fribourg-Freiburg SA ist für die Entwicklung, den Bau, den Betrieb, die Förderung und die Animation des künftigen Innovationsquartiers blueFACTORY zuständig. Die blueFACTORY befindet sich im Herzen von Freiburg und ist Teil des Switzerland Innovation Park. Als solches ist es für seine Kompetenz auf dem Gebiet des Lebensraumes der Zukunft anerkannt. Das Quartier zählt heute über 340 Personen, die in etwa fünfzig Einrichtungen tätig sind (KMU, Start-up, innovative Akteure und Universitätsforschung) und fördert die Prinzipien der nachhaltigen Entwicklung und der Kreislaufwirtschaft.

EN

Founded in 2014, Bluefactory Fribourg-Freiburg SA's mission is to develop, build, promote, and foster community life in the blueFACTORY emerging innovation district. Located in the heart of Fribourg, blueFACTORY is part of the Switzerland Innovation Park and is recognised for its competence in the field of the habitat of the future. There are at present around 340 people working on the site from around fifty entities (SMEs, start-up, innovators, and university researchers) promoting principles of sustainable development as well as those of the circular economy.

# Partenaires Partner Partners

## EPFL

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### 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.



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

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, Industrie-technologien 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.



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 Bluefactory Fribourg-Freiburg SA en sera 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 Bluefactory Fribourg-Freiburg 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. Bluefactory Fribourg-Freiburg SA will be 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.



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

### Canton of Fribourg



**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



**Olivier Allaman**  
Fribourg Development Agency, Department of Economy and Employment

### EPFL



**Etienne Marclay**  
Vice President for Human Resources and Operations until 2020  
Co-Chair of the Joint Steering Committee



**Matthias Gäumann**  
Vice President for Operations as of 1.1.2021  
Co-Chair of the Joint Steering Committee



**Andreas Mortensen**  
Vice President for Research until 31.12.2020



**Jan Hesthaven**  
Vice President for Academic Affairs as of 1.1.2021



**Marc Gruber**  
Vice President for Innovation until 31.12.2020



**Ursula Oesterle**  
Vice President for Innovation as of 1.1.2021



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

### HEIA-FR



**Jean-Nicolas Aebischer**  
Director

### UNIFR



**Astrid Epiney**  
Rector

COMITÉ DIRECTEUR | LEITUNGSKOMITEE | EXECUTIVE COMMITTEE

EPFL



**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)

HEIA-FR



**Jean-Philippe Bacher**

Head of ENERGY Institute  
Smart Living Lab HEIA-FR Manager

UNIFR



**Stephanie Teufel**

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

Canton of Fribourg



**Olivier Allaman**

Fribourg Development Agency,  
Department of Economy and  
Employment

COMMISSION SCIENTIFIQUE | WISSENSCHAFTLICHE KOMMISSION | SCIENTIFIC COMMISSION

EPFL



**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)



**Dolaana Khovalyg**

Head of Thermal Engineering for  
Built Environment Laboratory (TEBEL)



**Dusan Licina**

Head of Human-Oriented Built  
Environment Lab (HOBEL)



**Sergi Aguacil**

Head of Building2050 Group

HEIA-FR



**Jean-Philippe Bacher**

Head of ENERGY Institute  
Smart Living Lab HEIA-FR Manager



**Florinel Radu**

Head of TRANSFORM Institute  
until 30.4.2021



**Séréna Vanbutsele**

Head of TRANSFORM Institute  
as of 1.5.2021



**Daia Zwicky**

Head of iTEC Institute

UNIFR



**Stephanie Teufel**

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



**Anton Sentic**

Deputy-Head of iimt for the  
Smart Living Lab  
until 31.3.2021



**Denis Lalanne**

Head of Human-IST Institute



**Martin Beyeler**

Professor, Institute for Swiss and  
International Construction Law

# 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.



# Recherche | Forschung | Research

DOMAINES DE RECHERCHE | FORSCHUNGSGEBIETE | FIELDS OF RESEARCH



## 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

EPFL

## Structural Xploration Lab (SXL)



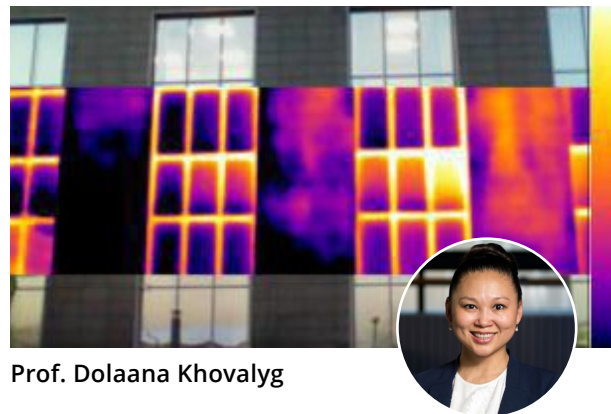
Prof. Corentin Fivet

## Laboratory of Construction and Architecture (FAR)



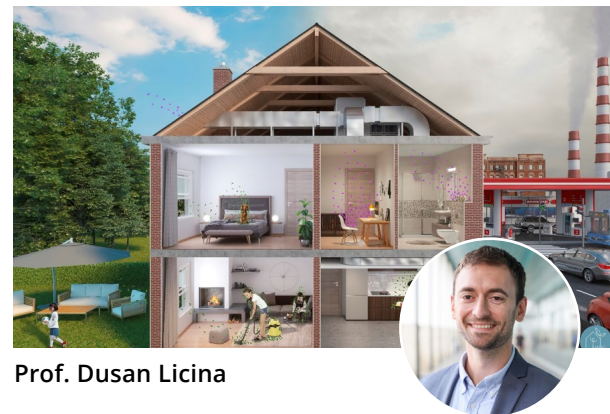
Prof. Paolo Tombesi

## Thermal Engineering for the Built Environment Laboratory (TEBEL)



Prof. Dolaana Khovalyg

## Human-Oriented Built Environment Lab (HOBEL)



Prof. Dusan Licina

## Building Innovation Research and Integration Support Group (Building2050)



Dr. Sergi Aguacil


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

## Institute of Applied Research in Energy Systems (ENERGY)



Prof. Jean-Philippe Bacher

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

Prof. Florinel Radu  
until 30.4.2021Prof. Séréna Vanbutsele  
as of 1.5.2021

## Institute of Construction and Environmental Technologies (iTEC)



Prof. Daia Zwicky

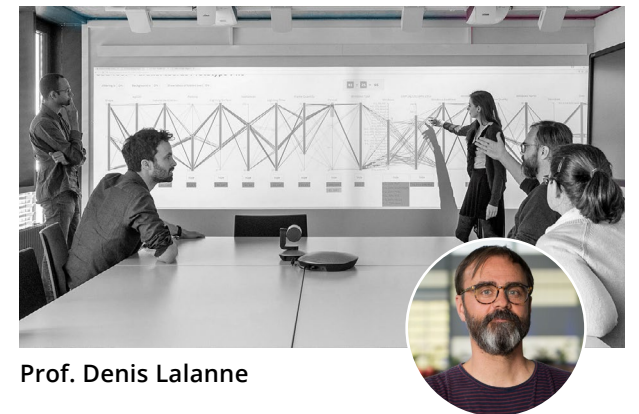

 UNIVERSITÉ DE FRIBOURG  
 UNIVERSITÄT FREIBURG

## international institute of management in technology (iimt)



Prof. Stephanie Teufel

## Human-IST Institute and Human-Building Interaction



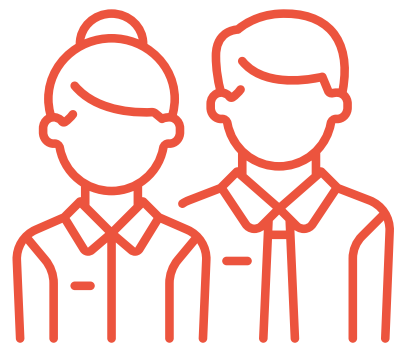
Prof. Denis Lalanne

## Institute for Swiss and International Construction Law



Prof. Jean-Baptiste Zufferey

# STAFF



136 People



28 Countries

# EVENTS



19  
31

EVENTS\*

\*ORGANISED BY THE  
SMART LIVING LAB

INTERNATIONAL  
CONFERENCES\*

\*PARTICIPATION BASED ON  
CONFERENCE PAPERS

# SURFACE AREA

2,284 m<sup>2</sup>

OFFICES AND  
LABORATORIES

EPFL 48  
PEOPLE



71  
PEOPLE

UNI  
FR 17  
PEOPLE

# RESEARCH



4

DOMAINS



11

GROUPS



8

FACILITIES



105

PROJECTS



114

PUBLICATIONS\*  
\*OUT OF A TOTAL OF 525 SINCE 2015

# WEB | SOCIAL MEDIA

16,692

WEBSITE USERS

59,885

PAGE VIEWS

753  
FOLLOWERS

1,421  
FOLLOWERS

674  
FOLLOWERS

# COMMUNICATION | PRESS



x 32

NEWS ARTICLES\*

\*ABOUT THE SMART LIVING LAB



x 4

PRESS RELEASES



x 4

VIDEOS



x 11

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>

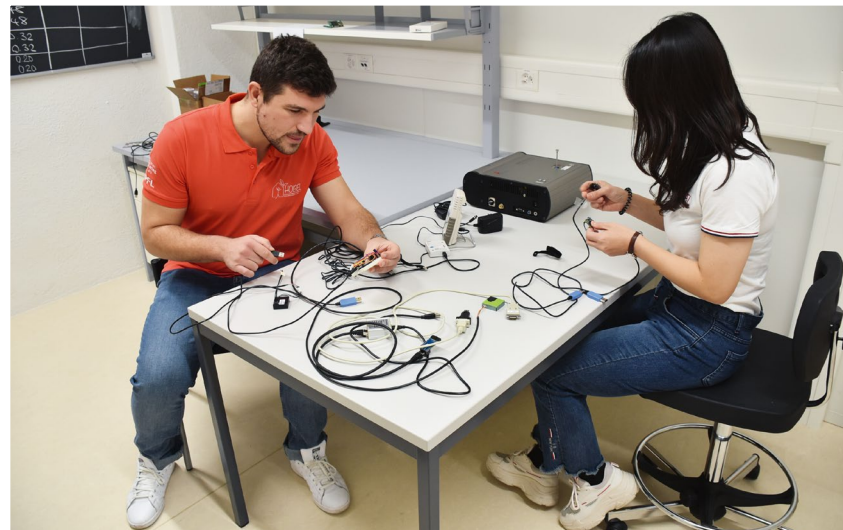
NEIGHBORHUB

# FACTS & FIGURES 2020

## L'EPFL et le Smart Living Lab

### Die EPFL und das Smart Living Lab

### EPFL and Smart Living Lab



FR

Le Smart Living Lab est intimement lié à la création du campus associé de l'EPFL à Fribourg, reposant sur un partenariat avec le Canton de Fribourg dans le cadre du projet de la requalification du site de blueFACTORY. L'EPFL développe un réseau de campus pour la recherche et l'innovation dans les cantons de Fribourg, Genève, Neuchâtel et du Valais, en plus de sa présence dans le canton de Vaud, bénéficiant ainsi d'opportunités d'extension, de synergies académiques et de liens privilégiés avec le tissu économique régional. L'objectif étant d'associer les cantons romands à la « success-story » de l'institution fédérale.

L'EPFL a créé à Fribourg quatre chaires pour lesquelles des professeur-e-s ont été engagé-e-s entre 2016 et 2018. Deux chaires sont rattachées à l'Institut d'architecture et de la ville : le Laboratoire de construction et d'architecture FAR dirigé par Paolo Tombesi, professeur ordinaire, et le Laboratoire d'exploration structurale SXL dirigé par Corentin Fivet, professeur assistant tenure track. Deux chaires sont rattachées à l'Institut d'ingénierie civile : le Laboratoire d'ingénierie thermique de l'environnement construit TEBEL

dirigé par Dolaana Khovalyg, professeure assistante tenure track, et le Laboratoire de l'environnement construit orienté sur l'humain HOBEL dirigé par Dusan Licina, professeur assistant tenure track. Le groupe scientifique Building2050, consacré à l'intégration de l'innovation dans le bâtiment et au développement des collaborations au sein du Smart Living Lab sous la responsabilité de Sergi Aguacil Moreno, est rattaché à la Vice-présidence pour les opérations et à la Faculté de l'environnement naturel, architectural et construit (ENAC).

Les équipes scientifiques de l'EPFL poursuivent leur croissance à Fribourg en attirant des talents internationaux de premier rang.

Des doctorant-e-s et post-doctorant-e-s sont engagé-e-s à mesure que les professeur-e-s obtiennent des fonds compétitifs pour la recherche (Fonds national suisse, Horizon Europe, etc.). Une doctorante et un doctorant bénéficient d'une bourse EPFLinnovators en partenariat avec l'industrie. Deux thèses de doctorat sont effectuées en co-supervision par la HEIA-FR et l'EPFL, une nouveauté rendue possible par la proximité au sein du Smart Living Lab. Les avancées scientifiques

EPFL

www.epfl.ch



dans la construction durable développées localement sont aussi adaptées et transférées à d'autres contextes : la coopération avec la Colombie sous le patronage du SECO et l'aide humanitaire en collaboration avec le CICR.

Le Smart Living Lab est un centre à caractère unique pour l'EPFL, un environnement véritablement interdisciplinaire, propice à un dialogue fertile entre architecture et génie civil, ainsi qu'à l'interface entre recherche et pratique. L'expérience acquise et les connaissances produites par le développement du bâtiment du Smart Living Lab serviront aux autres campus de l'EPFL, notamment en matière de numérisation (utilisation du BIM), d'intégration architecturale du photovoltaïque ou de conception flexible des espaces de travail.

DE

Das Smart Living Lab ist eng verbunden mit der Schaffung des assoziierten Campus der EPFL in Freiburg, der auf einer Partnerschaft mit dem Kanton Freiburg basiert und im Rahmen des Neugestaltungsplans des Standorts blueFACTORY entsteht. Neben ihrer Präsenz im Kanton Waadt entwickelt die EPFL in den

Kantonen Freiburg, Genf, Neuenburg und Wallis ein Campus-Netzwerk für Forschung und Innovation und profitiert so von Expansionsmöglichkeiten, akademischen Synergien und privilegierten Beziehungen zum regionalen Wirtschaftsgefüge. Ziel ist es, die französischsprachigen Kantone an der Erfolgsgeschichte der Bundesinstitution teilhaben zu lassen.

In Freiburg richtete die EPFL vier Lehrstühle ein, für die zwischen 2016 und 2018 Professorinnen und Professoren angestellt wurden. Zwei Lehrstühle sind dem Institut Architektur und Stadtplanung angegliedert: das von Paolo Tombesi, ordentlicher Professor, geleitete Labor für Bauwesen und Architektur FAR und das von Corentin Fivet, Tenue-Track-Assistenzprofessor, geleitete Labor für strukturelle Exploration SXL. Zwei Lehrstühle sind dem Institut für Bauingenieurwesen angegliedert: das Labor für Wärmetechnik und bebaute Umwelt TEBEL, das von Dolaana Khovalyg, Tenue-Track-Assistenzprofessorin, geleitet wird, und das Labor für bebaute Umwelt mit Schwerpunkt auf dem Menschen HOBEL, das von Dusan Licina, Tenue-Track-Assistenzprofessor, geleitet wird. Die Forschungsgruppe Building2050, die sich mit der Integration von Innovationen in Gebäuden und der Entwicklung der Zusammenarbeit innerhalb des Smart Living Lab beschäftigt, ist unter der Leitung von Sergi Aguacil Moreno dem Vizepräsidium für Betrieb und der Fakultät für Bau, Architektur und Umwelt (ENAC) angegliedert.

In Freiburg können die Forschungsteams der EPFL durch die Anwerbung internationaler Spitzentalente weiter ausgebaut werden.

Doktorandinnen und Doktoranden sowie Post-Doktorandinnen und Post-Doktoranden werden angestellt, sobald die Professorinnen und Professoren kompetitive Forschungsmittel (Schweizer Nationalfonds, Horizon Europe usw.) erhalten. Eine Doktorandin und ein Doktorand haben in Partnerschaft mit der Industrie ein EPFLinnovators-Stipendium erhalten. Unter der Co-Be-

treuung von HTA-FR und EPFL werden zwei Doktorarbeiten geschrieben – ein Novum, das der räumlichen Nähe innerhalb des Smart Living Lab zu verdanken ist. Die vor Ort entwickelten wissenschaftlichen Fortschritte im nachhaltigen Bauen werden auch auf andere Kontexte abgestimmt und übertragen: Zusammenarbeit mit Kolumbien unter der Schirmherrschaft des SECO und humanitäre Hilfe in Zusammenarbeit mit dem IKRK.

Für die EPFL ist das Smart Living Lab ein ganz besonderes Zentrum – ein wirklich interdisziplinäres Umfeld an der Schnittstelle zwischen Forschung und Praxis, das einen fruchtbaren Dialog zwischen Architektur und Bauingenieurwesen ermöglicht. Die bei der Entwicklung des Smart Living Lab-Gebäudes gewonnenen Erfahrungen und Erkenntnisse werden auch für die anderen Campus der EPFL zur Verfügung stehen, insbesondere was die Bereiche Digitalisierung (Einsatz von BIM), architektonische Integration von Photovoltaik und flexible Gestaltung von Arbeitsräumen angeht.

EN

The Smart Living Lab is closely linked to the creation of the EPFL Fribourg campus, based on a partnership with the Canton of Fribourg, as part of the blueFACTORY site enhancement project. In addition to its presence in the canton of Vaud, EPFL is building a network of campuses for research and innovation in the cantons of Fribourg, Geneva, Neuchâtel, and Valais, thus benefiting from expansion, growth opportunities, academic synergies, and developing close ties with the regional economic fabric. The objective is to involve the French-speaking Swiss cantons into the federal institution success story.

EPFL created four chairs in Fribourg and hired professors between 2016 and 2018. Two chairs are hosted by the Institute of Architecture and the city: the Laboratory of Construction and Architecture (FAR) led by Paolo Tombesi, full professor, and the Structural Xploration Lab (SXL) led by Corentin Fivet, tenure track assistant professor. Two chairs are hosted by the

Civil Engineering Institute: the Thermal Engineering for the Built Environment Laboratory (TEBEL), led by Dolaana Khovalyg, tenure track assistant professor, and the Human-Oriented Built Environment Lab (HOBEL), led by Dusan Licina, tenure track assistant professor. The scientific group Building2050, devoted to the integration of innovation in the construction sector and developing collaborations within the Smart Living Lab, led by Sergi Aguacil Moreno, reports to the Vice Presidency for Operations and the School of Architecture, Civil and Environmental Engineering (ENAC).

EPFL scientific teams continue to grow in Fribourg by attracting top international talents.

Doctoral candidates and post-doctoral fellows are hired as professors are granted competitive research funds (SNSF, Horizon Europe, etc.). Two doctoral candidates have been awarded an EPFLinnovators scholarship in partnership with industry. Two doctoral theses are being written under the joint supervision of both, EPFL and the HEIA-FR, which is made possible through proximity within the Smart Living Lab. Scientific advances developed locally in sustainable construction are also adapted and transferred to other contexts: cooperation with Colombia under the patronage of SECO, and humanitarian aid in collaboration with the ICRC.

The Smart Living Lab is a centre with a unique character for EPFL, a truly interdisciplinary environment that fosters a vivid dialogue between architecture and civil engineering at the intersection of research and practice. The experience acquired and knowledge generated through the development of the Smart Living Lab building will be put to good use by other EPFL campuses, particularly in terms of digitisation (use of BIM), incorporation of solar power into architecture, and flexible workspace design.

# La HEIA-FR au sein du Smart Living Lab

## Die HTA-FR im Smart Living Lab

## HEIA-FR enters the Smart Living Lab


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


FR

En 2020, malgré un contexte très particulier, le Smart Living Lab a continué d'être une formidable opportunité pour développer des activités de recherche interdisciplinaires et mettre en valeur les compétences de la Haute école d'ingénierie et d'architecture de Fribourg (HEIA-FR).

Avec une vingtaine de projets en cours qui impliquent sept instituts de la HEIA-FR et un appel à projets ayant permis de démarrer quatre projets d'envergure, la HEIA-FR poursuit la mise en œuvre de son programme de recherche au cœur des domaines d'activité du Smart Living Lab.

DE

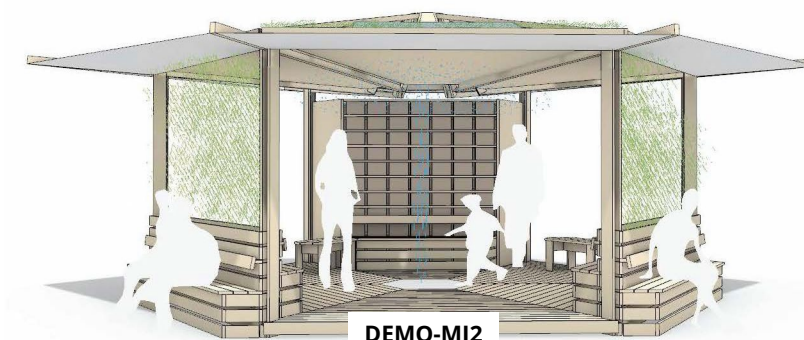
Trotz des sehr speziellen Kontextes im Jahr 2020 bot das Smart Living Lab weiterhin die grossartige Gelegenheit, interdisziplinäre Forschungsaktivitäten zu entwickeln und die Kompetenzen der Hochschule für Technik und Architektur Freiburg (HTA-FR) hervorzuheben.

Mit rund zwanzig laufenden Projekten, an denen sieben Institute der HTA-FR beteiligt sind, und einer Projektausschreibung, die den Start von vier Grossprojekten ermöglichte, setzt die HTA-FR ihr Forschungsprogramm mit Fokus auf die Forschungsgebiete des Smart Living Lab weiter um.

EN

In 2020, despite a rather specific context, the Smart Living Lab held fast as an incredible opportunity to develop interdisciplinary research activities and continued to shine a light on the skills of the School of Engineering and Architecture of Fribourg (HEIA-FR).

With roughly twenty ongoing projects involving seven institutes from the HEIA-FR and a call for proposals that led to four major projects, the HEIA-FR research programme, which plays a central role in the Smart Living Lab's areas of activity, continues to blossom.



FR

La HEIA-FR se distingue par son positionnement au point de rencontre entre la recherche et les besoins du marché, dans une approche interdisciplinaire. Ses instituts de recherche appliquée en architecture et urbanisme (TRANSFORM), en génie civil (iTEC) et en énergie (ENERGY) nouent d'étroites collaborations avec des entreprises et collectivités publiques régionales.

Parmi les projets démarrés en 2020 :

- » **SETUP PRO** vise à développer une méthode opérationnelle permettant de décliner l'objectif de neutralité carbone à l'échelle du quartier ;
- » **Assainissement 4.0** propose un outil d'estimation rapide des performances énergétiques et structurelles d'un parc immobilier basé sur le Machine Learning. Il a pour but de faciliter l'élaboration de plans stratégiques d'intervention à l'échelle d'une ville ou d'un parc de bâtiments ;
- » **City Pulse SIM** développe un outil d'aide à la décision en matière de planification urbaine au travers d'une maquette interactive ;
- » **DEMO-MI2** étudie et expérimente à l'échelle réelle des mesures locales de mitigation des îlots de chaleur urbains.

Par son programme de recherche, son implication dans le processus de développement du futur bâtiment, ainsi que ses liens forts avec les acteurs-trices du marché, la HEIA-FR réalise la vision du Smart Living Lab et concrétise un réel centre de compétence et d'innovation.

DE

Die HTA-FR hebt sich durch ihre Positionierung am Schnittpunkt zwischen Forschung und Marktbedürfnissen sowie durch ihren interdisziplinären Ansatz von anderen Hochschulen ab. Ihre Institute der anwendungsorientierten Forschung für Architektur (TRANSFORM), Bau- und Umwelttechnologien (iTEC) und Energiesysteme (ENERGY) setzen auf eine enge Zusammenarbeit mit lokalen Unternehmen und öffentlichen Körperschaften.

Nachfolgend eine Auswahl von im Jahr 2020 lancierten Projekten:

- » **SETUP PRO** strebt an, eine praktikable Methode zu entwickeln, mit der das Ziel der Klimaneutralität auf Quartiers-ebene erreicht werden kann;
- » **Assainissement 4.0** bietet ein Instrument zur schnellen Abschätzung von Energieeffizienz und Strukturleistung eines Immobilienbestandes auf der Basis von Machine Learning. Dadurch soll die Ausarbeitung von strategischen Interventionsplänen auf Ebene Stadt oder auf Ebene Immobilienbestand erleichtert werden;
- » **City Pulse SIM** entwickelt durch ein interaktives Modell ein Instrument für die Entscheidungshilfe in der Stadtplanung;
- » **DEMO-MI2** untersucht lokale Massnahmen zur Abschwächung von urbanen Hitzeinseln und experimentiert mit diesen.

Durch ihr Forschungsprogramm, ihre Einbindung in den Entwicklungsprozess des projektierten Gebäudes sowie ihre starke Vernetzung mit den Marktteilnehmenden verwirklicht die HTA-FR die Vision des Smart Living Lab und bildet ein echtes Kompetenz- und Innovationszentrum.

EN

The HEIA-FR sets itself apart through its position at the intersection between research and market demand, promoting an interdisciplinary approach. Its institutes of applied research in architecture and urban planning (TRANSFORM), civil engineering (iTEC) and energy (ENERGY) build close collaborations with companies and regional public bodies.

Among the projects launched in 2020:

- » **SETUP PRO** seeks to develop an operational method for scaling carbon neutrality targets down to look at individual neighbourhoods;
- » **Assainissement 4.0** looks to create a tool to assess the energy and structural performance of a building portfolio based on machine learning. The aim is to streamline the process of developing strategic intervention plans for a town or entire building portfolio by making use of available digital data;
- » **City Pulse SIM** is developing a decision-making aid for urban planning through an interactive model;
- » **DEMO-MI2** studies and experiments with local measures for mitigating urban heat islands on a real-life scale.

Through its research programme, its involvement in the development process for the future building and its steadfast bonds with market players, the HEIA-FR is turning the Smart Living Lab vision into a reality, building a true hub for skills and innovation.

# L'Université de Fribourg au Smart Living Lab

## Die Universität Freiburg im Smart Living Lab

### The University of Fribourg at the Smart Living Lab



UNIVERSITÉ DE FRIBOURG  
UNIVERSITÄT FREIBURG

[www.unifr.ch](http://www.unifr.ch)

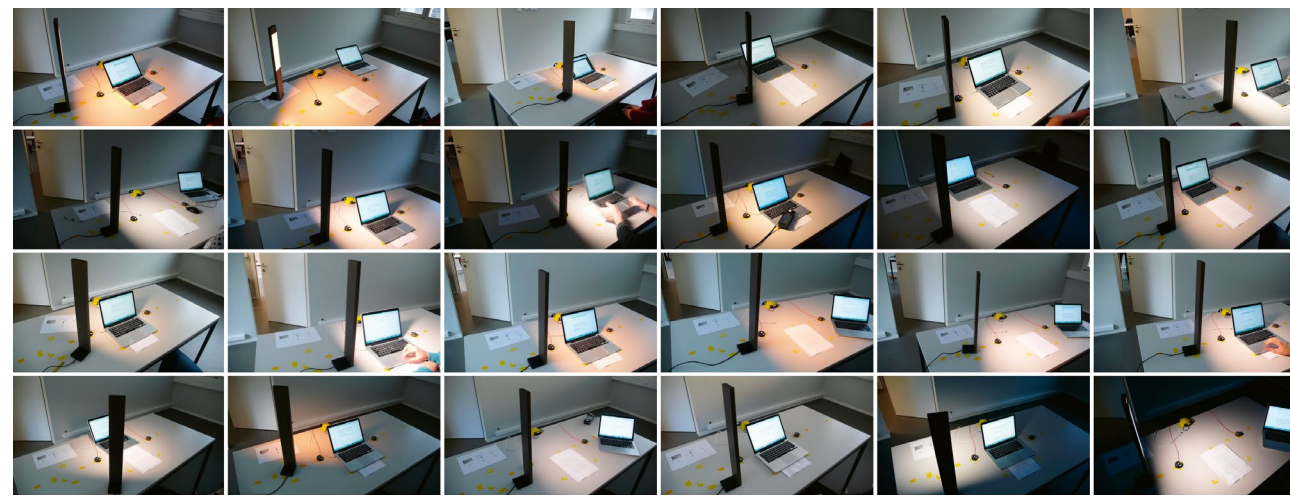
**17** Team members

**23** Publications

**8** Conferences

**16** Teaching activities

**11** Research projects



© Human-IST LUCIDELES pilot experiment results, task-light individual placement in paper/screen task (December 2020)

#### L'Université en bref

L'Université de Fribourg (UNIFR) est ancrée dans le Smart Living Lab avec trois groupes de recherche : l'international institute of management in technology (iimt), qui se concentre sur le comportement des consommateurs-trices et les thèmes liés à l'innovation et à la technologie ; le centre de recherche Human-IST, qui étudie de plus près l'interaction entre l'humain et le bâtiment ; l'institut pour le droit suisse et international de la construction, qui se consacre à la recherche sur les aspects juridiques de la construction. Grâce à cette diversité de sujets de recherche, l'Université génère une valeur ajoutée intégrale pour le Smart Living Lab et peut également mettre en réseau le monde universitaire avec des partenaires industriels locaux et internationaux.

#### Die Universität in Kürze

Die Universität Freiburg (UNIFR) ist mit drei Forschungsgruppen im Smart Living Lab verankert. Das international institute of management in technology (iimt), welches sich auf das Verbraucherverhalten und Innovations- und Technologiethemen konzentriert, das Human-IST Forschungszentrum, welches die Mensch-Gebäude-Interaktion näher betrachtet sowie das Institut für Schweizerische und internationales Baurecht, welches sich der Forschung rund um die rechtlichen Aspekte im Bauwesen widmet. Durch diese Breite der Forschungsthemen generiert die Universität einen integralen Mehrwert für das Smart Living Lab und kann zudem die akademische Welt mit lokalen aber auch internationalen Industriepartnern vernetzen.

#### About the University

The University of Fribourg (UNIFR) is anchored in the Smart Living Lab with three research groups. The international institute of management in technology (iimt), which focuses on consumer behavior and innovation and technology topics, the Human-IST research center, which takes a closer look at human-building interaction, and the Institute for Swiss and international construction law, which is dedicated to research around legal aspects in construction. Through this breadth of research topics, the university generates an integral added value for the Smart Living Lab and can also network the academic world with local but also international industry partners.

FR

#### Projets phares

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

**Une collecte des déchets efficace et durable**

L'équipe de recherche de l'iimt s'est concentrée sur le développement d'outils qui soutiennent les systèmes de gestion des déchets municipaux. Elle s'est notamment appuyée sur les concepts des études de transition pour identifier les obstacles systémiques dans les marchés locaux, les infrastructures, les processus politiques ou le comportement des utilisateurs-trices. Ces travaux ont reflété et renforcé ceux des partenaires du projet, qui se sont pour leur part concentrés sur l'optimisation mathématique des itinéraires de collecte des déchets et sur le développement de modèles d'aide à la décision orientés vers la pratique, ainsi que sur l'essai de diverses technologies innovantes dans des municipalités choisies. Dans le cadre du projet, la boîte à outils de soutien à l'innovation a pris une forme concrète et la mise en œuvre d'outils axés sur les actrices et acteurs, tels que les groupes de discussion et les événements d'information dans les projets pilotes, aura lieu tout au long de l'année prochaine.

#### Human-IST

**LUCIDELES Exploitation de la lumière du jour et de l'éclairage électrique intelligents et centrés sur l'utilisateur pour économiser l'énergie**

L'augmentation de l'automatisation dans les bâtiments afin de diminuer l'éclairage électrique (EL) et l'augmentation de l'exposition à la lumière du jour (DL) pour des raisons de santé, de confort et d'économie d'énergie souffrent d'une perception négative de la part des utilisateurs-trices. Le projet LUCIDELES vise à étudier le potentiel d'une interaction délibérée entre une conception d'interface centrée sur l'utilisateur-trice et un contrôle intelligent de la lumière du jour et de l'éclairage électrique, afin d'optimiser le confort, de promouvoir son acceptation par l'utilisateur et, en définitive, d'économiser l'énergie électrique.

DE

#### Leuchtturm-Projekte

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

**Effiziente und nachhaltige Abfallsammlung**

Die Forschenden des iimt konzentrierten sich auf die Entwicklung von Instrumenten, welche die lokalen und kommunalen Abfallwirtschaftssysteme unterstützen. Dabei griffen sie auf Konzepte aus den Transitions-Studien zurück, um systemische Barrieren in lokalen Märkten, Infrastrukturen, politischen Prozessen oder im Nutzerverhalten zu identifizieren. Dies spiegelte und unterstützte die Arbeit der Projektpartner, welche sich auf die mathematische Optimierung von Abfallsammelrouten und die Entwicklung von praxisorientierten Entscheidungsunterstützungsmodellen, sowie auf die Erprobung verschiedener innovativer Technologien in ausgewählten Gemeinden konzentrierten. Im Rahmen des Projekts nahm die Toolbox zur Innovationsunterstützung konkrete Form an. Die Implementierung von Instrumenten wie Fokusgruppen und Informationsveranstaltungen in Pilotprojekten wird im Laufe des kommenden Jahres stattfinden.

#### Human-IST

**LUCIDELES Nutzung von benutzerzentriertem intelligentem Tageslicht und elektrischer Beleuchtung zur Energieeinsparung**

Die zunehmende Automatisierung in Gebäuden, um die elektrische Beleuchtung (EL) zu verringern und aus Gesundheits-, Komfort- und Energiespargründen um mehr Tageslicht (DL) zu benutzen, leidet unter einer negativen Benutzerwahrnehmung. Das LUCIDELES Projekt zielt darauf ab, das Potenzial eines gezielten Zusammenspiels zwischen einem benutzerzentrierten Interface-Design und einer intelligenten Tageslicht- und elektrischen Lichtsteuerung zu untersuchen, um den Komfort zu optimieren, die Benutzerakzeptanz zu fördern und letztlich elektrische Energie zu sparen.

EN

#### Flagship projects

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

**Efficient and sustainable waste collection**

iimt researchers focused on developing tools supporting localised transitions in municipal waste management systems, drawing on concepts from Transition Studies to identify systemic barriers in local markets, infrastructures, political processes or user behaviour. This both mirrored and bolstered the work done by the project partners, who focused on mathematical optimisation of waste collection routes and the development of practice-oriented decision support models, and on the trialling of various innovative technologies in chosen municipalities. Within the project, the innovation support toolbox was taking concrete shape and the implementation of actor-focused tools such as focus groups and information events in pilot projects will take place throughout the upcoming year.

#### Human-IST

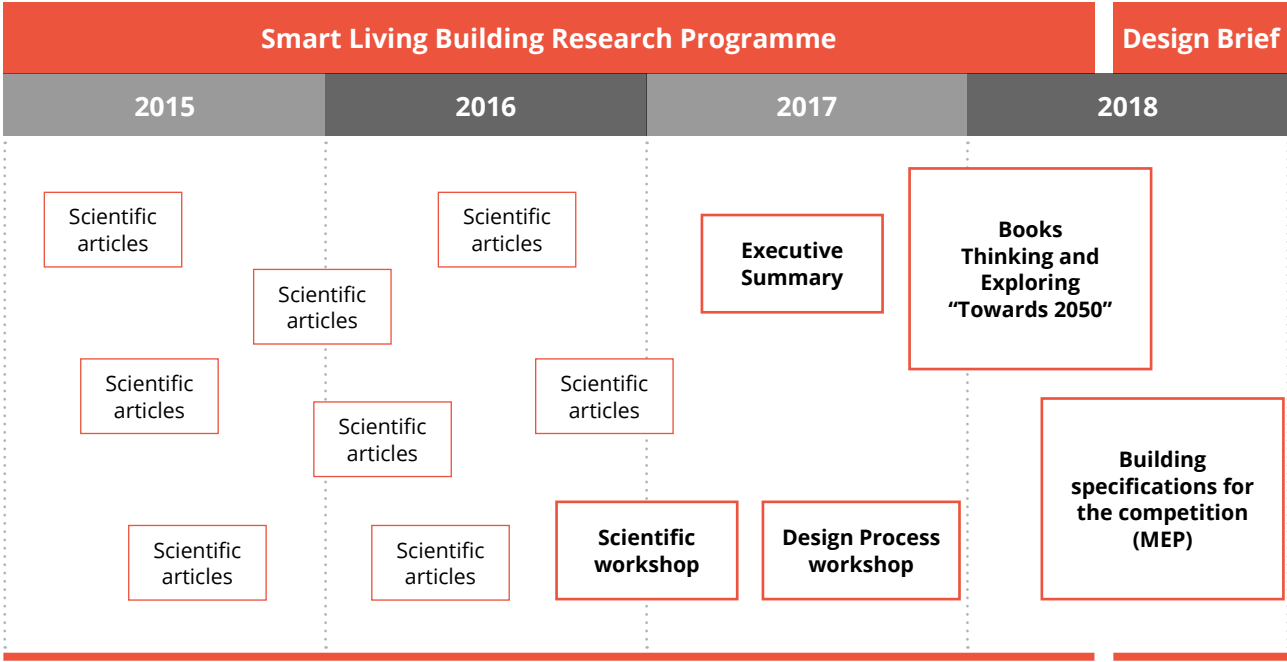
**LUCIDELES Leveraging User-Centric Intelligent Daylight and Electric Lighting for Energy Saving**

The increase of automation in buildings in order to diminish electric lighting (EL) and increase daylight (DL) exposure for health, comfort and energy saving purposes suffers from negative user perception. The LUCIDELES project aims at studying the potential of a purposeful interplay between a user-centric interface design and an intelligent daylight and electric lighting control, in order to optimize comfort, promote its user acceptance and, in definitive, save electric energy.

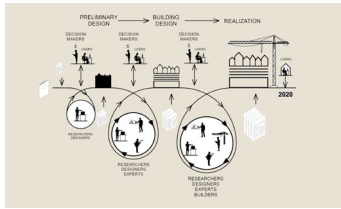
# Bâtiment du Smart Living Lab

## Smart Living Lab-Gebäude

## Building of the Smart Living Lab



Editorial project "Towards 2050", 2018.



MEP basis developed during the four years research programme, December 2018.

### Roadmap

FR

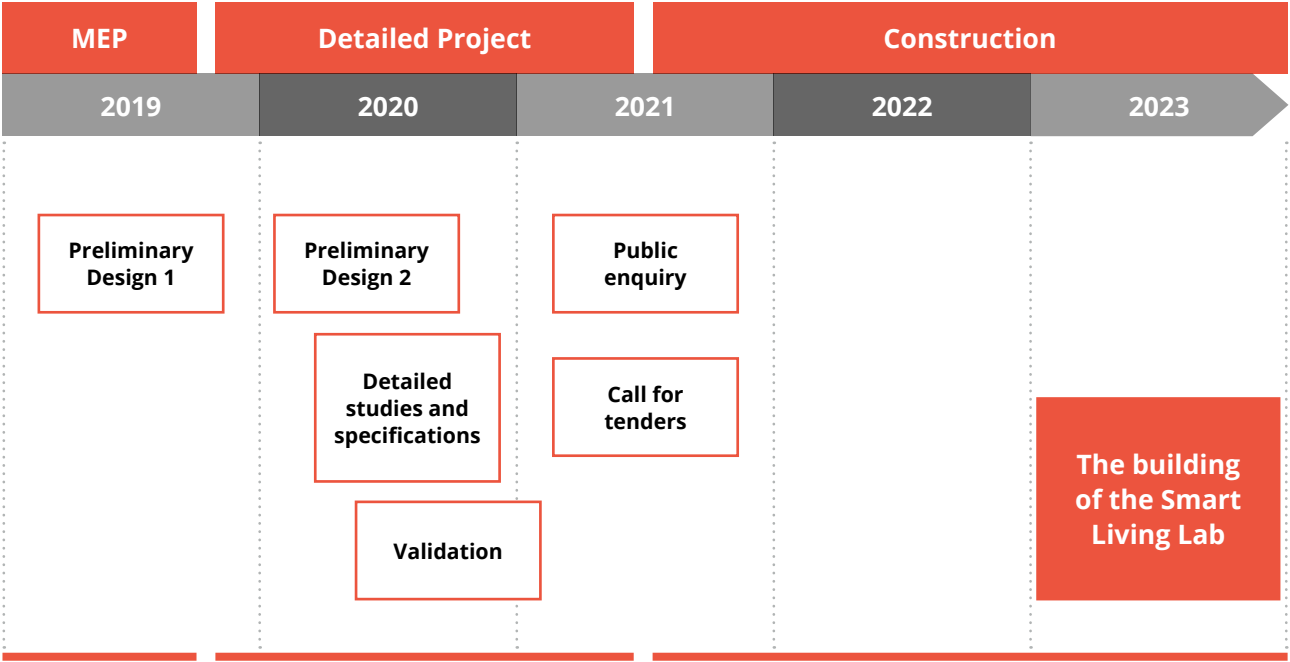
Conçu sur la base d'une vision globale issue de plus de quatre ans de recherche, le bâtiment du Smart Living Lab est le résultat d'un mandat d'études parallèles (MEP) en étroite collaboration avec les chercheurs et futurs utilisateurs du bâtiment. L'appel d'offres, issu du projet lauréat développé par Behnisch Architekten, a été publié en mars 2021 et Bluefactory Fribourg-Freiburg SA en est le maître d'ouvrage.

DE

Das Smart Living Lab-Gebäude wurde auf der Grundlage einer globalen Vision entworfen, die aus mehr als vierjähriger Forschung resultiert. Es ist das Ergebnis eines parallelen Studienauftragsverfahrens (MEP) in enger Zusammenarbeit mit Forschern und zukünftigen Nutzern des Gebäudes. Die Ausschreibung, die sich aus dem von Behnisch Architekten entwickelten Siegerprojekt ergibt, wurde im März 2021 veröffentlicht und Bauherr ist die Bluefactory Fribourg-Freiburg SA.

EN

Designed on the basis of a global vision resulting from over four years of research, the building of the Smart Living Lab is the result of an innovative Parallel studies mandate (Mandat d'études parallèles - MEP) carried out in close collaboration with researchers and the building's future users. The Call for Tenders, resulting from the winning project developed by Behnisch Architekten, was launched in March 2021 and Bluefactory Fribourg-Freiburg SA is the project owner.

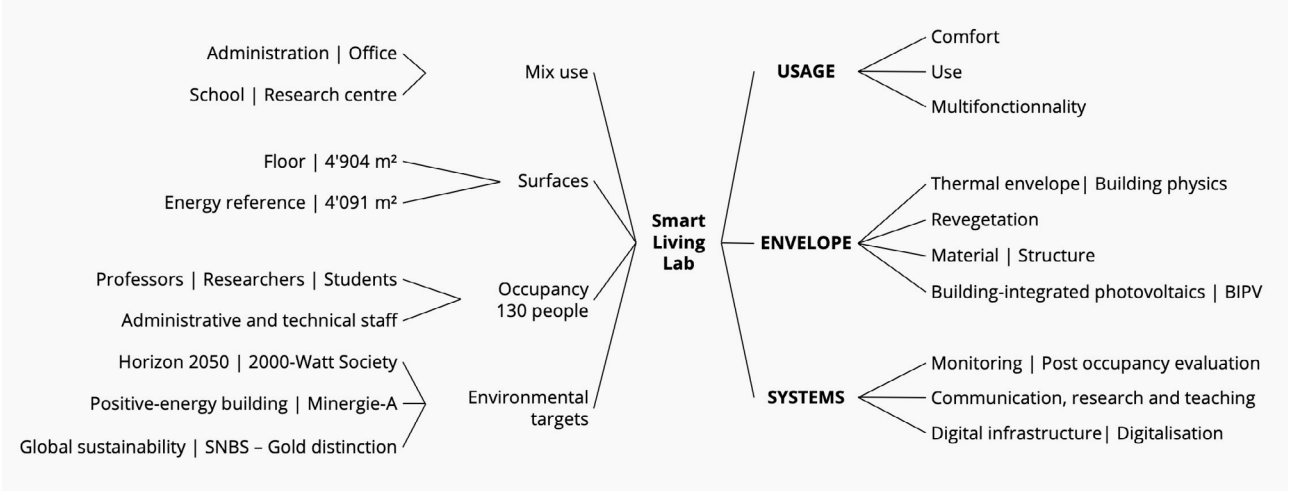


MEP winning project by Behnisch Architekten, July 2019.



Call for tenders: 26 March 2021. Submission deadline: 12 July 2021.

### Scientific issues (full mind map)



# Temps forts Höhepunkte Highlights

UNE WINTER SCHOOL À FRIBOURG POUR ÉTUDIER LE CONFORT DES ESPACES DE CO-WORKING  
EINE WINTER SCHOOL IN FREIBURG ZUR ERFORSCHUNG DES KOMFORTS IN CO-WORKING SPACES  
WINTER SCHOOL IN FRIBOURG TO STUDY COMFORT IN COWORKING SPACES



Interview avec Prof. Dolaana Khovalyg  
Interview mit Prof. Dolaana Khovalyg  
Interview with Prof. Dolaana Khovalyg

« Nous avons établi des liens solides entre six universités qui peuvent déboucher sur de futures collaborations »

« Wir haben starke Verbindungen zwischen sechs Universitäten aufgebaut, die zu einer zukünftigen Zusammenarbeit führen können. »

“We built strong links between six universities that can lead to future collaborations.”

FR

30 étudiant-e-s de Suisse et de Corée du Sud, issu-e-s des domaines de l'architecture, du génie civil, de l'informatique, du management et des sciences de l'environnement, ont participé à la première édition du programme ARC-HEST. Elles-ils ont analysé le confort intérieur lors d'une Summer School qui s'est tenue à Séoul en août 2019, et d'une Winter School qui a eu lieu à Fribourg en février 2020. Dolaana Khovalyg, professeure assistante à l'EPFL et responsable du Laboratoire d'ingénierie thermique de l'environnement construit (TEBEL), nous en dit plus sur cet ambitieux programme qui a déjà permis de tisser des liens solides entre les six universités partenaires.

## Quel est l'objectif principal de l'échange académique Suisse-Corée dans le cadre du programme ARC-HEST ?

L'objectif général du programme est l'étude des synergies entre la conception architecturale, les facteurs humains et les technologies dans les immeubles de bureaux. Il examine également leurs effets combinés sur la qualité de l'environnement intérieur et l'interaction humain-bâtiment dans un contexte local, à la fois culturel et architectural. La toute première édition du programme s'est concentrée sur les espaces de co-working qui sont de plus en plus populaires, en particulier parmi les start-up et les indépendant-e-s.

## En quoi cet échange académique Suisse-Corée ARC-HEST est-il novateur ?

Les professeur-e-s et les étudiant-e-s impliqué-e-s dans cette première édition du programme étaient d'origines très diverses — à la fois multidisciplinaires et multiculturelles. Les étudiant-e-s ont donc bénéficié d'une approche holistique de l'analyse des espaces de travail partagés. En conséquence, les solutions recommandées pour améliorer le confort multidimensionnel et les interactions humain-bâtiment dans les espaces de co-working se sont révélées innovantes et audacieuses.

## Selon vous, quelles sont les réalisations les plus significatives de ce programme ?

Le programme renforce la coopération scientifique et académique entre la Suisse et la Corée du Sud. Lors de la Summer School, nous avons été accueillis à l'ambassade de Suisse en Corée et, pendant la Winter School, nous avons été reçus à la résidence de l'ambassade de Corée en Suisse. Au cours de ces deux visites, les ambassadeurs ont souligné l'importance du programme.

## Quel a été l'impact de ce programme ?

Le programme a eu un impact positif indubitable sur les étudiant-e-s et les professeur-e-s impliqué-e-s. Les participant-e-s ont eu la chance de voyager, de se faire de nouveaux amis, de travailler dans un environnement multiculturel, d'apprendre à effectuer des mesures réelles dans les bâtiments et d'acquérir de l'expérience dans le travail d'équipe. Pour certain-e-s

étudiant-e-s, il s'agissait de leur toute première occasion de voyager à l'étranger. Au début, le programme était un défi pour les organisateurs-trices et les professeur-e-s, car nous devions collaborer au sein d'une équipe internationale et multidisciplinaire d'envergure. Dans l'ensemble, le programme a été un franc succès jusqu'à présent et nous avons établi entre six universités des liens solides qui peuvent déboucher sur de futures collaborations.

*Avec le soutien du Science and Technology Office Seoul, le Smart Living Lab et ses trois institutions partenaires (EPFL, École d'architecture et d'ingénierie de Fribourg et Université de Fribourg) ont lancé le programme d'échange académique ARC-HEST (Architecture for human environment with smart technologies) entre la Suisse et la Corée du Sud. En collaboration avec les universités SungKyunkwan, Ewha et Hanyang de Corée du Sud, ce programme d'échange se concentre sur la question de la durabilité et du confort de l'environnement bâti.*

DE

Dreissig Studierende aus der Schweiz und aus Südkorea aus den Bereichen Architektur, Bauingenieurwesen, IT, Management und Umweltwissenschaften nahmen an der ersten Ausgabe des ARC-HEST Programms teil. Sie analysierten den Innenraumkomfort während einer Sommerakademie in Seoul im August 2019 und einer Winterakademie in Freiburg im Februar 2020. Die EPFL-Assistenzprofessorin Dolaana Khovalyg, Leiterin des Thermal Engineering for the Built Environment Laboratory (TEBEL), erzählt uns mehr über die erste Ausgabe dieses ehrgeizigen Programms, das bereits starke Synergien zwischen den sechs Partneruniversitäten geschaffen hat.

## Was ist der Schwerpunkt des ARC-HEST schweizerisch-koreanischen akademischen Austausches?

Der allgemeine Schwerpunkt des Programms ist die Untersuchung der Synergie zwischen architektonischem Design, menschlichen Faktoren und Technologien in Bürogebäuden. Es untersucht auch ihre kombinierte Wirkung auf die Umweltqualität in Innenräumen und die Interaktion zwischen Mensch und Gebäude in einem lokalen Kontext - sowohl kulturell als auch architektonisch. Die allererste Ausgabe des Programms konzentrierte sich auf Co-working Spaces, die vor allem bei Start-ups und Freiberuflern immer beliebter werden.

## Was ist innovativ am ARC-HEST schweizerisch-koreanischen akademischen Austausch?

Sowohl die Pädagogen als auch die Studierenden, die an dieser ersten Ausgabe des Programms beteiligt waren, hatten sehr unterschiedliche Hintergründe – sowohl multidisziplinär als auch multikulturell. Die Studierenden profitierten daher von einem ganzheitlichen Ansatz zur Analyse von Büroräumen. Als Ergebnis waren die empfohlenen Lösungen zur Verbesserung des multidimensionalen Komforts und der Mensch-Gebäude-Interaktionen in Co-working Spaces innovativ und mutig.

### Was sind Ihrer Meinung nach die wichtigsten Errungenschaften dieses Programms?

Das Programm stärkt die Wissenschafts- und Bildungszusammenarbeit zwischen der Schweiz und Südkorea. Während der Sommerakademie wurden wir in der Schweizer Botschaft in Seoul und während der Winterakademie in der Residenz des koreanischen Botschafters in der Schweiz empfangen. Während beider Besuche hoben die Botschafter die Bedeutung des Programms hervor.

### Welche Auswirkungen hat dieses Programm gehabt?

Zweifellos hat das Programm einen grossen Einfluss auf die beteiligten Studierenden und Dozierenden gehabt. Die Studierenden hatten die Möglichkeit zu reisen, neue Freunde zu finden, in einer multikulturellen Umgebung zu arbeiten, zu lernen, wie man tatsächliche Messungen in Gebäuden durchführt, und Erfahrungen in der Arbeit in Teams zu sammeln. Für einige Studierende war es die allererste Gelegenheit, ins Ausland zu reisen. Zu Beginn war das Programm für die Organisatoren und Professoren eine Herausforderung, da wir in einem grossen, internationalen und multidisziplinären Team arbeiten mussten. Insgesamt war das Programm bis heute ein grosser Erfolg, und wir haben starke Verbindungen zwischen sechs Universitäten aufgebaut, die zu einer zukünftigen Zusammenarbeit führen können.

*Mit der Unterstützung des Science and Technology Office Seoul haben das Smart Living Lab und seine drei Partnerinstitutionen (EPFL, Hochschule für Technik und Architektur Freiburg und die Universität Freiburg) das akademische Austauschprogramm ARC-HEST (Architecture for human environment with smart technologies) zwischen der Schweiz und Südkorea ins Leben gerufen. Zusammen mit den Universitäten SungKyunKwan, Ewha und Hanyang aus Südkorea konzentriert sich dieses Austauschprogramm auf die Frage der Nachhaltigkeit und des Komforts der gebauten Umwelt.*

EN

Thirty Swiss and Korean students, from the fields of architecture, civil engineering, IT, management and environmental sciences, participated in the first ARC-HEST programme. They analysed indoor comfort during a Summer School held in Seoul in August 2019, and a Winter School held in Fribourg in February 2020. EPFL Assistant Professor Dolaana Khovalyg, Head of the Thermal Engineering for the Built Environment Laboratory (TEBEL), tells us more about this ambitious programme which has already generated strong links between the six partner universities.

### What is the main focus of the ARC-HEST Swiss-Korean Academic Exchange?

The overall focus of the programme is the study of the synergy between architectural design, human factors, and technologies in office buildings. It also examines their combined effect on

indoor environmental quality and human-building interaction in a local context – both cultural and architectural. The first programme focused on coworking spaces, which are increasingly popular, especially among start-ups and freelancers.

### What is innovative about the ARC-HEST Swiss-Korean Academic Exchange?

The educators and the students involved in this initial edition of the programme had very diverse backgrounds - both multidisciplinary and multicultural – meaning that the students therefore benefited from a holistic approach to analysing office spaces. As a result, the recommended solutions to improving multidimensional comfort and human-building interactions in coworking spaces were innovative and bold.

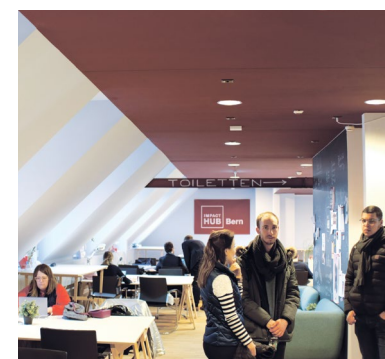
### What do you think are the most significant accomplishments of this programme?

The programme strengthens scientific and educational cooperation between Switzerland and South Korea. During the Summer School, we were welcomed at the Swiss Embassy in Korea, and during the Winter School, we were welcomed at the Residence of the Republic of Korea in Switzerland. During both visits, the Ambassadors highlighted the significance of the programme.

### What has been the impact of this programme?

Without a doubt, the programme has had a positive impact on the students and professors involved. Students had a chance to travel, make new friends, work in a multicultural environment, learn how to perform measurements in buildings, and gain experience of working in teams. For some students, it was their first opportunity to travel abroad. At the beginning, the programme was challenging for the organizers and professors because it required a large, international multidisciplinary team. Overall, the programme has been a great success to-date and we have built strong links between six universities that have the potential to lead to future collaborations.

*With the support of the Science and Technology Office Seoul, the Smart Living Lab and its three partner institutions (EPFL, School of Architecture and Engineering of Fribourg, and the University of Fribourg), have launched the ARC-HEST (Architecture for human environment with smart technologies) Academic Exchange Programme between Switzerland and South Korea. Together with the SungKyunKwan, Ewha, and Hanyang Universities in South Korea, this exchange programme focuses on the issue of sustainability and comfort in the built environment.*



## NEIGHBORHUB | « PÔLE D'ÉTÉ – SPIELPLATZ DER GENERATIONEN »



FR

Après son succès à la compétition internationale d'habitat solaire à Denver (USA), le NeighborHub revit au sein du Smart Living Lab de Fribourg. Reconstituée au cœur du site de blueFACTORY en mars 2018, la maison solaire a pour but de faire converger les habitant-e-s d'un quartier pour imaginer des solutions en faveur d'un avenir plus durable. Le NeighborHub est aussi utilisé comme prototype de recherche au sein du Smart Living Lab pour les aspects de la gestion de l'énergie, du confort et des interactions avec les utilisateurs-trices, liés au futur de l'environnement bâti.

En 2020, le site de blueFACTORY s'est mué pour le deuxième été consécutif en « Pôle d'été - Spielplatz der Generationen », cette place de jeux innovante et participative autour du NeighborHub. En écho aux préoccupations environnementales de la jeunesse dans les rues, cet espace dévolu à la mobilité douce a dévoilé un terrain d'aventure non conventionnel, de création et de liens entre les générations. Son point fort : un circuit cyclable ludique et évolutif grâce à de micro-projets de construction. Autour des travaux et du programme d'activités, c'est bel et bien l'exploration et la convivialité qui ont mis le Pôle d'été en ébullition !

DE

Nach dem Erfolg am internationalen Wettbewerb für nachhaltiges Habitat in Denver (USA) erhält der NeighborHub im Smart Living Lab in Freiburg ein zweites Leben. Seit März 2018 steht das Solarhaus nun wieder im Quartier blueFACTORY und wird immer mehr zum gemeinschaftlich genutzten Haus der Quartierbewohner und Nachbarn zur Entwicklung von Lösungen für eine nachhaltigere Zukunft. Der NeighborHub dient auch als Prototyp für die Forschung des Smart Living Lab. Der Umgang mit Energie, Komfort und Interaktion mit den Benutzerinnen und Benutzern steht im Mittelpunkt der Untersuchung.

Im Jahr 2020 verwandelte sich das blueFACTORY-Gelände rund um den NeighborHub zum zweiten Mal in Folge in den innovativen und partizipativen «Pôle d'été - Spielplatz der Generationen». In Anlehnung an die Umwelthanliegen der Jugendlichen hat dieser Raum nicht nur die sanfte Mobilität auf einem unkonventionellen Abenteuergelände gefördert, sondern auch Generationen miteinander verbunden. Seine Stärke: ein spielerischer und sich entwickelnder Fahrradparcours dank Mikrobauprojekten. Neben der Arbeit und dem Aktivitätsprogramm waren es in der Tat das Erkunden und die Geselligkeit, welche den Pôle d'été in Schwung brachten!

EN

Following its success at the international sustainable housing competition in Denver (USA), the NeighborHub resides once more at Fribourg's Smart Living Lab. Rebuilt in the heart of the blueFACTORY site in March 2018, the solar house aims to bring together the inhabitants of a neighbourhood to develop solutions to facilitate a more sustainable future. The NeighborHub is also used as a research prototype within the Smart Living Lab on the topics of energy management, comfort and user interaction as they relate to the future of the built environment.

In 2020, the blueFACTORY site was transformed for the second summer in a row into the innovative and participatory "Pôle d'été - Spielplatz der Generationen" around the NeighborHub. Reflecting the environmental concerns of young people in the streets, this space has not only promoted soft mobility in an unconventional adventure playground, but has also connected generations. Its strength: a playful and evolving cycle circuit, created through micro-building projects. In addition to the work and the activity programme, the exploration and the conviviality of the Pôle d'été caused a real buzz!

## PERSPECTIVES – RECHERCHE ET INNOVATION AVEC LE SMART LIVING LAB PERSPEKTIVEN – FORSCHUNG UND INNOVATION MIT DEM SMART LIVING LAB PERSPECTIVES – RESEARCH AND INNOVATION WITH THE SMART LIVING LAB



FR

Réalisé à blueFACTORY en collaboration avec la Promotion économique du Canton de Fribourg (PromFR), l'évènement « Perspectives » a offert le 23 septembre 2020 aux entreprises fribourgeoises un panorama des opportunités de recherche et d'innovation avec le Smart Living Lab.

Visant à présenter le centre de recherche dédié au futur de l'habitat, il a mis l'accent sur des témoignages d'entrepreneurs-euses de la région qui mènent des projets conjoints avec le Smart Living Lab. Un « marché de la recherche » a permis également à la centaine de participant-e-s, des entreprises fribourgeoises dynamiques et des scientifiques à la pointe de l'innovation, de partager leur savoir-faire dans les domaines de l'habitat, de l'énergie et de la construction. Les discussions furent très riches et assurément porteuses de nouvelles synergies.

DE

In Zusammenarbeit mit der Freiburger Wirtschaftsförderung (PromFR) bot die Veranstaltung «Perspektiven» Freiburger Unternehmen am 23. September 2020 in der Halle bleue der blueFACTORY einen Überblick über die Forschungs- und Innovationsmöglichkeiten mit dem Smart Living Lab.

Ziel der Veranstaltung war es, das Forschungszentrum, das sich der Zukunft des Wohnens widmet, vorzustellen. Im Mittelpunkt standen dabei Erfahrungsberichte von Unternehmern aus der Region, die gemeinsame Projekte mit dem Smart Living Lab durchführen. Ein «Forschungsmarkt» ermöglichte es den rund hundert Teilnehmern, dynamischen Freiburger Unternehmen und Wissenschaftlern an der Spitze der Innovation, ihr Know-how in den Bereichen Lebensraum, Energie und Bauwesen zu teilen. Die Diskussionen waren sowohl viel- wie auch reichhaltig und brachten neue Synergien hervor.

EN

In collaboration with the Fribourg Economic Development Agency (PromFR), the "Perspectives" event offered an overview of research and innovation opportunities with the Smart Living Lab to Fribourg companies on 23 September 2020 at blueFACTORY.

Designed to show off the research centre dedicated to the future of the built environment, it focused on testimonials from entrepreneurs from the region who are conducting joint projects with the Smart Living Lab. A "research market" also allowed the hundred participants, dynamic Fribourg companies and scientists at the cutting edge of innovation, to share their know-how in the fields of housing, energy and construction. The discussions were fruitful and will certainly lead to new collaborations.

## PROJETS DE RECHERCHE ET INNOVATION FORSCHUNGS- UND INNOVATIONSPROJEKTE RESEARCH AND INNOVATION PROJECTS

FR

Découvrez quatre projets de recherche et d'innovation impliquant des laboratoires de recherche du Smart Living Lab et des entreprises de la région.

DE

Entdecken Sie vier Forschungs- und Innovationsprojekte, an denen Forschungslaboratorien des Smart Living Lab und Unternehmen aus der Region beteiligt sind.

EN

Find out about four research and innovation projects involving Smart Living Lab research laboratories and companies from the region.



ReuSlab

FR

Le projet « ReuSlab », piloté par le Laboratoire d'Exploration Structurale de l'EPFL, l'Institut iTEC de la HEIA-FR et les entreprises Stephan SA, JPF Ducret SA, Ancotech SA et Holcim Suisse SA, propose un système porteur de bâtiment modulaire, réutilisable et adaptable, conciliant des exigences statiques, architecturales, écologiques et économiques.

DE

Das Projekt « ReuSlab », das vom Structural Xploration Lab der EPFL, dem iTEC-Institut der HTA-FR und den Firmen Stephan AG, JPF Ducret AG, Ancotech AG und Holcim Schweiz AG geleitet wird, schlägt ein modulares, wiederverwendbares und anpassungsfähiges Gebäudeunterstützungssystem vor, das statische, architektonische, ökologische und wirtschaftliche Anforderungen vereint.

EN

The “ReuSlab” project, led by the Structural Xploration Lab of EPFL, iTEC Institute of the HEIA-FR and the companies Stephan SA, JPF Ducret SA, Ancotech SA, Holcim Switzerland SA, proposes a modular, reusable and adaptable load-bearing system, which balances static, architectural, ecological and economic requirements.



blueEnergy

FR

Le projet « blueEnergy », dirigé par l'Institut iTEC de la HEIA-FR en partenariat avec SINEF SA et BFF SA, prévoit de développer un modèle générique pour analyser le potentiel thermique et mécanique des eaux locales. Ces connaissances scientifiques seront validées après leur implémentation réussie sur le site de blueFACTORY, ce qui permettra d'en déduire un plan d'affectation (PAC) idéal.

DE

Das Projekt « blueEnergy » unter der Leitung des iTEC-Instituts der HTA-FR, in Partnerschaft mit SINEF SA und BFF SA, plant die Entwicklung eines generischen Modells zur Analyse des thermischen und mechanischen Potenzials der lokalen Gewässer. Die wissenschaftlichen Erkenntnisse werden durch die Umsetzung an einem konkreten Standort validiert, wonach anschliessend der ideale zukünftige Nutzungsplan (KNP) daraus abgeleitet wird.

EN

The “blueEnergy” project led by the iTEC Institute of the HEIA-FR, in partnership with SINEF SA and BFF SA, aims to develop a generic model to analyse the thermal and mechanical potential of local waters. This scientific knowledge will be validated by implementing it on the blueFACTORY site, in order to determine an ideal allocation plan (PAC).



Hot &amp; Cold PCM

FR

Consommant 34 % de l'énergie suisse, le chauffage/refroidissement immobilier doit être amélioré, notamment lors de rénovations. Le projet « Hot & Cold PCM » propose de remplacer le chauffage de vieux bâtiments par des échangeurs de chaleur PCM à faible coût qui stockent la chaleur et le froid avec l'énergie renouvelable disponible, et la restituent si nécessaire. Cette étude est conduite par l'Institut ENERGY de la HEIA-FR avec le soutien d'Innosuisse et des partenaires WT SA, Amstein + Walthert, DCA Architectes SA et Sottas Building.

DE

Die Heizung und Kühlung von Immobilien, die 34 Prozent der Schweizer Energie verbrauchen, muss verbessert werden. Das Hauptthema ist die Sanierung von Altbauten. Das « Hot & Cold PCM »-Projekt schlägt vor, die Heizung von Altbauten durch preiswerte PCM-Wärmetauscher zu ersetzen, die Wärme und Kälte mit verfügbarer erneuerbarer Energie speichern und bei Bedarf wiederherstellen. Diese Studie wurde vom Institut ENERGY der HTA-FR mit Unterstützung von Innosuisse und den Partnern WT AG, Amstein + Walthert, DCA Architectes SA und Sottas Building durchgeführt.

EN

Real estate heating/cooling consumes 34% of Swiss energy. This must be improved. The main issue is the refurbishment of old buildings. The “Hot & Cold PCM” Project suggests replacing heating with low cost PCM heat exchangers which store heat and cold with available renewable energy and return it when required. This study is conducted by the ENERGY Institute of the HEIA-FR with the support of Innosuisse and the partners WT SA, Amstein + Walthert, DCA Architectes SA and Sottas Building.



Waste Collection

FR

Le but du projet « Waste Collection » est de développer un outil d'aide à la décision pour des systèmes communaux de gestion des déchets. Il se base sur un modèle d'optimisation et l'implémentation de technologies innovantes, et se concentre sur des améliorations en termes d'efficacité et de durabilité. En collaboration avec Schwendimann SA et System-Alpenluft SA, l'iimt de l'UNIFR a créé un processus de soutien à l'innovation permettant la mise en place et la diffusion d'innovations dans le domaine de la gestion des déchets dans certaines communes de Suisse. Ces processus se basent sur les connaissances développées dans le cadre des Transitions Studies.

DE

Das Ziel des Projektes « Waste Collection » ist die Entwicklung von Entscheidungsunterstützungstools für Kehrichtsammelprozesse in Schweizer Gemeinden, welche die Sammlung im Hinblick auf die Effizienz und die Nachhaltigkeit optimieren. Zusammen mit Schwendimann AG und System-Alpenluft AG beschäftigt sich das iimt der UNIFR im Rahmen des Projekts mit der Entwicklung eines Innovationsunterstützungsprozesses, welcher die Implementierung und Diffusion von Abfallmanagementinnovationen in den Gemeinden unterstützen soll und auf Konzepten aus Transition Studies basiert.

EN

The aim of the “Waste Collection” project is to develop a decision-making support tool for municipal waste management systems based on optimisation modelling and the deployment of innovative technologies, focusing on efficiency and sustainability improvements. Together with Schwendimann AG and System-Alpenluft AG, the UNIFR iimt is creating an innovation support process, bolstering the uptake and diffusion of waste management innovation in Swiss municipalities; with the process being based on insights from Transition Studies.

# Promotion

# Öffentlichkeitsarbeit

# Outreach

| ÉVÉNEMENTS   VERANSTALTUNGEN   EVENTS |                                                                                                                                |                                                                                           |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| DATE                                  | TITLE                                                                                                                          | SPEAKER                                                                                   |
| 2020-01-29                            | Smart Living Lunch   Form follows availability                                                                                 | Jan Brütting, EPFL                                                                        |
| 2020-02-12                            | Café scientifique   Sharing Economy                                                                                            | Virgile Pasquier, UNIFR                                                                   |
| 02/<br>14-02-2020                     | Swiss-Korean Academic Programme ARC-HEST   Architecture for human environment with smart technologies   Fribourg Winter School | EPFL, HEIA-FR, UNIFR, Hanyang University, EWha Womans University, SKKU, STO Seoul         |
| 2020-02-20                            | Invited Talk   Urban biodiverse habitats for Animals, Plants and Humans – Cities of the Future                                 | Nathalie Baumann, ZHAW                                                                    |
| 2020-03-04                            | Invited Talk   Reducing CO2 emissions from cementitious materials                                                              | Karen Scrivener, EPFL                                                                     |
| 2020-03-04                            | Les Dialogues Durabilité   Espaces de vie et Bien-être dans la durabilité                                                      | Marilyne Andersen, EPFL                                                                   |
| 2020-03-30                            | Public defense of PhD thesis   Data-driven method for low-carbon building design at early stages                               | Thomas Jusselme, EPFL                                                                     |
| 2020-06-16                            | Smart Living Lunch   Grammar-based structural design explorations to tame infinity                                             | Ioannis Mirtsopoulos, EPFL                                                                |
| 2020-07-01                            | Invited Talk   The Active Smart Building                                                                                       | Eric Cassar, ARKHENSPACES                                                                 |
| 2020-07-10                            | ENERGY Café Presentation   Carbon budget and daylight performance                                                              | Nazanin Rezaei Oghazi, HEIA-FR                                                            |
| 2020-09-03                            | #TecToday: Big Data et bâtiments connectés                                                                                     | Jean-Philippe Bacher, HEIA-FR                                                             |
| 2020-09-16                            | Smart Living Lunch   LowNeX: Exergy Modeling & Optimization of Low Temperature Networks                                        | Yolaine Adihou, HEIA-FR                                                                   |
| 2020-09-23                            | Perspectives: recherche et innovation avec le Smart Living Lab                                                                 | EPFL, HEIA-FR, UNIFR, PromFR, Bluefactory Fribourg-Freiburg SA, BIC, CCIF, FFE, FPE, UPCF |
| 2020-10-06                            | Humanitarian tents - Thermal performance and internal air quality+A3:A20                                                       | Martin Beyeler, UNIFR                                                                     |
| 2020-10-13                            | Newcomers Breakfast                                                                                                            | EPFL, HEIA-FR, UNIFR                                                                      |
| 2020-10-30                            | Public defense PhD thesis   Algorithms to ease the reuse of construction materials                                             | Jan Brütting, EPFL                                                                        |
| 2020-11-03                            | Table Ronde   Gestion intelligente des réseaux énergétiques à l'échelle du quartier et de la ville                             | Malick Kane, HEIA-FR                                                                      |
| 2020-11-18                            | Humanitarian tents - Thermal performance and internal air quality                                                              | André Ullal, EPFL                                                                         |
| 2020-12-09                            | Living in Extremes: Dynamic Thermal Environment in Traditional Nomadic Yurts                                                   | Dolaana Khovalyg, EPFL                                                                    |

| MÉDIAS   MEDIEN   MEDIAS |                                                                                                     |                           |
|--------------------------|-----------------------------------------------------------------------------------------------------|---------------------------|
| DATE                     | TITLE                                                                                               | MEDIA                     |
| 2020-01-09               | Un concours hors normes pour un bâtiment expérimental et évolutif MEP Smart Living Lab à Fribourg   | Tracés                    |
| 2020-02-06               | Echange académique Suisse-Corée sur le thème du co-working                                          | HES-SO                    |
| 2020-02-13               | Un espace de co-working ausculté par des étudiants suisses et coréens                               | Alma & Georges            |
| 2020-03-08               | Un réseau intelligent gèrera le trafic                                                              | La Liberté                |
| 2020-04-15               | La qualité de l'air intérieur pas assez prise en compte                                             | La Liberté                |
| 2020-04-16               | La lumière du jour, source de bien être                                                             | Domotech                  |
| 2020-04-29               | Ouvrir les fenêtres ne suffit pas                                                                   | La Liberté                |
| 2020-04-30               | Béton textile et modularité au service de la durabilité                                             | Modulart                  |
| 2020-05-11               | La place de l'humain dans les sciences environnementales                                            | Journal Ra&D HEIA-FR      |
| 2020-05-29               | Rencontre avec Marilyne Andersen, une spécialiste de la lumière                                     | RTS, CQFD                 |
| 2020-06-03               | Rendre visibles les pulsations de la ville                                                          | bulletin.ch               |
| 2020-06-09               | Impact carbone de la construction : Vizcab lève 1,6 million d'euros                                 | Environnement Mazagine    |
| 2020-06-11               | Vizcab: Bauplaner erhalten Methode zur Ökobilanzierung                                              | Umwelt Perspektiven       |
| 2020-07-31               | Wood ID                                                                                             | Regiosuisse.ch            |
| 2020-08-05               | Locataires de l'annexe relogés                                                                      | La Liberté                |
| 2020-08-28               | La fibre du béton                                                                                   | Journal Ra&D HEIA-FR      |
| 2020-08-31               | Smart Living Lab: Designing the built environment of the future                                     | Fribourg Network Freiburg |
| 2020-08-31               | NeighborHub: du Solar Decathlon à la Maison Bleue - histoire d'un projet                            | Hochparterre              |
| 2020-09-04               | Vor sechs Jahren begann in Freiburg die Umgestaltung des ehemaligen Cardinal-Areals zur BlueFactory | SRF 1 / Schweiz aktuell   |
| 2020-09-09               | Rénovation énergétique plus respectueuse: Les enjeux autour de la qualité de l'air dans l'habitat   | Le Nouvelliste            |
| 2020-09-29               | L'âme de l'ingénieur                                                                                | Journal Ra&D HEIA-FR      |
| 2020-10-08               | Tennis in einer Bankfiliale: eine Rechtsfrage, die nicht naturwissenschaftlich zu beantworten ist   | Alma & Georges            |
| 2020-10-19               | Les recherches sur la transmission du virus par les aérosols avancent                               | RTS, 19h30                |
| 2020-10-20               | Béton textile, futur de la construction?                                                            | ArcInfo                   |
| 2020-10-30               | A software application to ease the reuse of construction materials                                  | TechXplore                |
| 2020-10-30               | Schweizer Software für nachhaltiges Bauen                                                           | Bote der Urschweiz AG     |
| 2020-10-31               | Computational methods to ease reuse of construction components                                      | Mirage News               |
| 2020-11-02               | EPFL-Algorithmen ermöglichen Wiederverwendung von Baumaterialien                                    | Punkt 4                   |
| 2020-11-03               | Il riciclo in edilizia diventa più facile                                                           | www.rinnovabili.i         |
| 2020-11-03               | Bien aérer permet de lutter contre le coronavirus et la pollution de l'air                          | RTS Info                  |
| 2020-11-23               | Le pavillon qui va jeter un froid                                                                   | La Liberté                |

# Projets de recherche Forschungsprojekte Research projects

 INDUSTRIAL PARTNERSHIP

 INTERNATIONAL OUTREACH

 LOCAL INNOVATION

 SPECIAL FUNDING\*

 PHD PROJECT

\* Recognized competitive funding schemes:

• EU

• Federal offices SFOE, FOEN, etc.

• Foundations and similar grants

• Innosuisse

• NPR

• SNSF

| DIRECTION   TEAM                                                                                                                                                                                                      | SUMMARY                                                                                                                                                                                                            | RESEARCH GROUP(S)<br>AND PARTNERS                                                                                                                   | START<br>END |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Accompagnement du MEP pour le bâtiment du Smart Living Lab</b> <div>VIEW</div>                                                                                                                                     |                                                                                                                                                                                                                    |                                                                                                                                                     |              |
| Radu, Florinel; Parrat, Jonathan; Bacher, Jean-Philippe; Aguacil, Sergi                                                                                                                                               | Survey and analysis of the entire parallel studies mandate (MEP) for the Smart Living Lab building as an innovative collaborative design process.                                                                  | HEIA-FR TRANSFORM<br>HEIA-FR ENERGY<br>EPFL Building2050                                                                                            | 2019<br>2020 |
| <b>Adaptation to Extreme Temperatures – The Study of Physiology and Lifestyle of Nomadic Pastoralists in Tuva-Siberia</b> <div>VIEW</div>                                                                             |                                                                                                                                                                                                                    |                                                                                                                                                     |              |
| 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 TEBEL<br>Thermophysiology & Metabolism group, Maastricht University (Netherlands)                                                              | 2019<br>2021 |
| <b>Affirming actions - Women in architecture</b> <div>VIEW</div>                                                                                                                                                      |                                                                                                                                                                                                                    |                                                                                                                                                     |              |
| 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<br>EPFL IA<br>EPFL ARCHIZOOM                                                                                                               | 2020<br>2021 |
| <b>ARC-HEST: Architecture for Human Environment with Smart Technologies</b> <div>VIEW</div>                                                                                                                           |                                                                                                                                                                                                                    |                                                                                                                                                     |              |
| Khovalyg, Dolaana; Licina, Dusan; Compagnon, Raphaël; Menzel, Götz; Teufel, Stephanie; Sentic, Anton; Lalanne, Denis; Nembrini, Julien                                                                                | Swiss-Korean academic exchange programme focusing on studying the working environment in conjunction with local culture and architecture.                                                                          | EPFL TEBEL<br>EPFL HOBEL<br>HEIA-FR TRANSFORM<br>UNIFR iimt<br>UNIFR Human-IST<br>SKKU<br>EWHA Womans University<br>Hanyang University<br>STO Seoul | 2019<br>2020 |

|                                                                            |                                                                                                                                                                               |                                                                                                |              |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|--------------|
| <b>ARMO-Cure Innosuisse</b> <div>VIEW</div>                                |                                                                                                                                                                               |                                                                                                |              |
| Zwicky, Daia; Chira, Alexandru                                             | Development of a maintenance and reinforcement system for large steel pipes.                                                                                                  | HEIA-FR iTEC<br>S&P Clever Reinforcement AG<br>Innosuisse                                      | 2020<br>2022 |
| <b>Assainissement 4.0</b> <div>VIEW</div>                                  |                                                                                                                                                                               |                                                                                                |              |
| Devaux, Mylène; Hennebert, Jean; Jusselme, Thomas; Schwab, Stefanie        | Development of a tool to assess the energetic and structural performance of a building portfolio based on machine learning.                                                   | HEIA-FR iTEC<br>HEIA-FR TRANSFORM<br>HEIA-FR ENERGY<br>HEIA-FR iCoSys                          | 2019<br>2020 |
| <b>Assessing the Potential of Building Component Reuse</b> <div>VIEW</div> |                                                                                                                                                                               |                                                                                                |              |
| Fivet, Corentin; Bastien Masse, Maléna; Lambec, Barbara; Wegmann, Raphaël  | Assessment of the reuse of building components as a key strategy in the circular economy.                                                                                     | EPFL SXL<br>SNSF                                                                               | 2020         |
| <b>Atlas du logement</b> <div>VIEW</div>                                   |                                                                                                                                                                               |                                                                                                |              |
| 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<br>2020 |
| <b>Audit-Arena</b> <div>VIEW</div>                                         |                                                                                                                                                                               |                                                                                                |              |
| Rotzetta, André; Vonlanthen, Marc                                          | Energy efficiency optimisation of an ice rink.                                                                                                                                | HEIA-FR ENERGY<br>HEIA-FR SeSi<br>Groupe E<br>Infoteam<br>La Pati<br>SBC Saia Burgess Controls | 2018<br>2020 |
| <b>Aurora-OFEN</b> <div>VIEW</div>                                         |                                                                                                                                                                               |                                                                                                |              |
| Niederhäuser, Elena-Lavinia; Torregrossa, Dimitri                          | Environmentally responsible energy management software for lithium batteries integrating the phenomenon of ageing.                                                            | HEIA-FR ENERGY<br>HEIG-VD IESE<br>EMPA<br>Aurora's Grid                                        | 2018<br>2020 |
| <b>BIM BEM</b> <div>VIEW</div>                                             |                                                                                                                                                                               |                                                                                                |              |
| Jusselme, Thomas; Rezaei Oghazi, Nazanin                                   | Energy simulation at the building level and integration of the digital model in the design phase.                                                                             | HEIA-FR ENERGY<br>EPFL LIPID                                                                   | 2019<br>2020 |

| 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<br>HEIA-FR TRANSFORM<br>Advent<br>Antiglio<br>BIC<br>Bluefactory Fribourg-Freiburg SA<br>Element AG<br>Grisoni Zaugg,<br>Groupe E<br>HEG-FR<br>Objectif BIM<br>UPCF | 2020         |                                                                                                                                                                                                                                                                                                                                                 |
| 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<br>Logitech<br>Innosuisse                                                                                                                                             | 2020<br>2021 |                                                                                                                                                                                                                                                                                                                                                 |
| BlueCAD                                                                                     |                                                                                                                                                                                                                                                                               |                                                                                                                                                                                       |              |                                                                                     |
| Kane, Malick; Adihou, Yolaine                                                               | New concept of advanced solar district heating/cooling networks for energy supply in buildings.                                                                                                                                                                               | HEIA-FR ENERGY<br>BFF SA<br>Groupe E Celsius<br>Service de l’Energie Fribourg                                                                                                         | 2018<br>2020 |                                                                                                                                                                                                                                                                                                                                                 |
| 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<br>HEIA-FR ENERGY<br>HEIA-FR TRANSFORM<br>BFF SA<br>Sinef SA<br>Groupe E                                                                                                 | 2019<br>2021 |                                                                                                                                                                                                                                                                                                                                                 |
| 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<br>2021 |                                                                                                                                                                                                                                                                                                                                                 |
| 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<br>2021 |                                                                                                                                                                                                                                                                                                                                                 |

| Centre romand de la qualité de l’air intérieur et du radon (croqAIR)                                                        |                                                                                                                                                                                                                                                        |                                                   |              |       |
|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goyette Pernot, Joëlle                                                                                                      | croqAIR houses the technical service for radon gas risk management in the building, on behalf of the Federal Office of Public Health.                                                                                                                  | HEIA-FR TRANSFORM<br>FHNW<br>FOPH<br>SUPSI        | 2016<br>2020 |                                                                                                                                                                             |
| City Pulse SIM                                                                                                              |                                                                                                                                                                                                                                                        |                                                   |              |                                                                                          |
| Radu, Florinel; Parrat, Jonathan; Ingram, Sandy; Fénart, Marc-Antoine                                                       | Simulation tool for urban interactions: allocations - densities – mobilities                                                                                                                                                                           | HEIA-FR TRANSFORM<br>HEIA-FR ITEC<br>HEIA-FR ISIS | 2020<br>2022 |                                                                                                                                                                             |
| 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         |                                                                                                                                                                             |
| ConDensUrbEN                                                                                                                |                                                                                                                                                                                                                                                        |                                                   |              |                                                                                          |
| Zwicky, Daia; Bernasconi, Andrea; Schwab, Stefanie; Lasvaux, Sebastien; Uboldi, Paride; Goulouti, Kyriaki                   | Development of practical concepts for the densification of urban living areas by raising existing buildings in a cost-effective and ecological manner.                                                                                                 | HEIA-FR ITEC<br>HEIA-FR TRANSFORM<br>HEIG-VD      | 2018<br>2020 |                                                                                                                                                                             |
| 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         |                                                                                                                                                                             |
| Construction of the BIM model of the Controlled Environments for Living Lab Studies (CELLS)                                 |                                                                                                                                                                                                                                                        |                                                   |              |                                                                                        |
| Aguacil, Sergi; Duque, Sebastian; Roman, Justine                                                                            | Provide researchers with a digital twin of the CELLS research facility to test experiments virtually before they are implemented in real conditions.                                                                                                   | EPFL Building2050                                 | 2019<br>2020 |                                                                                                                                                                             |
| Controlled testing of low-cost indoor environmental sensors                                                                 |                                                                                                                                                                                                                                                        |                                                   |              |                                                                                        |
| Licina, Dusan                                                                                                               | Testing the performance of indoor environmental sensors under a set of environmental conditions that are commonly encountered in buildings.                                                                                                            | EPFL HOBEL                                        | 2019         |                                                                                                                                                                             |

Déconstruction Sélective / Construction Réversible



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

Demo-mi²



|                                                                                                            |                                                                                                                                                             |                                                          |              |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------|
| Vonlanthen, Marc;<br>Compagnon, Raphaël;<br>Rotzetta, André;<br>Taillebois, Jean-Michel;<br>Cesari, Matias | Design, implementation and experimentation of a mobile demonstrator operating as a microclimate for scientific, educational and awareness-raising purposes. | HEIA-FR ENERGY<br>HEIA-FR TRANSFORM<br>Ville de Fribourg | 2020<br>2021 |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------|

Direct awards under the 2012 Government Procurement Agreement (GPA 2012) and the 2019 Federal Act on Public Procurement (FAPP 2019)



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|------------------|-------------------------------------------------------|--------------------------------------------------------------|------|
| Socchi, Caroline | Analysis of Art. XIII GPA 2012 and Art. 21 FAPP 2019. | UNIFR Institute for Swiss and International Construction Law | 2020 |
|------------------|-------------------------------------------------------|--------------------------------------------------------------|------|

eCOMBINE: Interaction between energy use, COMfort, Behaviour, and INdoor Environment



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|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------------|
| Khovalyg, Dolaana;<br>Licina, Dusan;<br>Barthelmes, Verena;<br>Andersen, Marilyne;<br>Wienold, Jan;<br>Karmann, Caroline;<br>Gonzalez Serano,<br>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 TEBEL<br>EPFL HOBEL<br>EPFL LIPID<br>UNIFR Human-IST | 2019<br>2021 |
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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<br>UNIFR DS&OR<br>Innosuisse<br>Schwendimann AG | 2019<br>2021 |
|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|--------------|

EnergyPlus



|                |                                                                                                                      |                                             |              |
|----------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|
| Aguacil, Sergi | Building energy model construction and calibration using actual data from sensor measurements and a weather station. | EPFL Building2050<br>EPFL FAR<br>EPFL HOBEL | 2019<br>2020 |
|----------------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|

Exergy Analysis of Geneva's District Heating Network



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|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------------|
| Khovalyg, Dolaana;<br>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<br>EPFL TEBEL<br>Services Industriels de Genève (SIG) | 2020<br>2021 |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------------|

FACILITY 4.0



|                                                                                                            |                                                                                                   |                                                                                                      |              |
|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------|
| Hennebert, Jean;<br>Bacher, Jean-Philippe;<br>Montet, Frédéric;<br>Marazzi, Sofia;<br>Pongelli, Alessandro | Building Management 4.0 - innovative services for performance monitoring and facility management. | HEIA-FR ENERGY<br>HEIA-FR iCoSys<br>Amotech Plus<br>BIC<br>ESTIA<br>GreenWatt<br>Losinger<br>So'Watt | 2019<br>2021 |
|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------|

Food Living Lab Fribourg



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|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------|
| Teufel, Stephanie;<br>Sentic, Anton;<br>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<br>Smart Living Lab<br>Management<br>Canton de Fribourg<br>Agroscope | 2020<br>2021 |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------|

Fri-Loranet



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

Generative Grammars for Structural Exploration



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|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| Fivet, Corentin;<br>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<br>2022 |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|

Hidden Genericity



|                                  |                                                                                                                           |          |              |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| Fivet, Corentin;<br>Ye, Jingxian | Identifying hidden genericity and reversibility in load-bearing components for buildings as a way to improve reuse loops. | EPFL SXL | 2018<br>2022 |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------|--------------|

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<br>Logitech<br>Innosuisse | 2018<br>2020 |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------|

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 |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|

ICU\_FRIBOURG: Ilots de chaleurs urbains (ICU) en ville de Fribourg



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|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|
| 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<br>Ville de Fribourg<br>OFEN | 2019<br>2021 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|

IL-PCM



|                                 |                                                                                                                                                                     |                                    |              |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------|
| Robadey, Jacques; Martin, Roger | Novel sustainable phase change materials (PCM) based on ionic liquids (IL) from natural and renewable sources designed to store and manage heat in smart buildings. | HEIA-FR ENERGY<br>HEIA-FR ChemTech | 2019<br>2020 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------|

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 TEBEL | 2019<br>2022 |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------|--------------|

Indoor air quality in humanitarian tents



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|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------|--------------|
| Licina, Dusan; Ullal, André; Vannucci, Riccardo; Tombesi, Paolo; Aguacil, Sergi; Goyette Pernot, Joëlle | Evaluation of indoor environmental quality in emergency shelters. | EPFL HOBEL<br>EPFL FAR<br>EPFL Building2050<br>EPFL TRANSFORM croqAIR | 2019<br>2020 |
|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------|--------------|

Indoor environmental quality and satisfaction in conventional and green-certified buildings



|               |                                                                                                                                 |            |      |
|---------------|---------------------------------------------------------------------------------------------------------------------------------|------------|------|
| Licina, Dusan | Comparison of human satisfaction in green-certified and conventional buildings, and of indoor environmental quality parameters. | EPFL HOBEL | 2018 |
|---------------|---------------------------------------------------------------------------------------------------------------------------------|------------|------|

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<br>2021 |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|

Interactive simulation of a crowd energy system



|                                                  |                                                                                                                         |                                                                 |              |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--------------|
| Sentic, Anton; Drazyk, Manuel; Teufel, Stephanie | The project explores the behaviour of prospective users in decentralised, prosumer-based energy systems (crowd energy). | UNIFR iimt<br>HEIA-FR TRANSFORM<br>HEIA-FR ROSAS<br>H. Glass SA | 2018<br>2020 |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--------------|

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 |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|

JURAD-BAT



|                                                                     |                                                                                                                                          |                                                                                                         |              |
|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------|
| Goyette Pernot, Joëlle; Perrelet, Théo; de Potter-Longchamp, Céline | A cross-border platform at the service of users and building professionals improving radon risk management in the Jura region buildings. | HEIA-FR TRANSFORM<br>croqAIR<br>Université de Franche-Comté<br>OFSP<br>ECONS SA<br>EHE SA<br>PLANAIR SA | 2016<br>2020 |
|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------|

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 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|

Léman2030



|                                                                                            |                                                                                                                     |                     |              |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------|--------------|
| Favre Boivin, Fabienne; Frei, Benjamin; Froidevaux, Manuel; Ribí, Jean-Marc; Spahni, Bruno | Measurement of the hydraulic and depollution performance of a new runoff water treatment system on a SBB test site. | HEIA-FR iTEC<br>SBB | 2018<br>2020 |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------|--------------|

Li-ion diagnosis



|                                                   |                                               |                |      |
|---------------------------------------------------|-----------------------------------------------|----------------|------|
| Niederhäuser, Elena-Lavinia; Torregrossa, Dimitri | Li-ion battery diagnosis for residential use. | HEIA-FR ENERGY | 2020 |
|---------------------------------------------------|-----------------------------------------------|----------------|------|

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 |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------|------|

LUCIDELES: Leveraging User-Centric Intelligent Daylight and Electric Lighting for Energy Saving



|                     |                                                                 |                          |      |
|---------------------|-----------------------------------------------------------------|--------------------------|------|
| Nembrini, Julien;   | User-centric study of interaction with a state-of-the-art       | UNIFR Human-IST          | 2020 |
| Kaempf, Jérôme;     | daylight/electric light control algorithm in an office setting. | Idiap Research Institute | 2021 |
| Papinutto, Michael; |                                                                 | Regent Lighting          |      |
| Colombo, Moreno;    |                                                                 | OFEN                     |      |
| Lalanne, Denis      |                                                                 |                          |      |

MACADAM - MitigAtion of ClimAte change by Design, Adaptation and Monitoring



|                           |                                                           |                       |      |
|---------------------------|-----------------------------------------------------------|-----------------------|------|
| Goyette Pernot, Joëlle;   | Determination of the urban microclimate so that           | HEIA-FR TRANSFORM     | 2018 |
| Camponovo, Reto; Rey,     | communities, urban planners, and landscape architects can | Hepia Genève          | 2020 |
| Joan Frédéric; Guillot,   | implement measures that condition the well-being of city  | croqAIR               |      |
| Victor; Galinelli, Peter; | users.                                                    | HES-SO                |      |
| Boivin, Pascal            |                                                           | Etat de Genève - OCEN |      |

Mapping Geneva’s embodied carbon legacy



|                     |                                                    |                              |      |
|---------------------|----------------------------------------------------|------------------------------|------|
| Fivet, Corentin;    | New methodology to assess the embodied carbon over | EPFL SXL                     | 2019 |
| De Wolf, Catherine; | time and space in the canton of Geneva.            | EPFL Habitat Research Center | 2021 |
| Vanbutsele, Séréna  |                                                    | EPFL DHLab Time Machine      |      |
|                     |                                                    | University of Geneva         |      |

Maximizing the potential for natural ventilation with regard to energy use and occupant well-being



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

Mobbot Innosuisse



|                       |                                     |              |      |
|-----------------------|-------------------------------------|--------------|------|
| Zwicky, Daia; Andrey, | Optimisation of shotcrete spraying. | HEIA-FR iTEC | 2019 |
| Jean-Paul; Frei,      |                                     | Mobbot SA    | 2020 |
| Benjamin; Schaller,   |                                     | Innosuisse   |      |
| Marc; Schaller, Yanis |                                     |              |      |

NaturaBIM



|                     |                                                            |                   |      |
|---------------------|------------------------------------------------------------|-------------------|------|
| Devaux, Mylène;     | Optimizing protection of buildings against natural hazards | HEIA-FR iTEC      | 2019 |
| Boumaref, Redouane; | by means of BIM (Building Information Modeling).           | HEIA-FR TRANSFORM | 2020 |
| Labieuse, Vincent;  |                                                            | AEAI              |      |
| Schwab, Stefanie    |                                                            |                   |      |

Navettes MIC Marly



|                   |                                                          |              |      |
|-------------------|----------------------------------------------------------|--------------|------|
| Conforti, César;  | Full-scale trial of a service using an automatic shuttle | HEIA-FR iTEC | 2017 |
| Ruffieux, Hervé;  | system operating on the Marly Innovation Center (MIC) in | TPF TRAFIC   | 2020 |
| Testenière, Laure | Fribourg.                                                |              |      |

NextEarthBuild



|                 |                                                        |              |      |
|-----------------|--------------------------------------------------------|--------------|------|
| Redaelli, Dario | Development of new approaches to the design and        | HEIA-FR iTEC | 2019 |
|                 | construction of buildings and outdoor facilities using | HEIA-FR SeSi | 2021 |
|                 | excavated earth.                                       | HEIG-VD      |      |

Occupant-Centric Hot Water Production based on Reinforcement Learning



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

Occupant-centric HVAC control for optimal air quality, comfort and energy use



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

OFROU2



|                       |                                                          |              |      |
|-----------------------|----------------------------------------------------------|--------------|------|
| Favre Boivin,         | Sampling and data processing methods for the assessment  | HEIA-FR iTEC | 2018 |
| Fabienne; Froidevaux, | of the depuration performances of runoff water treatment | OFROU        | 2020 |
| Manuel; Hager Jörin,  | systems (SETEC).                                         |              |      |
| Corinne               |                                                          |              |      |

OptiBat\_GWP



|                         |                                                             |                 |      |
|-------------------------|-------------------------------------------------------------|-----------------|------|
| Zwicky, Daia; Meszes,   | Identification of greenhouse gas emission benchmarks for    | HEIA-FR iTEC    | 2017 |
| Adam Attila; Reinhard,  | the construction of buildings in different planning phases. | Energie Schweiz | 2020 |
| Valérie Anne; Schaller, |                                                             | intep GmbH      |      |
| Marc                    |                                                             | OFEN            |      |

OptiSoil



|                    |                                                           |                  |      |
|--------------------|-----------------------------------------------------------|------------------|------|
| Commend, Stéphane; | Optimisation of support system for urban deep excavations | HEIA-FR iTEC     | 2019 |
| Jost, Colette      | with machine learning techniques.                         | HEIA-FR iCoSyS   | 2024 |
|                    |                                                           | EPFL             |      |
|                    |                                                           | Fondation Hasler |      |

PanBIM



|                     |                                                               |                   |      |
|---------------------|---------------------------------------------------------------|-------------------|------|
| Boumaref, Redouane; | Multidisciplinary reflection, including the various aspects   | HEIA-FR TRANSFORM | 2019 |
| Page, Gilles        | that make up the digital heritage value of a building, such   |                   | 2020 |
|                     | as energy efficiency, numerical simulations of the physics of |                   |      |
|                     | structures, and use and operation simulations.                |                   |      |

Particle release and transport from human skin and clothing: A CFD modelling methodology



|                           |                                                                                                                                                                                                                                                                                        |            |      |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|
| Licina, Dusan; Yang, Shen | This project aims to develop the first CFD modelling methodology for simulation of particle release and transport from human skin and clothing in specific office settings, and to quantify implications of building, environmental and personal factors on human inhalation exposure. | EPFL HOBEL | 2020 |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|

PCM Hot & Cold



|                  |                                                       |                                                                                          |              |
|------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------|--------------|
| Robadey, Jacques | PCM-based solutions for building heating and cooling. | HEIA-FR ENERGY<br>Amstein + Walthert<br>DCA Architectes SA<br>Innosuisse<br>Sottas<br>WT | 2019<br>2020 |
|------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------|--------------|

PelletSLL



|              |                                                                                                                    |              |              |
|--------------|--------------------------------------------------------------------------------------------------------------------|--------------|--------------|
| Zwicky, Daia | Development of alternative lightweight aggregates, to be used in lightweight concrete, by means of a “pelletizer”. | HEIA-FR iTEC | 2019<br>2020 |
|--------------|--------------------------------------------------------------------------------------------------------------------|--------------|--------------|

Performance of people at low-level activities in varying indoor temperatures



|                                                                                                                       |                                                                                                                                                                              |                                                                                                  |              |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------|
| Khovalyg, Dolaana; Chatterjee, Arnab; Kwak, Jiyoung; 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,<br>Department of<br>Endocrinology, Metabolism<br>& Cardiovascular system | 2020<br>2022 |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------|

PKW-STEP



|                                                                          |                                                                                                                     |                                                              |              |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|--------------|
| Pfister, Michael; Favre Boivin, Fabienne; Ribl, Jean-Marc; Spahni, Bruno | Numerical simulations and design tests to optimise the efficiency of sedimentation tanks in water treatment plants. | HEIA-FR iTEC<br>STEP de Vétroz-Conthey<br>Ingenieurbüro RIBI | 2017<br>2020 |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|--------------|

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<br>Pontificia Universidad Catolica de Chile<br>Drexel University<br>Municipalidad de El Quisco<br>Ministerio del Medio Ambiente de Chile | 2019<br>2021 |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------|

ProRen



|                                                                                                                              |                                                                                     |                                                                         |              |
|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------|
| Schwab, Stefanie; Radu, Florinel; Boumaref, Redouane; Bacher, Jean-Philippe; Devaux, Mylène; Parrat, Jonathan; Runser, Julie | Framework to facilitate an understanding of the entire building renovation process. | HEIA-FR TRANSFORM<br>HEIA-FR ENERGY<br>HEIA-FR iTEC<br>Etat de Fribourg | 2019<br>2020 |
|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------|

PROSEN



|                             |                                                                                                                                                                                                                      |                                                                |              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--------------|
| Radu, Florinel; Jan, Nicole | Better understanding of urban planning projects that include sustainability aspects, from a human, urbanistic, and architectural perspective, to help seniors remain in their homes in the best possible conditions. | HEIA-FR TRANSFORM<br>PRO SENECTUTE VAUD<br>Fondation Leenaards | 2018<br>2020 |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--------------|

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<br>HEIA-FR TRANSFORM | 2020<br>2021 |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------|--------------|

Psychological and physiological reactions to artificial light dimming in office environments



|                                                      |                                                                    |                 |              |
|------------------------------------------------------|--------------------------------------------------------------------|-----------------|--------------|
| Lalanne, Denis; Papinutto, Michael; Nembrini, Julien | Study of the influence of backlighting influencing visual comfort. | UNIFR Human-IST | 2019<br>2020 |
|------------------------------------------------------|--------------------------------------------------------------------|-----------------|--------------|

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 |
|-----------------|-----------------------------------------------------------------------------|--------------------------------------------------------------|------|

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<br>EPFL Library<br>HES-SO<br>iZed<br>Smart Living Lab Communication<br>UNIFR | 2019<br>2021 |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|--------------|

Quantification of the alea (or uncertainty) in analyses performed at iTEC (QualiTEC)



|                                                                                                                                           |                                                                                                                                                                                                                                                                                                             |              |              |
|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|
| Commend, Stéphane;<br>Jost, Colette; Favre,<br>Fabienne; Bullinger,<br>Géraldine; Froidevaux,<br>Manuel; Pfister,<br>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<br>2021 |
|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|

Radon investigation in Swiss buildings



|                                                        |                                                                                                                  |                                 |      |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------|------|
| Licina, Dusan; Goyette<br>Pernot, Joëlle; Rey,<br>Joan | Collaborative effort between HEIA-FR TRANSFORM and EPFL HOBEL to advance the state of knowledge of indoor radon. | EPFL HOBEL<br>HEIA-FR TRANSFORM | 2020 |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------|------|

RAME - Radon Mitigation Efficiency



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

Rapa Nui



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

RCB



|                                                       |                                                                                           |                            |              |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------|--------------|
| Zwicky, Daia; Macchi,<br>Niccolò; Serpell,<br>Ricardo | Ecological optimisation of concrete made with recycled aggregates (RC) and basalt fibres. | HEIA-FR iTEC<br>STRABAG AG | 2020<br>2021 |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------|--------------|

Research BIM specifications for the Smart Living Lab building



|                                     |                                                                                                   |                   |              |
|-------------------------------------|---------------------------------------------------------------------------------------------------|-------------------|--------------|
| Aguacil, Sergi; Duque,<br>Sebastian | Building Information Modeling (BIM) requirements for the tender of the Smart Living Lab building. | EPFL Building2050 | 2019<br>2020 |
|-------------------------------------|---------------------------------------------------------------------------------------------------|-------------------|--------------|

Reuse potential of reinforced concrete building structures



|                                   |                                                                                                                                                                                     |                    |              |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------|
| Fivet, Corentin;<br>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<br>Doc.CH | 2020<br>2024 |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------|

ReuSlab



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

SAR - Sociology and architecture



|                                |                                                                                                                                                                            |                   |              |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|
| Radu, Florinel; Jan,<br>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<br>2021 |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|

SETUP Pro



|                                                                                   |                                                                                                                                                                                    |                                     |              |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------|
| Jusselme, Thomas;<br>Radu, Florinel; Rezaei<br>Oghazi, Nazanin;<br>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<br>HEIA-FR ENERGY | 2020<br>2021 |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------|

Shelter | Humanitarian Tents



|                                                                                                                     |                                                                                                                               |                                                                             |              |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------|
| Ullal, André; Vannucci;<br>Riccardo; Tombesi,<br>Paolo; Licina, Dusan;<br>Aguacil, Sergi; Goyette<br>Pernot, Joëlle | Assessment of thermal performances and indoor air quality of standard humanitarian tents on the blueFACTORY site in Fribourg. | EPFL FAR<br>EPFL Builging2050<br>EPFL HOBEL<br>HEIA-FR TRANSFORM<br>croqAIR | 2019<br>2020 |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------|

Slide-PM



|                                     |                                                                                                                                                                                                                                                                    |                                   |              |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------|
| Commend, Stéphane;<br>Jost, Colette | Prototyping to measure the interaction between debris flows and the existing building to develop a software application capable of assessing the damage of a real structure taking into account its ultimate state of rupture, after a given torrential lava flow. | HEIA-FR iTEC<br>HEIG-VD<br>GEOMOD | 2019<br>2020 |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------|

SLL Hardware



|                                                   |                                                                       |                                    |      |
|---------------------------------------------------|-----------------------------------------------------------------------|------------------------------------|------|
| Zwicky, Daia; Macchi,<br>Niccolò; Schaller, Yanis | Acquisition of equipment linked to Smart Living Lab research domains. | HEIA-FR iTEC<br>Canton de Fribourg | 2020 |
|---------------------------------------------------|-----------------------------------------------------------------------|------------------------------------|------|

Smart Living Lab Application to the European Network of Living Labs



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

SmartMob - Mobilier adaptable et réutilisable



|                                                                     |                                                                                       |                   |              |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------|--------------|
| Buri, Hani; Radu, Florinel; Bahnsen, Ilse; Taillebois, Jean-Michaël | Refurbishment of the TRANSFORM Institute's office at blueFACTORY involving its users. | HEIA-FR TRANSFORM | 2019<br>2020 |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------|--------------|

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 |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------|------|

SuppoMorand



|             |                                                                |                        |              |
|-------------|----------------------------------------------------------------|------------------------|--------------|
| Rime, Alain | Bending strength test of glazing fasteners for industrial use. | HEIA-FR iTEC Morand SA | 2018<br>2020 |
|-------------|----------------------------------------------------------------|------------------------|--------------|

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<br>EPFL Building2050<br>EPFL EssentialTech Centre<br>ETHZ Sustainable Construction D-BAUG<br>ICRC | 2020 |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------|

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<br>2021 |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|

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<br>2022 |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|

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 |
|---------------|-----------------------------------------------------------------------------------------------|------------|------|

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 |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------|------|

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. | University of Pennsylvania<br>Princeton University | 2020<br>2021 |
|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------|

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<br>HEIA-FR ENERGY<br>HEIA-FR TRANSFORM | 2019<br>2021 |
|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|--------------|

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<br>2023 |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|

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<br>OFROU<br>GEOTEST SA | 2017<br>2021 |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------|--------------|

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<br>2022 |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------|

Waste Reclamation | Elastic Gridshell



|                                                                      |                                                                          |                  |      |
|----------------------------------------------------------------------|--------------------------------------------------------------------------|------------------|------|
| Montagne, Nicolas; Fivet, Corentin; Baverel, Olivier; Douthe, Cyril; | Design and construction of an elastic gridshell from reclaimed material. | EPFL SXL<br>ENPC | 2019 |
|----------------------------------------------------------------------|--------------------------------------------------------------------------|------------------|------|

# Publications

# Publikationen

# Publications

## RESEARCH PUBLICATIONS 2020

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

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