smart living lab

EPFL

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

UNI FR
UNIVERSITÉ DE FRIBOURG
UNIVERSITÄT FREIBURG

10 YEARS OF IMPACT
2024 ANNUAL REPORT

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Editorial

2024: Ten years of impact culminating in the construction of the building

In 2024, the Smart Living Lab (SLL) celebrated its 10th anniversary. There were many drivers behind this grand project, which would not have come to fruition without the support of the State of Fribourg, EPFL, the School of Engineering and Architecture of Fribourg (HEIA-FR) and the University of Fribourg. The first is the realisation of a pioneering vision for sustainable construction. The second is a desire to create a new form of interdisciplinary research partnership. The third is the transformation of a brownfield site into an innovation district complete with a state-of-the-art campus. The fourth is the arrival of EPFL in Fribourg. The fifth is a shared ambition to construct a demonstrator building like no other.

This publication is both a report on the Smart Living Lab's activities over the past year and a retrospective of its first decade. It maps the main development milestones, the major joint achievements of the three academic institutions which work there, and the activities of the laboratories and institutes that have emerged since the Smart Living Lab was established.

The future flagship Smart Living Lab building will be an ecosystem for research and experimentation under real-life conditions and with the active participation of its occupants. The design of this unique low-carbon facility is the product of extensive research; these activities are summarized in this report. The journey from concept to implementation ended in 2024, paving the way for construction work to begin in 2025. With the facility scheduled to open in 2027, the Smart Living Lab team is based in temporary premises on the Bluefactory site.

There was another reason why 2024 was a landmark year for the Smart Living Lab. On 1 April, Corentin Fivet succeeded Professor Marilyne Andersen as academic director. Professor Fivet, who hails from Belgium and studied architecture and engineering there, left MIT in Boston in 2016 to take up a tenure-track assistant professor post at ENAC's Institute of Architecture. He was also one of the first professors EPFL hired for its new campus in Fribourg. In 2023, he was promoted to associate professor. At the 10th anniversary celebrations, the Smart Living Lab team warmly thanked Professor Andersen for her decade-long service. The SLL will continue to honour and build on her scientific and human legacy by seeking out scientific answers to the most pressing challenges facing humanity in Switzerland and around the world. Its efforts will focus particularly on finding solutions that guarantee a built environment that is of high quality, accessible to all, and respects planetary boundaries.

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Martin Gonzenbach
Director of Operations of Smart Living Lab and EPFL Fribourg

Review of Marilyne Andersen

A Decade of Innovation: Celebrating the Smart Living Lab's First 10 Years

A little over ten years ago, in March 2014, the Smart Living Lab (SLL) was officially launched with the promise of becoming a research and innovation hub for the sustainable future of the built environment. Uniting the complementary expertise and scientific cultures of EPFL, the School of Engineering and Architecture Fribourg (HEIA-FR), and the University of Fribourg (UNIFR), its vision ever since has been to rethink how we live, work, and interact with our surroundings, prioritizing energy efficiency, digital transformation, and human well-being. As Dean of EPFL's School of Architecture, Civil and Environmental Engineering (ENAC) from 2013 to 2018, then as Academic Director of the Smart Living Lab until 2024 when Prof. Corentin Fivet took over, I had the privilege of spearheading the development of this very unique collaborative endeavour.

© Thomas Delley

Marilyne Andersen
Academic Director of Smart Living Lab (2014-2024)

Located at Bluefactory Fribourg – an innovation district reborn from the Cardinal brewery dear to any local citizen – a unique feature of the SLL was to be housed in a to-be-designed experimental building that would be ahead of its time in terms of sustainability standards and able to literally act as a lab. Its smartness was to lie not only in technological breakthroughs or sophisticated controls but in a holistic interpretation of how to live and work sustainably.

The initial impetus of the SLL was dual: establishing it as a research center with the highest standards of academic excellence and instilling it with a DNA for transdisciplinarity. In addition to the four new and brilliant EPFL professors hired between 2016 and 2018 in Fribourg, a specialized group named Building 2050 was established with the mission to co-develop, with all the researchers at the Smart Living Lab, the scientific foundations of a state-of-the-art design brief for the experimental building, with ambitions going beyond best practice.

To create a shared momentum, I initiated and led a collaborative project involving all three institutions of the SLL, whose students would form the "Swiss team" and participate in the U.S. Solar Decathlon 2017 competition. Together, they designed and built the NeighborHub, a solar-powered house not just self-sufficient but community-oriented. Featuring innovations like facade-integrated solar panels, water recycling, and smart energy management, the NeighborHub triumphed with 8 podiums out of 10, and came out first overall. Today, it stands proudly at Bluefactory, serving as a social and educational hub, inspiring local communities to adopt eco-friendly practices.

Based on the outcomes of a 5-year research programme coordinated by the Building 2050 group, an unconventional design competition was launched in 2018 involving a collaborative tender that invited multidisciplinary teams to reimagine sustainable construction and learn from each other's progress at the intermediate dialogues. The process emphasized early-stage whole-life carbon footprint minimization and adaptive spaces, resulting in four visionary proposals. The winning design, set for completion in 2027, will house cutting-edge labs, all embodying sustainability principles but with distinct and complementary areas of focus.

Another flagship achievement was to have enabled the launch and development of the SWICE project (2022-2029), funded by the Swiss Federal Office of Energy's SWEET program and bringing together 10 academic institutions and about 30 partners from the public and private sectors across Switzerland. All members of this large consortium have joined forces on exploring how lifestyles and work habits can evolve into more energy-conscious ones while making the changes acceptable or even embraced by the population, through pilot tests in living lab environments.

The Smart Living Lab isn't just a research center; it's a movement proving that thoughtful innovation can create harmonious, efficient habitats. Here's to the next 10 years of transforming dreams into reality!

Joint Steering Committee

Composition of 2024

Canton of Fribourg

Olivier Curty
State Councillor,
Director of Economy
and Employment,
Co-chair of the Joint
Steering Committee

Sylvie Bonvin-Sansonnens
State Councillor,
Director of Public
Education and Culture

Jerry Krattiger
Fribourg Development Agency,
Department of Economy
and Employment

EPFL

Matthias Gäumann
Vice President for Operations,
Co-chair of the Joint
Steering Committee

Jan Hesthaven
Vice President for
Academic Affairs

Ursula Oesterle
Vice President
for Innovation

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

HEIA-FR

Jean-Nicolas Aebischer
Director

Unifr

Katharina Fromm
Rector

The chairpersons are identified with an orange circle.

Executive Committee

EPFL

Marilyne Andersen
Academic Director
of Smart Living Lab
Co-chair of the
Executive Committee
until April 1st, 2024

Corentin Fivet
Head of Structural
Xploration Lab (SXL),
Academic Director
of Smart Living Lab,
Co-chair of the
Executive Committee
since April 1st, 2024

Dusan Licina
Head of Human-Oriented
Built Environment Lab
(HOBEL)

Martin Gonzenbach
Director of Operations
EPFL Fribourg and
Smart Living Lab,
Co-chair of the
Executive Committee

HEIA-FR

Jean-Philippe Bacher
Smart Living Lab HEIA-FR Manager

Unifr

Hans-Georg Fill
Head of Digitalization and
Information Systems Group (DIGITS),
Smart Living Lab Unifr Manager

Canton of Fribourg

Jerry Krattiger
Fribourg Development Agency,
Department of Economy and Employment

Scientific Commission

EPFL

Marilyne Andersen
Academic Director of Smart Living Lab
Chair of the Scientific Commission
until April 1st, 2024

Corentin Fivet
Head of Structural Xploration Lab (SXL),
Academic Director of Smart Living Lab,
Chair of the Scientific Commission
since April 1st, 2024

Dusan Licina
Head of Human-Oriented Built Environment Lab (HOBEL)

Dolaana Khovalyg
Head of Laboratory of Integrated Comfort Engineering (ICE)

Andrew Sonta
Head of Civil Engineering and Technology for Human-Oriented Sustainability (ETHOS)

Sergi Aguacil
Head of Building2050 Group (BUILD)

HEIA-FR

Jean-Philippe Bacher
Smart Living Lab
HEIA-FR Manager

Patrick Favre-Perrod
Head of ENERGY Institute

Séréna Vanbutsele
Head of TRANSFORM Institute

Fabienne Favre Boivin
Head of iTEC Institute

Unifr

Hans-Georg Fill
Head of Digitalization and Information Systems Group (DIGITS),
Smart Living Lab Unifr Manager

Denis Lalanne
Head of Human-IST Institute

Martin Beyeler
Professor, Institute for Swiss and International Construction Law

Bernard Ries
Head of Decision Support & Operations Research Group (DS&OR)

Smart Living Lab

Research and development center for the future of the built environment

The Smart Living Lab is a joint project between the Canton of Fribourg, 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.

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. Smart Living Lab administrative and technical staff make sure that the research centre runs as smoothly as possible.

Research domains

Well-being and behaviours

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

Construction technologies

Monitor resource effectiveness and accelerate processes of change in construction.

Energy systems

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

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.

Research groups

PERSONALIZED COMFORT

Laboratory of Integrated Comfort Engineering (ICE)

Prof. Dolaana Khovalyg

REUSE

Academic Direction of Smart Living Lab, Structural Xploration Lab (SXL)

Prof. Corentin Fivet

INDOOR AIR

Human-Oriented Built Environment Lab (HOBEL)

Prof. Dusan Licina

HUMAN CITIES

Civil Engineering and Technology for Human Oriented Sustainability Lab (ETHOS)

Prof. Andrew Sonta

INTERDISCIPLINARITY

Building2050 Group (BUILD)

Dr. Sergi Aguacil

HEIA-FR
HTA-FR

SUSTAINABLE ENERGY

Institute of Applied Research in Energy Systems (ENERGY)
Prof. Patrick Favre-Perrod

TRANSFORMATION

Institute of Architecture: Heritage, Construction and Users (TRANSFORM)
Prof. Séréna Vanbutsele

BUILT ENVIRONMENT

Institute of Construction and Environmental Technologies (iTEC)
Prof. Fabienne Favre Boivin

DIGITALIZATION

Digitalization and Information Systems Group (DIGITS)
Prof. Hans-Georg Fill

DECISION SUPPORT

Decision Support & Operations Research Group (DS&OR)
Prof. Bernard Ries

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RULES

Institute for Swiss and International Construction Law
Prof. Martin Beyeler

INTERACTION

Human-IST Institute (Human Centered Interaction Science and Technology)
Prof. Denis Lalanne

Retrospective 2014–2024

2014

» EPFL and the State of Fribourg sign an agreement on the creation of the EPFL Fribourg campus and the Smart Living Lab (SLL)

© Canton de Fribourg

» Launch of the "Building2050" research program aimed at providing the teams behind the design and planning of the future SLL building teams with approaches to advance the project's ambitious sustainability goals

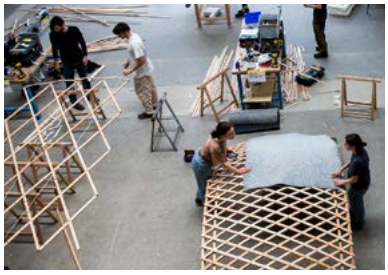
2015

» Arrival of the Smart Living Lab on the Bluefactory site, including the "Building2050" research program (dir. Thomas Jusselme) from EPFL, the ENERGY Institute (dir. Jean-Philippe Bacher) and TRANSFORM Institute (dir. Florinel Radu) from the HEIA-FR, and the three Unifr participating institutes: iimt (dir. Stephanie Teufel), Human-IST (dir. Denis Lalanne) and LAW (dir. Jean-Baptiste Zufferey with Martin Beyeler for the SLL) from Unifr

© Alain Herzog - EPFL

2016

» Creation of the PopUp workshop with a view to build a prototype solar house for the Solar Decathlon competition. Since then, it has been used as a space for the construction of building elements and even entire buildings for teaching and research purposes



© dr

» Professor Paolo Tombesi takes up his post as director of the Construction and Architecture Laboratory (FAR) at EPFL

2017

» Professor Corentin Fivet takes up his post as Director of the Structural Xploration Lab (SXL) at EPFL

» The Institute of Built Environment Technologies (iTEC), headed by Professor Daia Zwicky, integrates in the SLL

» Victory for the 250 students and 150 supervisors from the three institutions of the Smart Living Lab and HEAD in Denver (USA). Its NeighborHub project wins the Solar Decathlon

© Simon Pracchinetti

» Launch of Big Building Data (BBData) to develop a scalable cloud platform and tools for storing and processing data generated by the future Smart Living Lab building

2018

» Professor Dusan Licina takes up his post as director of EPFL's Human-Oriented Built Environment Laboratory (HOBEL)

» New mission for the Building2050 Group, led by Sergi Aguacil Moreno

» Professor Dolaana Khovalyg takes up her post as Director of EPFL's Integrated Comfort Engineering Laboratory (ICE)

» Return of Neighborhub to Fribourg. Will serve as an activator for the Bluefactory site

© Stemutz

» Energissima trade fair with SLL as guest of honor (March 2018)

» Creation of the Enoki start-up by Solar Decathlon participants

2019

» Public exhibition of the work of the collaborative "Parallel Study Mandate" (MEP), a novel competition to design the future SLL building

© Murielle Gerber

2020

» First edition of the ARC-HEST exchange program between the Smart Living Lab and universities in South Korea. Following fieldwork by Swiss students in South Korea in August 2019, their South Korean counterparts visit Fribourg in February 2020

© dr

» First doctorate completed at the SLL. Nineteen others will follow

» SLL hosts the first Perspectives event for the Fribourg business community

2021

» Appointment of Professor Séréna Vanbutsele as head of the TRANSFORM Institute

» Creation of Aeternum, a start-up developing a construction system using building slabs that can be adapted and reused over several life cycles in accordance with circular economy principles and thanks to technologies developed at the Smart Living Lab

» The DEMO-MI2 prototype pavilion is installed at several sites in the city of Fribourg to combat urban heat islands

© dr

» The SLL becomes a member of the European Network of Living Labs, EnoLL

2022

» Professor Andrew Sonta takes up his post as director of EPFL's Engineering for Human-Centered Sustainability (ETHOS) laboratory (1 September 2022)

» Appointment of Patrick Favre-Perrod as head of the ENERGY Institute

» Affiliation of the Digitalization and Information Systems (DIGITS) group, led by Professor Hans-Georg Fill, with the SLL

» Launch of the SWICE program with support from the Swiss Federal Office of Energy (SFOE) and coordinated by SLL. Its aim is to identify and quantify the potential for energy savings and improvements in quality of life that can result from new lifestyles and ways of working, changes in mobility behavior, and different economic models

© Alain Herzog – EPFL

» SLL affiliation of the Decisions Support & Operations Research (DS&OR) group, led by Professor Bernard Ries

» *Vivre Plus Mieux* and *Habiter Demain* exhibitions at the Smart Living Lab

2023

» The CISBAT international scientific conference is organized by the Smart Living Lab for the first time and attracts close to 400 attendees.

© Stemutz

» Appointment of Fabienne Favre Boivin as head of the iTEC Institute

2024

» Corentin Fivet succeeds Marilyne Andersen as SLL academic director

» Construction of the STEP pavilion facade prototype

© Alejandro Paz (EPFL PL-MTI)

» First edition of the MISTI Workshop, co-organized with the MIT Media Lab

Building2050 Group

"My team and I are making the Smart Living Lab a place where research, practice and common sense coalesce so that each phase of the building project becomes a scientific and collective experience and the buildings of tomorrow are co-imagined."

Sergi Aguacil Moreno
Doctor of Architecture Engineering, Head of the Building2050 Group (EPFL)

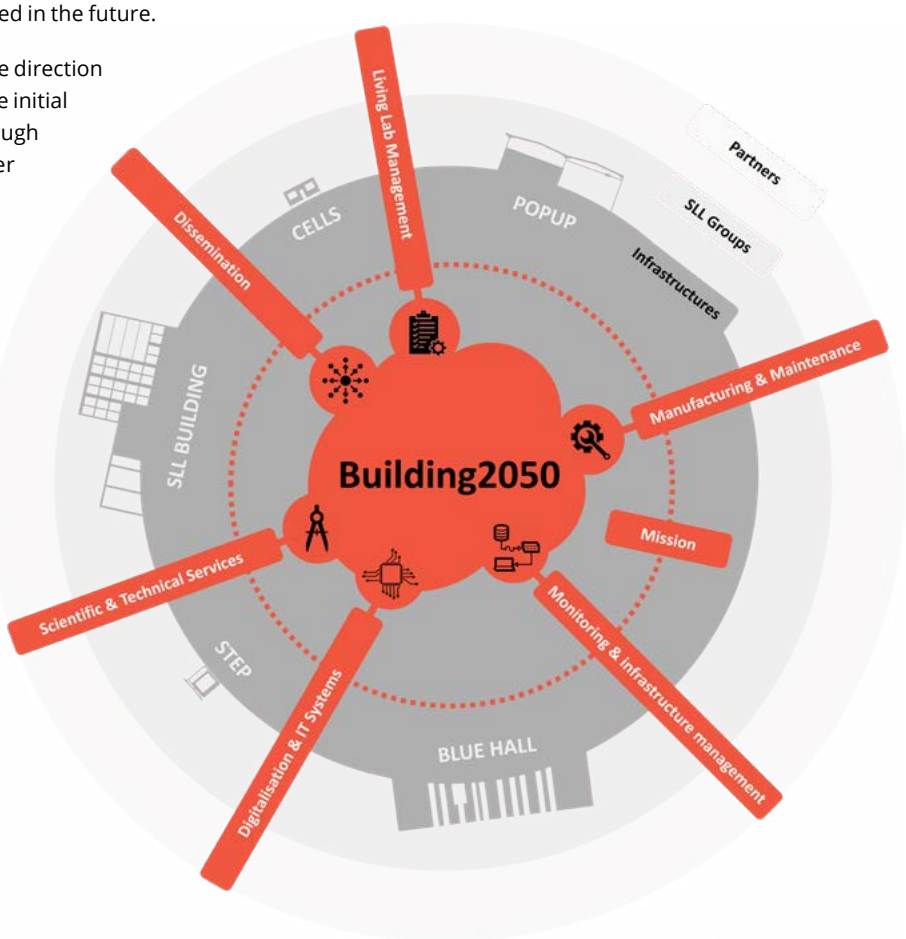
The Building2050 Group ensures that innovation and sustainability are an integral part of every stage of the Smart Living Lab (SLL) building's life cycle, from design to operation. Its principal mission is to guarantee consistency between academic research, architectural design and technical implementation so that the building functions as a living scientific instrument which benefits not only the SLL community but also its local and international scientific and industrial partners.

The Group is positioned at the interface between research, engineering, and operational practice and plays a central role in the development of the SLL. It coordinates interdisciplinary expertise, facilitates knowledge transfer, and designs experimental tools to anticipate how the building, which is designed as a standalone living lab, will be used in the future.

Building2050, which at the time was under the direction of Professor Thomas Jusselme, carried out the initial conceptual development of the building through applied research projects bringing together the three partner institutions: EPFL, HEIA-FR, and Unifr.

Since 2018, the Group, under the leadership of Sergi Aguacil (PhD in architecture engineering), has evolved into a hybrid unit specializing in living lab management. It therefore creates the conditions needed to carry out experiments under real-world conditions and coordinates the scientific, technical, and strategic aspects of the SLL building.

At the same time, it raises the visibility of the SLL among the international scientific research community through its publications and presentations at conferences and public events on subjects like codesign in architecture, digitalization and the reset of complex objectives like carbon budgets which factor in a building's entire life cycle. Research projects led by laboratories associated with the SLL also benefit from the Group's proactive support, especially on prototyping, 3D modelling and the writing of funding applications.



Assistance at every stage of the Smart Living Lab building project

Building2050 makes a major contribution to the development of the Smart Living Lab building through its participation in flagship projects. These run in parallel with the major phases of the building's life cycle – from the planning phase to day-to-day operations – and reflect the Group's integrated and collaborative approach to its scientific work.

1. Responding to research needs: from vision to planning

The Group acts as an interface between the scientific community and the project management teams to enable the translation of research needs into concrete and consistent technical specifications that can be integrated in the architectural plans. This mediation between the academic vision and practical constraints has produced a strategic deliverable, the Research Specifications, which ensures coherence between the scientific ambitions of the Smart Living Lab and the building's actual design.

2. Co-design of the building with local stakeholder input

By adopting a co-design approach, the Group is actively contributing to the detailed planning phase by working closely with the project owner, architects, engineers, and future users. It leads workshops given over to issues of particular relevance to the SLL building project, such as integrated photovoltaics, thermal and visual comfort, digital modelling and simulation, material circularity, as well as building performance and air quality monitoring. These exchanges enable the direct integration of research findings into planning decisions, which in turn makes the building a tool that evolves in line with academic needs.

3. Preparations for the use of the new building as a living laboratory

The Group is also involved in several applied research initiatives and projects to test the building's future infrastructure, fine-tune the technical specifications and anticipate its use as a scientific tool. The objective is clear: to ensure the Smart Living Lab offers an environment that supports experimentation under real-life conditions. This approach, based on evidence-based science and rooted in practice ('research by doing/by design'), aims to integrate innovation, performance and sustainability in every stage of the project lifecycle.

Through the combined use of design, co-design, and applied research practices, every member of the Building2050 Group plays their part in ensuring that the Smart Living Lab building becomes a living scientific instrument which is unique, rooted in local realities, and helpful to sustainability transition research.

Flagship projects

REFLEX

» Open-source virtualization platform. Enables real-time monitoring of energy and environmental data at the EPFL's Lausanne and Fribourg campuses to support the low-carbon management of these sites.

DARE – Data Assets for Research Experiments

» Structures the digital services of the future building by strengthening tool interoperability and optimises the management of experiment-generated data. It also includes several complementary modules:

- **APPLi**
  Connects sensors, databases, and immersive environments for the purposes of visualizing, analyzing, and controlling spaces remotely.
- **SUIVI**
  Digital monitoring of the construction site using a comprehensive recording system (drones, 360° cameras, timelapses, virtual tours).
- **HABLO**
  Measures space occupancy and comfort indicators in the Blue Hall building where the Group is currently based.

BIPV – Building Integrated Photovoltaics

» Supports the integration of photovoltaics in the planned building through advanced simulations, dedicated scientific expertise and close collaboration with contractors. This project is also laying the foundations for STOCKH_2, a seasonal cogeneration hydrogen storage system. This pilot installation has already been included in the building plans (at the level of plant room planning, safety, and system integration).

STEP – Sustainable Technologies Experimentation Pavilion

» A full-scale co-design and experimentation platform which hosts several project-related devices, including a circular demountable facade, a replica photovoltaic pergola, a weather station, and a network of data collection sensors.

Monitoring of photovoltaic performance on the STEP pavilion
© Alejandro Paz (EPFL PL-MTI)

A building ahead of its time

© Behnisch Architekten

The Smart Living Lab building is much more than just a building: it is a 5,000 m² inhabited research infrastructure designed to conduct advanced studies on human well-being, bioclimatism, and the ecological and energy challenges associated with the built environment.

The structure, whose construction began in 2025, is the result of collaboration between researchers from EPFL, HEIA-FR, and the University of Fribourg, as well as the construction company, the architect, and the engineers. This unique infrastructure – designed to adapt to future needs in order to remain at the cutting edge of technology and support innovation – will offer flexible spaces fully equipped with measuring instruments (and ready to accommodate additional ones in the future), enabling the assessment of the impact of real-life experiments.

Through its design and construction process, carried out with the involvement of its future users, the building already stands as an international reference in full-scale applied research, fostering knowledge transfer to the economic sector of the canton and beyond.

From the earliest phases, the design of the SLL building was guided by the objective of minimizing its carbon footprint across its entire life cycle. The proposed methodology set ambitious targets without imposing predetermined solutions. The building is now aiming for Minergie-A-ECO and SNBS Gold certifications. At every stage, decisions sought to reconcile scientific innovation, energy efficiency, and ecological exemplarity while taking technical and economic constraints into account:

- **Carbon footprint:** Minimization of CO_2 emissions, notably through the use of locally sourced wood and low-carbon concrete based on LC3 cement (developed by EPFL).
- **Modularity:** Easy interchangeability and reuse of materials.
- **Flexibility:** Adaptable functionalities, layouts, and configurations to meet evolving needs.
- **Circularity:** Prefabricated wooden elements enabling disassembly and reuse at the building's end of life.
- **Bioclimatic design:** Winter gardens and a central atrium that promote natural ventilation and passive comfort management depending on the season.
- **Energy:** Use of the district's remote heating network and anergy grid powered by geothermal energy, along with electricity production via photovoltaic panels integrated into the thermal envelope.
- **Green and solar roof:** Plant evapotranspiration enhances photovoltaic performance, while alternating sun and shade supports biodiversity.
- **Water management:** Integration into the district's sponge-city concept for local management of rainwater and runoff. Valorization of urine as fertilizer, treatment of blackwater through vermicomposting, and phytopurification of greywater.

building.smartlivinglab.ch

2018
Preparation of the collaborative Parallel Studies Mandate based on Building2050 Group research during the 2014–2018 period

2019
Collaborative Parallel Studies Mandate and announcement of the winner

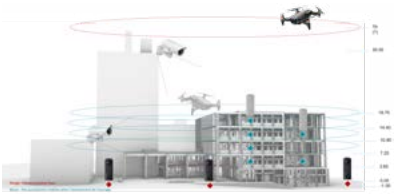
2020
Preparation of the preliminary project and detailed building plans that factor in the academic needs and environmental ambitions put forward by the Building2050 Group

2021
Call for tenders and contract awarded to JPF Entreprise Générale SA

2022
Building permit granted

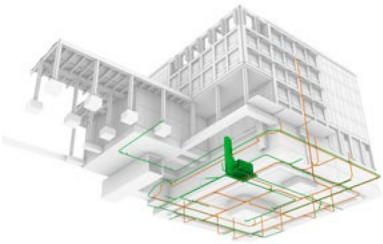
Experimenting and Demonstrating for Sustainability

The development of the building, conceived as a full-scale experimental tool, is part of an approach structured around several thematic axes coordinated by the Building2050 group, with the main ones outlined below.



A unique construction site charter that benefits the environment and research

The SLL construction site balances research and environmental needs through consumption and resource monitoring in real time and the continuous digital documentation of the building process in the form of images captured at regular intervals and using several techniques.



Radon: integrated strategy and continuous monitoring

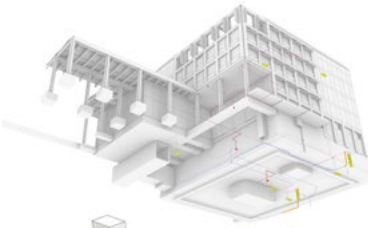
The SLL building project factored in radon risk management from the outset. This is reflected in the choices made regarding the building envelope, waterproofing and structural measures like gas drainage and a radon barrier membrane. A novel monitoring system will make it possible to track gas levels and evaluate the effectiveness of existing solutions thanks to measuring probes placed at different levels in the ground and in the building envelope. The monitoring data will also help advance research on radon and indoor air quality.

A demountable façade

The entire building uses a modular facade solution which features a certain number of demountable units. This will enable the damage-free testing, replacement and reuse of building elements. It will also facilitate experiments on the building envelope under real-life conditions.

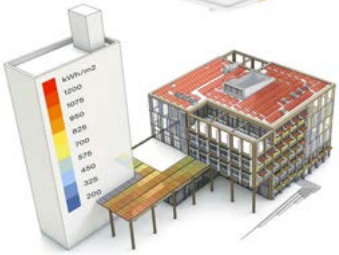
Digital twin: digitalize the construction and operational processes

BIM (Building Information Modelling) has been used since phase 51 of the project. The aim here is to provide users with high-quality, detailed 3D models which accurately replicate the real-life structure. These will facilitate the day-to-day running and monitoring of the building and assist research on digital practices.



A monitoring system that is useful for research

The building comes with a sensor system that tracks its performance. It was installed as soon as construction began. The flexibility of this infrastructure means that more sensors can be added at a later date to enable experiments under real-life conditions and provide data for applied research.



Integrated solar energy, storage and autarky

The building produces electricity for its own consumption thanks to a photovoltaic system which is demand- and context-optimized and seamlessly integrated in the architecture. It is also connected to a storage system that will evolve over time into an innovative hydrogen-based cogeneration system. The aim here is to achieve 50–60% energy self-sufficiency while meeting Minergie-A label standards.

2023
Project consolidation, including integration of optimization proposals submitted by the Building2050 group

2024
Development of implementation plans

2025
Construction work begins

2026
Construction continues

2027
Closeout and commissioning

First Steps of the Smart Living Lab Building Construction Site

From earthworks to sensor installation, here is a chronological overview of the first stages of the Smart Living Lab building construction site. Launched in January 2025, this initial phase incorporates measurement systems to support scientific research.

January-May 2025

» Earthworks

» Installation of geothermal probes

» Water and radon drainage

» Installation of radon and humidity measurement probes in the natural ground

May-July 2025

» Foundations

» Reinforcement and concrete pouring of the basement slab

» Installation of radon measurement probes and temperature sensors in the slab insulation

July-September 2025

» Basement walls

» Start of vertical cores and installation of prefabricated concrete columns

» Reinforcement and installation of embedded electrical systems in the ground-floor slab

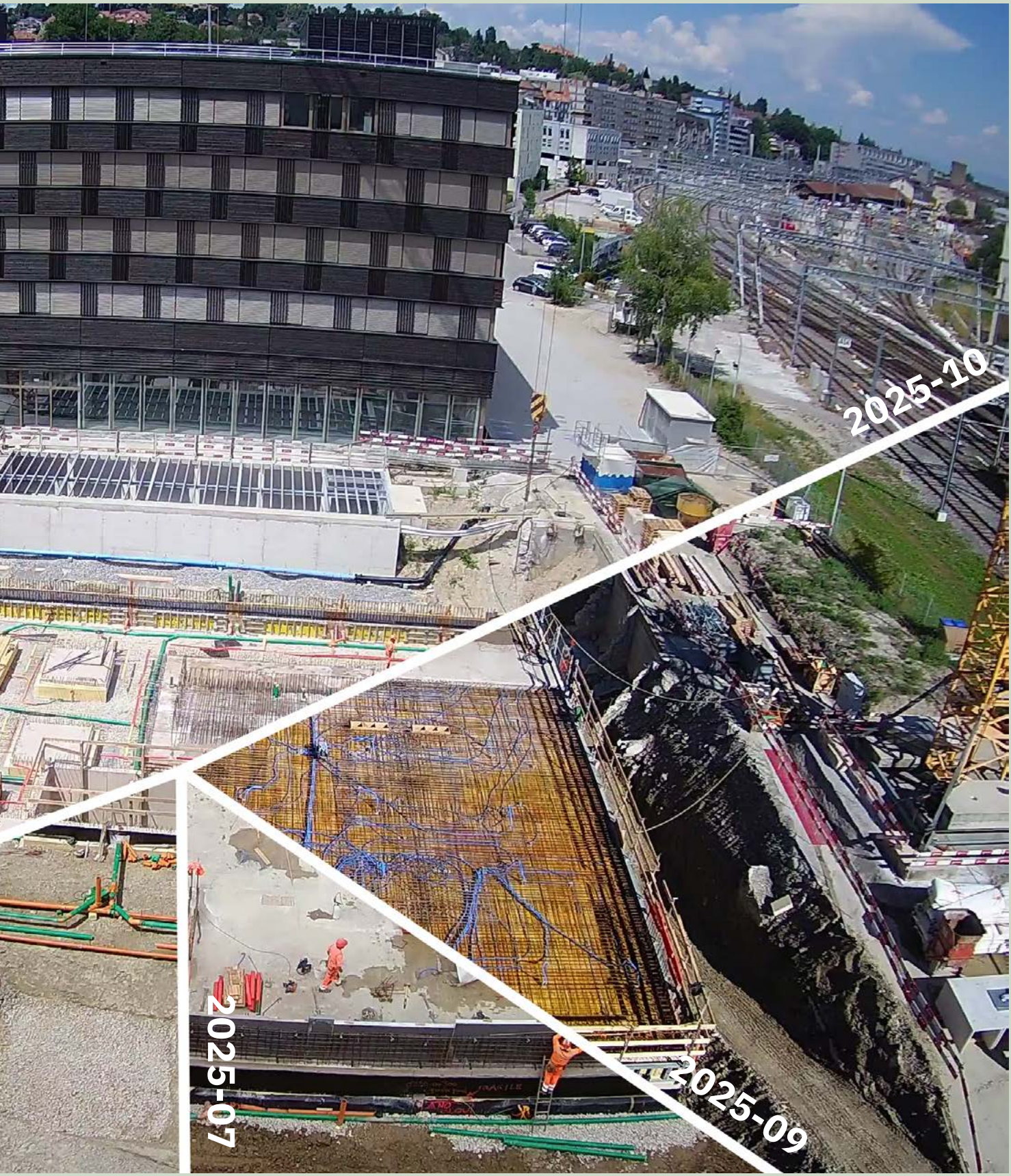
September-October 2025

» Pouring of the ground-floor concrete slab

» Installation of temperature sensors in wall insulation

» Installation of radon and humidity measurement probes around the building

» Backfilling and installation of radon drainage around the perimeter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Collaboration with the JPF Group

"Building this kind of iconic structure is a showpiece for us"

Daniel Kolly
Architect and Project Manager, JPF General Contractor SA

Embarking on a construction project as unique and complex as the Smart Living Lab building is not for the faint-hearted. The project's general contractor JPF SA has no regrets about taking on this challenge. Between two site meetings with the Building2050 team, Daniel Kolly, the SLL project manager at JPF and HEIA-FR alumnus (architecture), found time to talk to us about the reasons why his company, based in the Fribourg town of Bulle, wanted to be involved in the innovative and complex project. He also discusses the obstacles along the way, particularly the repercussions of the Covid-10 pandemic and the war in Ukraine, as well as the positives of the JPF-SLL partnership.

Why did JPF bid for the SLL building contract?

Building this kind of iconic structure is a showpiece for us. Working on a high-spec project like the SLL raises our profile and demonstrates our expertise. The project also represented an economy of scale opportunity because we were also the general contractor on Building B (editor's note: the first new build on the Bluefactory site. It is next to the future SLL building and was completed in 2024) and this would allow us to pool resources. However, the hoped-for economy of scale did not materialize because building work began two years later than planned due to the Covid pandemic and the war in Ukraine.

Did this delay cause any problems?

Far from it. The delay gave us more time to gain a better understanding of users' needs. We had a series of additional meetings with teams from the Building2050 Group to discuss specific issues. We then instructed our contractors based on the outcomes of these talks. We also used the extra time to hire a Building Information Model (BIM) manager as well as an environmental engineer to advise on sustainability issues. We would have had to bring these people on board sooner or later, but the delay was a chance to involve them from the get-go rather than muddling through until the time came to recruit them. We are now perfectly on schedule thanks to all this preliminary work.

However, this preliminary work was still necessary given the project's complexity, wasn't it?

As this is a prototype building, it is undoubtedly the most challenging project I have worked on since I joined JPF a decade ago. There were many more details to discuss, and consensus had to be systematically reached between the stakeholders: researchers, architects, civil engineers, contractors and external heating, ventilation and electricity companies. It's a meeting of different worlds that don't quite speak the same language. But I would like to point out that we enjoyed a very constructive working relationship.

Dialogue is key to addressing the challenges involved in such a building project. Can you give us some specific examples?

From an environmental perspective, we have to manage the quantity of materials arriving and leaving the site. As part of the digital monitoring of the project, we have to provide information on the number of workers, the type of machinery, as well as our water and fuel consumption. Our environmental engineer will be able to analyze the monitoring data and ultimately propose solutions or improvements for future building projects.

You had the tricky job of taking care of the various integrated elements that will used by the researchers, right?

We have to make sure that the on-site workers don't damage the multiple data collection sensors. We are aware that the building will be used first and foremost as a research facility. We are therefore doing everything we can to make sure that it is fit for purpose.

Partnership with Bluefactory

"We want an innovation district that the people of Fribourg can be proud of"

Philippe Jemmely
Director of Bluefactory Fribourg-Freiburg SA

There is perhaps no-one better placed to discuss the site and its buildout over the last 10 years than Philippe Jemmely. In 2016, the Fribourg native and EPFL alumnus (materials science and engineering) was named as the new director of Bluefactory Fribourg-Freiburg SA (BFF), the company which owns, develops, and runs the eponymous site. Jemmely is full of praise for the innovation district and especially for the three universities working there. He sees the Bluefactory–Smart Living Lab partnership as not only an incredible opportunity to exploit the full economic potential of the former Cardinal Brewery site but also a real boom for Fribourg society generally.

It has been 10 years since the Smart Living Lab arrived on the Bluefactory site. What are your main takeaways from the last decade?

Since EPFL arrived in Fribourg in 2014, the innovation district has forged an identity which is deeply connected to the habitat of the future. This ecosystem has facilitated the emergence of start-ups like YORD and Enoki and attracted established companies like Bcomp and Climate Services. The EPFL's Centre for Worldwide Sustainable Construction (editor's note: the CWSC, which was founded in 2024, has bases in Lausanne and Fribourg and a solid network of international partners) will further strengthen this ecosystem when it moves to the BFF site. Its presence constitutes an amazing asset for the canton and its building sector which currently employs 13,000. Given the environmental challenges facing the planet, increasing attention is given to climate-sensitive renovation strategies. The BFF and its stakeholders are well-equipped to tackle this issue head on.

What is the most powerful symbol of the SLL–BFF partnership?

It is, without a doubt, the synergy between EPFL, the HEIA and the University of Fribourg, and all the collaborative projects that have ensued! These include NeighborHub, technology transfers with Fribourg companies, and radon experiments. Of course, there is also the iconic SLL building, which epitomizes this collective knowledge and spirit of collaboration and will add a laboratory dimension to the site.

Is this zero-carbon building which operates according to circular economy principles, an asset for the site? If so, why?

The flagship SLL building boosts the credibility of the BFF site and allows us to draw on the research that informed its design. For example, all the ideas that came from the Building2050 group as well as Thomas Jusselme's work on energy-efficient buildings also informed the design and planning of Building B (editor's note: the first new build on the Bluefactory site was finished in 2024 and is next door to the future SLL building). To minimize transport emissions, the soil excavated from the Building B plot was kept on site.

How does Bluefactory support the Smart Living Lab?

We try to be the best host we can be by providing our tenants with the conditions they need to accomplish their mission and being as responsive as possible to their needs. We also make certain spaces available for experimental work, such as the PopUp workshop and the facade prototype pavilion. We also raise political and public awareness of the SLL's work and achievements.

What are your hopes for the next 10 years?

Our goal is to successfully integrate the site in the urban landscape. We want it to become Fribourg's 13th district and a place where private and commercial residents live side by side. We want an innovation district that the people of Fribourg can be proud of, just as the people of Valais are proud of their Energypolis Campus (editor's note: an innovation park in Sion that brings together EPFL and the HES-SO Valais–Wallis). My ultimate dream would be for Fribourg to realize that the presence of the Smart Living Lab and EPFL constitutes an exceptional gateway to the world.

Events

The Smart Living Lab regularly helps to create dialogue on sustainable habitat-related issues and demonstrate its core competencies and expertise in these areas. It hosts and (co-)organizes local, national and international events, and participates in conferences, other forums and trade fairs. Below are some of the notable public, scientific, and trade events that the SLL has attended over the last decade.

CISBAT

In 1991, the Solar Energy and Building Physics Lab (LESO-PB) at EPFL organized and hosted the first scientific conference for a Sustainable Energy Transition in the Built Environment (CISBAT). In 2023, the Smart Living Lab took over the running of this international event. With the support of the Swiss Federal Office of Energy (SFOE), CISBAT 2023 brought 400 researchers together to discuss operations, well-being and circularity, the three main strands of the SLL's work. Plenary lectures, workshops, presentations, posters, and a visit to the SLL site encouraged interdisciplinary dialogue, which led to the publication of close to 300 open-access articles in the Journal of Physics: Conference Series. A follow-up conference, again organized by the SLL, was held in 2025.

www.cisbat.epfl.ch

© dr

Energissima

Energissima is a trade fair that focuses on energy solutions and sustainable technologies and is held at the Espace Gruyère in Bulle. The Smart Living Lab has participated twice. In 2018, it attended the event for the first time and was its guest of honour; its self-made, zero-carbon stand was a nod to circular economy principles, as it was constructed from wood panels left over from the NeighborHub project, a solar-powered house designed by a team of students which won the 2017 Solar Decathlon in Denver. In 2022, EPFL's Energy Centre presented a model of the future Smart Living Lab building while several HEIA-FR institutes, including ENERGY and TRANSFORM which are affiliated with the SLL, shared details of the research projects they were working on.

© Stemutz

© Stemutz

JAU-NE

The Smart Living Lab was the academic partner of the 2019 Neuchâtel Architecture and Urban Planning Day (JAU-NE). The SLL presented its research projects and interactive demonstrators, including the Crowd Energy game which shows how to buy, generate, store, and sell energy at a neighborhood scale, and CityPulse, a dynamic urban planning tool. The event was also an opportunity to showcase the NeighborHub model and screen a film about the future SLL building.

Perspectives

Organized by the Smart Living Lab in partnership with the Fribourg Economic Development Agency in 2020 and 2022, the Perspectives event brought together companies from the canton of Fribourg to explore research and development opportunities in collaboration with Smart Living Lab researchers. The program featured testimonials from entrepreneurs who successfully carried out joint projects, and a dedicated research marketplace fostered new exchanges between the academic, professional, and industrial communities around the Lab's ongoing initiatives.

© Nicolas Brodard

KidsUni

The Smart Living Lab regularly hosts “KidsUni” workshops in partnership with the University of Fribourg. These events give children aged between 9 and 11 an opportunity to discover how to design low-carbon buildings using virtual and augmented reality tools, how to build small, full-scale structures from environmentally friendly materials, and how mathematics plays a role in decisions that affect our way of life.

© Justine Roman

Explora

Four University of Fribourg research groups, which are also affiliated with the Smart Living Lab, regularly participate in “Explora” open days, including the 2023 edition. These events are a unique opportunity for the researchers to share their work on sustainable construction solutions with the public at large.

© Sonia Villegas

© dr

EPFL Open Days

The EPFL Open Days provide the Smart Living Lab with a valuable platform to show the public why the work of SLL-affiliated EPFL research groups matters. These events are also an opportunity to highlight the prominent role that the SLL plays within ENAC.

TRANSFORM Round Tables

Since 2022 the Smart Living Lab has hosted a series of round tables organized by the TRANSFORM Institute in collaboration with the HEIA-FR and the magazine Tracés. This series of discussions, entitled “Everything transforms”, explores different themes in relation to architectural and urban planning transformation: from the evolution of teaching practices and the future role of architects to the renovation potential of existing building stock. Three sessions were held in 2024. The first looked at architectural experiments under real-life conditions, their educational potential and implications for the project process. The second explored urban building projects in iconic locations where transformation processes are under way. The discussions centered around the balancing act between repairing and enhancing what is already there and forward-looking and reasonable development. The final 2024 round table focused on the multiple challenges of guaranteeing good air quality in schools. From fall 2024, these discussions will take the form of a biannual transformation-themed symposium.

MISTI workshop

In January 2024, the MISTI workshop, co-organized by the SLL and the MIT Media Lab, brought together professors, researchers, and students to explore and discuss a range of subjects, including environmental sensing, comfort, data interaction, sleep optimization, rehabilitation, and augmentation. Drawing participants from various disciplines, the event became a melting pot of ideas, fostering rich discussions, and opening new avenues for built environment research. The follow-up workshop was held at MIT in November 2024.

© dr

Ten Smart Living Lab success stories

The success of this ambitious and unique scientific project is reflected in the many research projects that have helped to write the wider Smart Living Lab story. For this retrospective, we have chosen 10 stories, one for each of the years that the SLL has been in operation. While far from exhaustive, the selection is representative and illustrates the successful collaborations between the SLL's academic partners, its international reach, and the technology transfers between SLL research and industry.

NeighborHub: the first resounding collaborative success

1

Presentation of the NeighborHub before its departure for the Solar Decathlon © Alain Herzog - EPFL

As soon as it was established in Fribourg, the Smart Living Lab embarked on an incredible challenge: to enter the 2017 Solar Decathlon, a prestigious biennial international competition organized by the US Department of Energy. EPFL, HEIA-FR, Unifr, and the Geneva University of Art and Design (HEAD) put together a multidisciplinary team of 250 students and 150 supervisors from industry and academia. With financial support from close to 50 partners, the group created NeighborHub, a visionary solar house designed and built in Fribourg which addresses several sustainability-related themes, such as renewable energy, water management, waste management, material choices, and biodiversity. The goal of the project was to encourage the public to reduce its energy consumption and preserve natural resources. The structure was dismantled on site in Fribourg and shipped to Denver, Colorado where it was reassembled by 44 members of the team and exposed to freezing temperatures and severe storms. The judges were extremely impressed by the project and awarded it not only the top prize, but also first place in six out of the ten sub-competitions, and second and third places in the remaining two. The prizewinning NeighborHub returned in a blaze of glory to the Bluefactory site, where it now hosts repair cafés, urban gardening workshops, cooking classes centered around local, and seasonal produce, as well as conferences. At the same time, it continues to serve its scientific mission as a research prototype for energy management, comfort, and user interaction experiments. The project also inspired six of the Solar Decathlon team to create their own start-up. Founded in 2018, Enoki aims to facilitate the transition to sustainable lifestyles and improve residents' quality of life by creating neighborhoods that foster greater social interaction. The company is based at Bluefactory, in the "wood-ID" building. Constructed from indigenous timber and materials salvaged on site, the building has solar panels on the roof and uses a natural ventilation system.

PopUp Workshop: a unique place for experimentation and dialogue

ENAC Week © dr

When EPFL and HEIA-FR entered the Solar Decathlon competition, they had yet to find an adequate space where they could design the NeighborHub, the prototype that would lead the Swiss team to victory in the 2017 edition of the prestigious international competition. Luckily, part of the Blue Hall, the former storage warehouse of the Cardinal brewery and currently the temporary home of the Smart Living Lab, was already well equipped with a wide range of tools. And so the "PopUp workshop" was born. Over the years, it has become an important space for sustainable architecture experimentation, teaching, and research. Thanks to its vast size, spanning hundreds of square meters, and its carpentry, plastering, metalworking, and painting equipment, the workshop has everything that is needed to develop prototypes, construction elements (facades, roofs, structures), and even full-scale buildings. Every year, it hosts "ENAC Weeks", an educational program which brings together Bachelor's students from the three sections of the EPFL faculty to collaborate on joint projects. Among the many prototypes created at PopUp are RE:CRETE, a prestressed arch-shaped pedestrian bridge made from the walls of a building undergoing renovation, and the Demo-Mi2 climate pavilion designed to combat urban heat islands. The workshop also monitors and upgrades the SLL experimental infrastructure. This includes climate chambers capable of measuring the effects of specific environmental conditions on indoor air pollutant dynamics, ventilation, and thermal comfort, and the CELLS (Controlled Environments for Living Lab Studies) prototype, which is used to test different comfort conditions and degrees of automation using (in)direct solar exposure. Finally, the workshop contributes to the design and production of all the elements of the future Smart Living Lab building, which will be used for research purposes, such as radon probes and the paddles to monitor the thermal envelope. The workshop also hosts public events that explore the architecture of tomorrow.

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Vizcab: pioneering the carbon transition in construction

Thomas Jusselme presenting his research on building life-cycle analysis © Alain Herzog - EPFL

Vizcab is a platform designed to empower construction and real-estate professionals to decarbonize their building projects as quickly and as cost-effectively as possible. It is synonymous not only with the Smart Living Lab but also its co-founder Thomas Jusselme. Between 2014 and 2020, the lecturer and researcher at the Grenoble and Lyon Schools of Architecture took charge of EPFL's new "Building2050" research group, which is tasked with drawing up the guidelines on the design of the future Smart Living Lab building. During this period, he was working on his PhD thesis, which set out the data-driven method for low-carbon building design that he had developed based on life cycle assessment (LCA). Together with his business partner Guillaume Lafont, the scientist turned his method into a start-up, Vizcab, which is designed to be the fastest, most powerful, and collaborative platform of its kind in the field. It has since won multiple awards, such as the 2023 Microsoft Accelerator for Energy Efficiency for Vizcab Analytics, a comprehensive carbon emission tracking tool, and took home the top prize at the Urban TechChallengers competition in the "Building for the Future" category . Additionally, the company raised several rounds of funding, including €9 million in Serie A funding from prominent investors. This success underscores Vizcab's appeal and fit with industrial players. With the strengthening of the European regulatory framework through the EPBD, CSRD, and taxonomy to achieve carbon neutrality by 2050, international expansion is well within the company's reach. Vizcab is also the perfect example of successful transfers between Smart Living Lab research and the real economy. The same is also true of Thomas Jusselme himself, who is simultaneously co-CEO of Vizcab and professor of building energy efficiency at the ENERGY institute, which is part of the HEIA-FR and an SLL academic partner.

Aeternum: innovative solutions for sustainable construction

The Boat House © Aeternum

The mission of Aeternum is to develop versatile, reusable and carbon-neutral building solutions for real-estate owners. The start-up draws on research conducted by EPFL's Structural Xploration Lab (SXL) and HEIA-FR's Institute of Construction and Environmental Technologies (iTEC), both of which are part of the Smart Living Lab research ecosystem. Founded in 2020 by Alex Muresan, a research assistant at both institutes, and based in Zollikofen, Aeternum is a pioneer in the development of buildings with a modular, load-bearing structure that can be reconfigured easily and quickly to meet user demand. Standardized, sustainably manufactured components facilitate flexible and high-quality building spaces, unrestricted by column layout, slab shape, or floor plans. This efficient reuse strategy is also a welcome alternative for public authorities wishing to shrink their carbon footprint without incurring extra construction costs. A full-scale prototype at their base in Bern serves as a lab to experiment with interior finishes and run acoustic and thermal performance tests. It also provides the local community with a space where they can host events. "The Boat House" on the shores of Lake Zurich is the first complete building, designed, manufactured, and built using the Aeternum circular building system. The privately owned structure features the boathouse itself as well as a breakout area that doubles as a changing room. Aeternum is currently working on a series of other projects, including a school extension, a military barracks, and a seven-story office building. The start-up's work has attracted the interest of investors. In 2022, the company was selected as one of 130 applicants from 30 countries to join the Leonard's Acceleration Program led by the Vinci Group. It was also one of four winners of the NTN Innovation Booster for the Circular Building Industry which is supported by Innosuisse. In 2023, it gained further exposure through prominent investor events like Tech Tour Sustainable Construction Infrastructure and the EPFL Startup Champions Seed Night.

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Doctoral students: Swiss industry benefits from international talent

Since the Smart Living Lab was founded 10 years ago, 20 students have successfully completed their doctorates there. The fact that several of them come from abroad is proof positive of the SLL's ability to attract international talent. Many are now pursuing research careers at various universities across Switzerland, but quite a few have taken up key posts in in some of Switzerland's leading industries. This is the case for Seoyeon Yun, from South Korea, who completed her collaborative PhD at the HOBEL laboratory with support from the US multinational Honeywell. As she explains, this enabled her to "obtain scientific results in a real-world setting, which greatly enhanced the practical impact and applicability of my research." She now works at Smart Infrastructure, Siemens Switzerland AG, where she is a member of the Technology & Innovation team charged with developing the "Building X Comfort AI" software application to improve tenants' comfort and well-being. The AI-driven tool automatically optimizes indoor temperatures through the real-time monitoring of internal and external climate conditions, as well as the building's heating, ventilation, and air conditioning systems. Evangelos Belias, from Greece, also completed his thesis at the HOBEL laboratory with support from Estia SA. His PhD studies offered him a unique opportunity to better "understand the sustainability challenges that the building sector faces and gear my research towards practical solutions." He now works at Nestlé as a real estate and sustainability project manager. Evangelos attributes his career success to "the skills and experience gained while leading research and development projects at the SLL."

Professor Dusan Licina (far left) with doctoral students Seoyeon Yun (center) and Evangelios Belias (right) © dr

Towards 2050: quality publications that showcase SLL's ambitious mission

Opening of the first two volumes of the "Towards 2050" series
© Thomas Delley

The "Towards 2050" publishing project traces the development of the Smart Living Lab's ambitious undertaking, from 2015 through to 2018. This major interdisciplinary project focused on the uses, performance, and life cycle of the future Smart Living Lab building, with the aim of establishing building specifications based on robust scientific research. In May 2019, the first two books in the series were published by Park Books, a Swiss publishing house renowned internationally for the quality of its architecture and urban planning publications. The work was led by EPFL professors Marilyne Andersen, then academic director of the SLL, and Emmanuel Rey*. Thinking, Visions for Architectural Design brings together the thoughts of 12 experts from around the world on the challenges of transforming architecture to meet its sustainability goals by 2050. Exploring, Research-driven Building Design presents the SLL research that helped inform the design of its iconic building currently under construction. Once completed, it will meet the environmental objectives of the 2050 Energy Strategy while providing optimal comfort and quality of use. The next publication will map the construction process, and the series will end with an evaluation of the building's post-occupancy performance.

*Emmanuel Rey, director of EPFL's Laboratory of Sustainable Architecture and Technologies (LAST) since 2010, was a member of the working group responsible for crafting the initial vision that led to the signing of a framework agreement between EPFL and the State of Fribourg. He was also the chair of the Smart Living Lab building Scientific Committee, and a member of the panel of experts for the collaborative design competition (MEP) for the future Smart Living Lab building (see Success Story No. 9. "Parallel study mandate" for the SLL building: a revolutionary approach)

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ARC-HEST: an exchange program that boosts SLL's international visibility

© Thomas Delley

Forging links between different disciplines and cultures around a shared commitment to imagining more sustainable, humane, and inspiring built environments is the mission of the ARC-HEST exchange program, successfully run by a team of researchers, including members of the Smart Living Lab. It all began in August 2019, when 30 Swiss students from EPFL, HEIA-FR, and Unifr, along with South Korean students from EWHA, Hanyang University, and SungKyunKwan University, first met in Seoul. In February 2020, a follow-up meeting was held in Fribourg. During their time together, the students of architecture, civil engineering, computer science, management, and environmental sciences analyzed the synergies between architectural design, human factors, and office building technologies, as well as their combined effect on indoor environmental quality and human-building interaction in the given cultural context. After a forced hiatus due to the Covid-19 pandemic, the program resumed in 2022–23, with another summer session in one of the two countries and a winter session in the other. The most recent exchange took place in 2024–25, combining, as always, lectures, workshops, and visits to notable buildings. In addition, students were split into multidisciplinary groups and tasked with designing a method for evaluating buildings while collecting, processing, and evaluating data from existing buildings. They subsequently used their observations to develop innovative solutions that optimize the quality of the built indoor environment and user satisfaction. Beyond providing a space for learning, ARC-HEST strengthens scientific and cultural cooperation between Switzerland and South Korea and helps the SLL consolidate its credibility on the world stage.

ENoLL: international recognition strengthens SLL's position

Members of the SLL at the OpenLivingLab Days in Barcelona in 2023, ENoLL's flagship event © dr

In spring 2021, the Smart Living Lab gained international recognition when it joined the European Network of Living Labs (ENoLL), the largest international network of its kind. Created in 2006 during Finland's Presidency of the Council of the European Union, ENoLL currently has 184 members from 41 countries worldwide, which range from municipalities and research institutes to companies and user communities. Its mission is to foster cooperation between network members who are united by their desire to make innovation an open and collaborative process which is user-centered and powered by experimentation under real-life conditions. Membership of such a prestigious network strengthens the SLL's position as a local driver of innovation at the intersection of research, technology, and society. This vast network also offers the Smart Living Lab new opportunities to cooperate and create synergies with other Living Labs and their partners around the world. Furthermore, ENoLL membership paves the way for knowledge- and practice-sharing, which in turn will enrich and advance interdisciplinary research in Fribourg.

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"Parallel study mandate" for the SLL building: a revolutionary approach

Once completed, the new Smart Living Lab building will be a beacon of innovation and sustainability. The uniqueness of this construction project required an equally unique tendering process, which would be disruptive and act as a catalyst for change. The State of Fribourg and Bluefactory Fribourg Freiburg (BFF) SA opted for a "parallel study mandate", a collaborative design competition which would see them work closely with architects, engineers, researchers and future users on the preliminary design of this experimental building. The approach was so novel that it raised serious concerns in the construction industry. However, the success of this multiphase process ultimately showed that the sector's fears were unfounded. The first phase, which began in 2018, consisted of an open call for tenders in accordance with public procurement rules. At the end of this phase, out of the 23 applications from five different countries, four multidisciplinary groups were chosen. The winning teams subsequently exchanged ideas with each other and with the panel of experts which was made up of architects, external and independent engineers, building specialists, representatives from BFF SA and the State of Fribourg, the SLL's academic partners, as well as SLL researchers and future users. After two rounds of participatory dialogue, each group presented its design proposals. In July 2019, the panel of experts unanimously awarded the tender to the HOP project, hailing its openness, user-friendliness, scalability, and integrative design. The proposal, which was developed by Behnisch Architekten, Drees & Sommer Schweiz AG, and ZPF Ingenieure AG, stood out from other projects thanks to its seamless combination of centrality of uses, potential for experimentation, and first-rate environmental performance.

The MEP award winners pose in front of the model of the HOP project © Stemutz

SWICE: a large-scale project to cut energy consumption

The Smart Living Lab's sustainability expertise is on full display in SWICE (Sustainable Well-being for the Individual and the Collectivity in the Energy Transition), a major eight-year research project funded by the Swiss Federal Office of Energy (SFOE) and coordinated by the SLL. The aim of SWICE, which launched in 2022 and will run until 2030, is to support the implementation of Switzerland's Energy Strategy 2050 by identifying and quantifying the potential of new ways of working and living, changes in mobility behavior and different economic models to reduce energy consumption and improve the population's quality of life. The project team works hand in hand with local stakeholders — residents, employees, property managers, businesses, and communes — in six Living Labs across the country, including the SLL and Fribourg's Schönberg neighborhood. These serve as testing grounds for observing, trialing, and co-developing actionable solutions in three areas which influence energy demand and supply management: the built environment, open spaces, and mobility. A total of 10 Swiss universities and four research and consulting firms are involved in this ambitious research project, and benefit from the support of over 25 public and private partners. SWICE leverages the participants' collective expertise in sociology, engineering, mobility, architecture and social psychology to design a high-quality sustainable new way of life that optimizes individual well-being while promoting resource conservation.

www.sweet-swice.ch

© Thomas Delley

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Participants in a workshop of the SWICE Program © Thomas Delley

EPFL

A world-class institution that puts Fribourg on the map

© Stemutz

The *École polytechnique fédérale de Lausanne*, better known by its acronym EPFL, is one of Switzerland's two federal institutes of technology. The second is ETHZ, in Zurich. EPFL ranks among the best universities in the world, and its stellar reputation attracts top scientific talent from around the globe.

Teaching and research activities concentrate on engineering, natural sciences, architecture and mathematics, and interdisciplinarity is actively encouraged. Bachelor's and Master's level teaching takes place on the main EPFL campus on the shores of Lake Geneva, which hosts 14,000 students from 130 countries.

Since the 2010s, EPFL has been developing a network of associated campuses in the cantons of French-speaking Switzerland. Primarily research facilities, these "satellites" contribute to the core missions of EPFL and their work tends to focus on issues of relevance to the region where they are based. Partnerships have been established in each canton so that local ecosystems also benefit from EPFL's strengths and reputation.

EPFL Fribourg increasingly specializes in research on the built environment. It has four laboratories, each of which are led by a professor and attached to the School of Architecture, Civil and Environmental Engineering (ENAC) based at the main Lausanne campus.

This establishment of a permanent campus in Fribourg led EPFL, in partnership with the State of Fribourg and the canton's higher education institutions, to set up the Smart Living Lab. This move is also part of the redevelopment of the former Cardinal brewery site into an innovation district. Bluefactory, as the site is now known, is part of the Switzerland Innovation Park West network.

EPFL is responsible for the academic, operational and administrative management of the Smart Living Lab. While the Smart Living Lab building is under construction, EPFL Fribourg is based at temporary premises on the Bluefactory site.

Expansion plans are already in the pipeline for EPFL Fribourg. Although currently not as large as other EPFL campuses, Fribourg manages to offer unique opportunities and infrastructure to support a range of research activities, including the construction of large-scale prototypes and project-based learning. For example, students can work on their practical project ideas in the EPFL Fribourg prototyping hall ("PopUp workshop"), where technical staff are on hand to assist and supervise their activities.

→ **SXL Laboratory**

→ **HOBEL Laboratory**

→ **ICE Laboratory**

→ **ETHOS Laboratory**

A decade of service and innovation at the Smart Living Lab

An award-winning project made in Fribourg

The successful participation of NeighborHub team in the 2017 Solar Decathlon was the first time that the Smart Living Lab's academic partners worked together on a large-scale project. Since its return to Fribourg in 2018, the prizewinning solar-powered structure has served as a sustainable housing demonstrator and an activator for the entire Bluefactory district.

Students with an eye for business

Students who worked on Solar Decathlon have turned their project experience into a start-up. Enoki, as they have named their firm, specializes in architectural and sustainable neighborhood projects. The start-up has developed a modular timber construction system, which is already used in one of Bluefactory's impressive new builds. Fittingly, that building is also the start-up's headquarters.

Brain gain for Fribourg and Switzerland

EPFL recruits top scientific talent from around the world to work as professors, doctoral students and postdoc researchers at its Fribourg campus. Many of these cutting-edge researchers go on to make significant contributions to the regional and national economy. Others take up professorships at the HEIA-FR and leverage their position to strengthen academic ties between their home institution and EPFL.

Trailblazing researchers

Two of the four tenure track assistant professors at EPFL Fribourg have already been promoted to full assistant professors. Each one oversees their own research group and cutting-edge experimental facilities, providing them with the conditions they need to make major contributions to their field and generate new insights that drive technological innovation and advance professional practice. One indicator of the research excellence of EPFL Fribourg is the number of Swiss National Science Foundation grant recipients on its team.

Large-scale national projects

The SWICE research consortium, which is funded by the Swiss Federal Office of Energy (SFOE) as part of its SWEET program, was the brainchild of Professor Marilyne Andersen from the Smart Living Lab. She also served as its scientific coordinator until spring 2025.

International partnerships of national importance

Research projects with a global reach benefit from the exceptional input of EPFL Fribourg scientists. These include projects supported by the European Commission (Horizon Europe), assignments from the International Energy Agency, bilateral programs with the USA and South Korea, as well as development cooperation and humanitarian initiatives (e.g. ICRC, MedAir, SDC).

Fribourg campus: a local "satellite" with a vast skill pool

EPFL drew on its collective skills and expertise to establish and develop its Fribourg campus. For example, more than 100 members of EPFL staff were involved in the design of the SLL building. They included researchers based at the main Lausanne campus, as well as architects and laboratory construction specialists.

Highlights 2024

ENAC Fribourg grants

» The ENAC faculty has launched four new multiannual research projects involving laboratories based at the EPFL Lausanne campus and non-academic partners based in Fribourg.

New academic director

» On 1 April 2024, a decade on from the creation of the Smart Living Lab, Professor Marilyne Andersen handed over her academic director baton to Professor Corentin Fivet. In 2016, the Belgian architectural engineering graduate left MIT, in Boston, to take up a tenure-track assistant professor post in architecture and structural design at EPFL. He was one of the first professors hired by EPFL for its new Fribourg campus. In 2023, he was promoted to Assistant Professor.

Construction of the Swiss Solar Boat and RebuiLT Pavilion

» Students from the SwissSolarBoat team spent the entire summer of 2024 in EPFL Fribourg's PopUp workshop building the hull and floats of their solar-powered, hydrogen-fueled hydrofoil. Supported by EPFL as part of its MAKE program which promotes project-based learning, this impressive feat of engineering is set to take part in an international competition.

RebuiLT, another MAKE project led by EPFL Fribourg, sees students construct a pavilion from concrete reclaimed from a building undergoing demolition.

RebuiLT Pavilion © Solène Hoffmann

HEIA-FR

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

Pursuit of engineering and architectural excellence since 1896

© Sonia Villegas

For over 125 years, the School of Engineering and Architecture of Fribourg (HEIA-FR) has been producing engineers and architects who have dedicated their careers to addressing technological challenges and issues facing contemporary society.

The HEIA-FR is a bilingual higher education institution which runs Bachelor's programs in six fields: architecture, chemistry, civil engineering, electrical engineering, mechanical engineering, and computer science and communication systems. It also partners with the University of Applied Sciences and Arts Western Switzerland (HES- SO) to offer four Master's programs. The HEIA-FR is noted for its interdisciplinary approach and close ties to the worlds of industry and research.

The HEIA-FR's research institutes and competence centers actively work with regional economy players in three key areas: industrial technologies, construction and the environment, and information and communication technologies.

With its professional degree programs, research aligned with the needs of the economy, a bilingual learning environment, a modern infrastructure and an excellent location, the HEIA-FR is the partner of choice in western Switzerland when it comes to innovation and technical training.

→ **ENERGY Institute**

→ **TRANSFORM Institute**

→ **iTEC Institute**

A decade of service and innovation at the Smart Living Lab

The HEIA-FR has played a pivotal role in the development of the Smart Living Lab (SLL) since its inception 10 years ago. The School of Engineering and Architecture of Fribourg has helped to structure ambitious interdisciplinary research, set up novel experimental infrastructures and forge strong links with academic, economic and public circles.

From the outset of the SLL project, the HEIA-FR has been actively involved in defining the vision and structure of the new center of expertise. The creation of this one-of-a-kind research program has brought institutes together and provided conditions conducive to interdisciplinary collaboration, one of the core tenets of the Smart Living Lab.

The move to the Blue Hall, at the heart of the Bluefactory site, was a milestone in the history of the SLL. The opening of the PopUp workshop provided new experimental spaces where research teams can test and prototype their solutions under real-life conditions. This addition has also raised the visibility of the Smart Living Lab among its partners and the public at large.

The NeighborHub project, which won the Solar Decathlon, was the perfect showcase of the institution's interdisciplinary expertise. This living laboratory made it possible to test practical sustainable housing solutions and raise wider awareness of the challenges involved in successfully transitioning to cleaner sources of energy.

As evidenced by its call for renovation-specific projects, the creation of living labs and participation in the SFOE-funded SWICE program, the HEIA-FR has structured its research activities around unifying themes. This dynamism has generated collaborative projects and improved the scientific consistency of the Smart Living Lab's work.

Leveraging the structuring capabilities of these unifying themes has created synergies between disciplines and facilitated a joined-up response to the challenges of urban sustainability. Thanks to this approach, the teams from the HEIA-FR have consolidated their position and developed skills sought after by their external partners.

Active participation in the Parallel Study Mandate has made it possible to co-create an ambitious roadmap for the design and development of the Smart Living Lab building that effectively meets future users' needs. The facility will provide SLL research teams with the infrastructure they need to test their solutions under real-life conditions.

Over the years, the HEIA-FR has reinforced its in-house capabilities and stepped up its collaboration with the public and private sectors. These synergies have allowed the School of Engineering and Architecture to develop innovative, high-impact projects that bring the vision of a more sustainable society closer to reality.

SLL booth at the Energissima 2018 exhibition 2018 © Stemutz

Highlights 2024

3DReStruct

» Use of additive manufacturing techniques to reinforce metallic structures

BLAREC

» Building LCA data exchange: a first Swiss carbon performance framework for reporting and capitalization.

Eval2Rn

» Tool for the pre-construction and pre-renovation assessment of the radon risk

LIFS

» Multi-criteria assessment of floor construction systems and establishment of principles to reduce their environmental impact


Workshop InnovationBooster Living Labs for decarbonisation © Thomas Delley

Unifr
Interdisciplinarity and Innovation

UNIVERSITÉ DE FRIBOURG
UNIVERSITÄT FREIBURG

© Sonia Villegas

The University of Fribourg (Unifr) continues to play a central role within the Smart Living Lab, combining excellence in teaching and research with a strong interdisciplinary vision. Since 2022, Unifr has been represented in the Lab through four entities: the Human-IST Institute, the Institute for Swiss and International Construction Law, and the research groups Decision Support and Operations Research (DS&OR) and Digitalization and Information Systems (DIGITS). Together, they provide cutting-edge expertise at the intersection of law, digitalization, decision sciences, and human–technology interaction.

> The first institutes of the University of Fribourg involved in the founding vision and the establishment of the inter-institutional collaboration of the Smart Living Lab were the International Institute of Management in Technology (iimt), the Human-IST Institute, and the Department of Law of the University of Fribourg. During its early years, the iimt played a leading role in establishing Unifr's presence in the Lab and advancing research on consumer behavior, innovation, and technology management. In 2022, following iimt's departure, Professors Hans-Georg Fill and Bernard Ries took over coordination, while the integration of DIGITS and DS&OR consolidated Unifr's digital strategy and further broadened its interdisciplinary scope.

→ **Institute of Swiss and International Construction Law**

→ **Human-IST Institute**

→ **DIGITS Group**

→ **DS&OR Group**

The four current research units contribute to a deeper understanding of how people interact with digital systems and the smart living environment, developing innovative approaches in fields such as human-building interaction, virtual and augmented reality, immersive wellbeing and education, logistics, decision-making support, and the legal framework of construction and procurement. By combining perspectives from computer science, social sciences, technology, and law, Unifr actively fosters innovation while reinforcing interdisciplinarity.

Highlights of recent years include the development of AirSpecs, smart glasses co-created by Human-IST and the MIT Media Lab, capable of monitoring user comfort in real time and tested internationally and the comfortBox developed in collaboration with Logitec; new virtual reality tools for immersive wellbeing and 3D education formats, developed in collaboration with EPFL and other partners; and logistics and waste collection optimization projects by DS&OR, which address real-world challenges in urban management. The DIGITS group has strengthened international ties through exchanges and collaborations in augmented and virtual reality, while Human-IST has contributed to large-scale projects such as ARC-HEST, MITSI and SWICE, bridging Swiss and international research communities.

A decade of service and innovation at the Smart Living Lab

Human-Building Interaction & sustainability

Actively contributing to research in the domain of human-building interaction (Human-IST), comfort, well-being, and sustainability in the smart living environment through cutting-edge technologies is a key research focus. Flagship projects such as AirSpecs, ComfortBox, Immersive 3D videos, and Lucideles illustrate these innovative efforts.

Impactful international events

The Law group has played a key role in organizing major conferences and symposia, including the Swiss Public Procurement Conference and the SIA 2065 symposium, which brought together hundreds of experts from academia and industry.

Knowledge transfer & training

Knowledge transfer is a cornerstone of our mission. Through CAS programs, iimt's executive education, and outreach initiatives such as KidsUni, research outcomes are shared with academia, industry, and society.

Strategic international partnerships and academic exchanges

Collaborations with institutions such as MIT, Stanford, EDF, SBB, and partners in South Korea and Italy have fostered pioneering projects and enriched global academic exchanges since the early years of the Smart Living Lab.

Stronger interdisciplinary setup

The transition from iimt to DIGITS and DS&OR, along with new leadership, consolidated Unifr's digital strategy and strengthened interdisciplinary research.

Highlights 2024

Through its ongoing collaboration with the MIT Media Lab, initiated by a PhD exchange (Sailin Zhong) and nurtured through idea exchange between Prof. Lalanne and Prof. Paradiso, Human-IST researchers organized a major workshop connecting the Smart Living Lab and MIT. The event brought together researchers from EPFL, Unifr, HEIA-FR and MIT, and featured talks and a hackathon on environmental sensing, sleep, data interaction, and augmentation.

MIT Media Lab x Smart Living Lab workshop at MIT © dr

Celebrating 10 Years of the Smart Living Lab

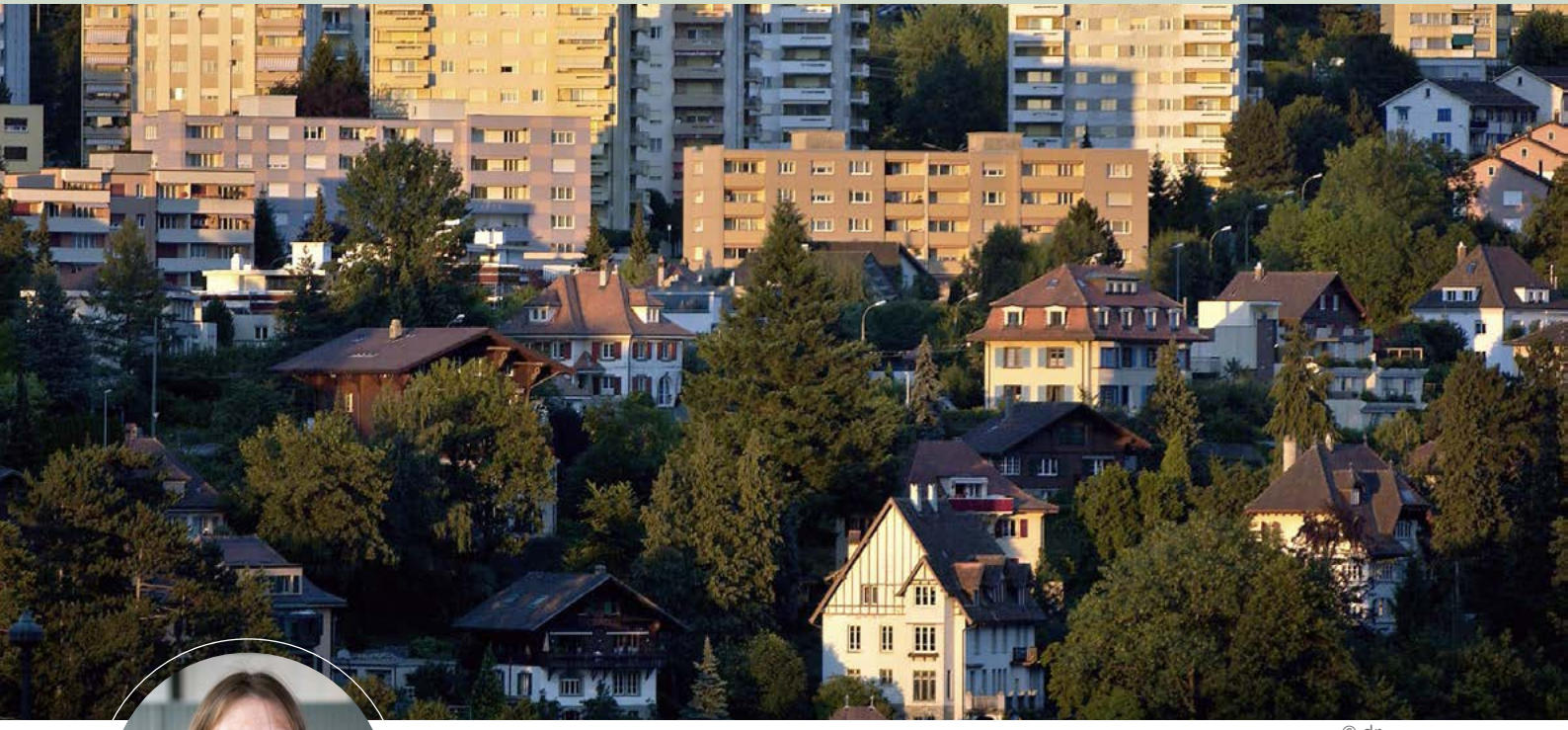
On March 26, 2024, we celebrated an evening filled with emotion, bringing together about a hundred people who all have played instrumental roles in shaping the Smart Living Lab as it stands today. This milestone offered an opportunity to celebrate a decade of innovation and collaboration but also a moment to express our heartfelt gratitude to Marilyne Andersen. Trailblazing and unwavering force behind this visionary project, she passed the baton of academic leadership to Corentin Fivet, Head of the Structural Xploration Lab (SXL), who now works alongside Martin Gonzenbach, Director of operations.

Photographs: © Stemutz Photo


smart
living
lab


EPFL

TRANSFORM Institute
A low-tech approach to innovation



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"The majority of the city of the future is already here, the challenge is to transform it and adapt existing buildings to live better together while respecting planetary boundaries."

Séréna Vanbutsele
Head of TRANSFORM Institute

Despite the climate emergency, new constructions continue to rise in French-speaking Switzerland. The construction sector is estimated to be responsible for about 40% of CO_2 emissions, as well as soil sealing, the gradual disappearance of biotopes, and pollutant waste. Faced with this reality, the TRANSFORM Institute aims to equip architects and public authorities with the tools to act on the transformation of existing buildings and their adaptation to reimagined lifestyles.

The TRANSFORM Institute develops applied research projects in architecture and urban planning. Comprising scientists and specialist architects, urban planners, geographers, and building physicists, the institute fosters interdisciplinary expertise to envision and create a sustainable built environment for the future. The institute addresses multiple scales, from the assembly of building elements to territorial planning. The building creation process is considered in its entirety, including design, construction, building use and its cultural values, renovation, and transformation at the end of the building's life cycle. While transformation in architecture is often equated with building renovation, particularly energy renovation, the projects at the TRANSFORM Institute demonstrate that this concept encompasses a broad range of skills and expertise. These include housing production, urban diversity, building typo-morphology, building health - particularly indoor air quality, digital tools for diagnosing the qualities of heritage buildings, and the reuse of construction materials. In their projects, the institute's research teams critically reflect on technologies and their sustainability. Innovation is more about the reappropriation, assembly, and combination of traditional, sometimes ancient techniques, rather than the invention of new technologies.

Key projects at the Smart Living Lab

Over the past 10 years, the TRANSFORM Institute has become particularly well-known for its research in four areas: energy retrofitting of historical buildings (projects include RurBat, ProRen, RenoBAT-FR, and TypoRENO); indoor air quality and radon (Jurad-Bat, Mesqualair, Scol'Air-FR, RnSLL); the development of eco-neighborhoods that address both human and environmental needs (TransHabNat, SWICE-WP3, BU-LO, SUNLOOP, MISS); and practice-based research, notably via the PopUp workshop and circular construction projects (ConcReTe, POLYNORM). The Institute, which was founded by Florinel Radu and has been led by Séréna Vanbutsele since 2021, now has more than 45 members. Team consolidation, doctoral thesis defenses, and the development and pooling of office, administrative and communication resources are vital if TRANSFORM is to successfully pursue its primary mission: becoming pioneers in its fields of expertise; identifying and understanding the needs of society rather than the market; and ensuring the transfer of knowledge, not only technology, between the Institute and its (primarily public-sector) partners.

Flagship project 2024

"Ile O'frais" in the Schoenberg district of Fribourg in August 2025 ©Agnès Collaud

O'Frais

» "Ile O'Frais" (Outdoor Comfort Living Lab) is a project within the Schoenberg Living Lab initiative. Based in the eponymous Fribourg neighborhood, the initiative is part of the SWICE WP5 and WP3 program and is carried out in partnership with REPER, a local association that facilitates community-based social and cultural activities. There is a strong applied dimension to the project, which launched in 2024. For example, it was used to test the temporary structure which has been designed to cool the public space and increase its user appeal. The "Ile O'Frais" is sited in one of the neighborhood's public spaces that is the most badly affected by the heat island effect. The participatory construction site began in August 2025 and brought together a team of architects from TRANSFORM, sociocultural activity leaders from REPER and local users (children at the nearby daycare center, teenagers and mothers). All helped to design and create the installation, which included shading, the painting of the ground and walls in light colors, and water features.

Recent Publications

Grandjean, Nicolas; Collaud, Agnès; Jeker, André; Mosimann, Reto; Vanbutsele, Séréna; 2024
POLYNORM - Dutch modular construction of the 1950s entirely made of steel sheet
Proceedings of the 5th International Congress on Construction History, 24-28 June 2024, Zurich, Switzerland

Radu, Florinel
Perma-cultivons les quartiers !
Tracés, 2024-12, Zürich, Suisse, espazium Verlag

Rey, Joan F., Antignani, Sara, Baumann, Sebastian, Di Carlo, Christian, Loret, Niccolò, Gréau, Claire, Gruber, Valeria, Goyette Pernot, Joëlle, & Bochicchio, Francesco (2024)
Systematic review of statistical methods for the identification of buildings and areas with high radon levels
Frontiers in Public Health, 12. DOI: 10.3389/fpubh.2024.1460295

Partnerships

» Canton of Fribourg, Climate Plan
» Fribourg Agglomeration
» City of Fribourg (urban planning and architecture, social cohesion, energy, heritage)
» Pro Fribourg
» Pro Natura
» REPER
» Ressourcerie
» Canton of Vaud (heritage and energy services, DGEO, ...)
» SFOE (Swiss Federal Office of Energy)
» FOPH (Swiss Federal Office of Public Health)
» Filogie
» OST
» EPFL
» HES-SO
» UNIGE, University of Geneva
» University of Fribourg
» Bureau DAC
» Durabilitas

ENERGY Institute
The role of multidisciplinary engineering in the energy transition

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"The ENERGY Institute contributes to the success of the Smart Living Lab. Our expertise in thermal networks, smart storage and low-carbon neighborhood planning is helping the SLL accomplish its mission of transforming energy challenges into actionable solutions."

Patrick Favre-Perrod
Head of ENERGY Institute

The teams at the ENERGY Institute are active in the management and optimization of energy use in buildings and infrastructure. They develop solutions for integrating renewable energy sources and optimizing electrical and thermal networks, conducting analyses and assessments at the building and neighborhood levels.

The Smart Living Lab has always been able to count on the ENERGY Institute and its energy engineering expertise, particularly in the fields of energy management and decarbonization. This input from this Institute within the HEIA-FR helps advance the SLL mission of creating a more sustainable built environment.

The Institute also participates in flagship research projects like SWICE, which seeks to identify the behavioral and social factors that could be leveraged to facilitate the clean transition. One of its primary contributions to the project is the evaluation of the effectiveness of living lab interventions that address the human, legal and economic factors at play in energy systems. SWICE is part of the national SWEET program and is coordinated by the SLL.

The ENERGY Institute has also increased the visibility of the Smart Living Lab thanks to its innovative prototypes (an urban cooling pavilion), sustained research output, and presentations at national and international forums. Its close collaboration with other institutes within the HEIA-FR, EPFL and the University of Fribourg cements the Smart Living Lab's reputation as a center of excellence in interdisciplinary research. At the same time, the design of the future Smart Living Lab building on the Bluefactory site has benefited from the Institute's active input.

Another strand of the ENERGY Institute's work is the development of actionable solutions that optimize thermal and electrical networks, smart building management and energy storage. Take the SmarTS project, for example. It meets the intermittency challenge of renewables by creating an innovative thermal battery made from phase change materials that store solar energy for night use. This work would be impossible without the right experimental infrastructure. The Institute is fortunate to have access to various thermal and electrical energy laboratories, including the Renewable Energy Integration Lab (LIRE) conveniently located next to the Blue Hall.

It would be fair to say that the ENERGY Institute embodies the ambition of the Smart Living Lab: turning energy challenges into tangible, sustainable and reproducible solutions that benefit society and the built environment.

Key projects at the Smart Living Lab

SmarTS (Smart thermal energy storage solution for buildings)

» Development of an innovative thermal battery with phase change materials (PCM), which stores renewable energy for use at night or in the absence of sunshine/wind. The project partners aim to co-produce a pre-series prototype.

The SmarTS project, which is supported by Innosquare, aims to revolutionize buildings' thermal storage with an innovative battery made from phase change materials (PCM). The system developed by the SmarTS team stores renewable energy produced during the day and releases it at night or in the absence of sunshine or wind. The project, which launched in May 2022, seeks to make MINERGIE buildings thermally self-sufficient from the months of March to November. Three prototypes will be developed; one will be installed permanently. Thanks to the automation and optimization of the heat exchanger and the combined multidisciplinary input of the project partners, SmarTS paves the way for a drastic reduction in fossil fuel dependence.

SWICE (Sustainable Well-being for the Individual and the Collectivity in the Energy transition)

» The ENERGY Institute is a major contributor to this flagship national project, funded by the SFOE over eight years and coordinated by SLL The project aims to reduce energy consumption in Switzerland through behavioral changes, living labs and social and technological innovations.

ADVENS (Platform for modeling and simulating integrated multisource heating networks)

» Development of a simulation tool to optimize the design, planning and running of industrial and urban thermal and electrical networks. The tool aims to improve energy efficiency and facilitate the integration of renewables in industrial heating networks.

BioLoop (Circularity of bio-based materials for a net-zero built environment)

» Assessment of the use of bio-based construction material to turn buildings into carbon sinks. Project partners are drawn from academia, industry and policymaking.

Flagship project 2024

BLAREC – Building LCA data exchange: a first Swiss carbon performance framework for reporting and capitalization

» BLAREC aims to create the first Swiss framework for reporting and capitalizing on Life Cycle Assessment (LCA) data for the building sector. As there are currently no common benchmarks and digital databases, the project seeks to overcome these gaps by developing a harmonized framework which promotes transparency and enables the comparison and exchange of carbon data. Thanks to an interdisciplinary approach, validation testing, and collaboration with public and private stakeholders, BLAREC hopes to accelerate the decarbonization of the sector.

Recent publications

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Dynamic LCA methodology to support post-occupancy decision-making for carbon budget compliance
Energy & Buildings. DOI: 10.1016/j.enbuild.2024.114006

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Exergy Analysis of Heating and Cooling
Academic Press. DOI: 10.1016/c2020-0-03373-6

Robadey, Jacques; Villeumier, Sylvain; Lalou Moncef, Justin; 2024
A cold storage PCM heat exchanger for daily summer free cooling with cold night air
Proceedings of 18. Symposium Energieinnovation (EnInnov) 2024, 14-16. Februar 2024, Graz, Austria

Partnerships

- » CSD
- » Bluefactory SA
- » Climate Services
- » CMA
- » E-nno
- » ETH Zurich
- » Gradesens
- » Groupe E
- » Romande Energie
- » Losinger Marazzi
- » OVALE & Partenaires
- » PSE-Energies Sàrl
- » Richemont
- » SIG
- » SINEF SA
- » Tecphy Sàrl
- » Urbaplan
- » Yord
- » SFOE (Swiss Federal Office of Energy)
- » HES-SO

SXL Laboratory
Demystifying the reuse potential of building elements

© dr

"Nothing is more sustainable than something that has already been built. Let's not waste it."

Corentin Fivet
Head of SXL Lab

For several years, the Structural Xploration Lab (SXL) had focused its research energies on identifying and developing tools that would facilitate the reuse of elements reclaimed from buildings that have been carefully "unbuilt", an approach that can help reduce the environmental impact of the construction industry. After it had successfully demonstrated that concrete reuse was technically feasible, SXL turned its attention to the real-life conditions that support the implementation, evaluation and mainstreaming of this practice. Recent research finds, that key determinants here are material performance, level of knowledge, evaluation frameworks and cultural context.

A survey of 35 industry players in North America reveals that experience heavily influences the perception of opportunities and obstacles. The more reuse projects professionals are involved in, the more their attitude evolves. For example, technical and regulatory constraints are initially considered barriers to implementation but over time these are supplanted by coordination, conceptualization and management issues. This process reflects a gradual professionalization within the construction industry whereby reuse becomes an integral part of the project rather than a disruptor. Collective learning improves not only the reliability of reuse practices but also their economic viability.

A further research project, which analyzed 21 procedures for assessing reuse potential in Europe and the United States, highlights the lack of a common framework. Most approaches still focus on the recycling of building materials rather than their direct reuse. The criteria used — strength, geometry, surface condition, ease of deconstruction — vary widely, making it difficult to compare results and complicates communication between resource managers, engineers, and architects. The project calls for standardized protocols that incorporate traceability, deconstruction planning, and transport and storage logistics with a view to making reuse a measurable, reproducible and industrializable practice.

Finally, a historical study reveals that reuse is not a recent innovation. Swiss archives from the 19th and 20th centuries show that there was a brisk trade in second-hand materials, where elements like beams, windows and stones were passed around different construction sites. With its focus on newness and standardization, the modern construction industry put an end to this practice. Its reintroduction today means re-engaging with a material intelligence that is informed by sustainability considerations, economy-of-means principles and the enhancement of what already exists.

By bringing together empirical, methodological, and historical approaches, SXL is helping to put reuse back at the heart of the building sector's transformation. Its research aims to quantify the environmental benefits of reuse, design digital assessment tools, and test prototypes made from unbuilt

elements. All its findings to date confirm the considerable reuse potential of built materials: deconstruction becomes a resource and "build to reuse" is emerging as one of the most promising approaches in the sustainable architecture field.

Key projects at the Smart Living Lab

Reusing concrete in new builds: opportunities and experimental validation

» The research explores the direct reuse of structural elements made from reinforced concrete and removed from buildings slated for demolition as an alternative to conventional recycling practices. Audit protocols were developed to assess the reusability of these elements. These comprised an inventory, geometric and material characterization, damage detection, and assignment of a reusability rating to guide their direct reuse. A full-scale prototype – a 10-meter post-tensioned arched footbridge made up of 25 concrete blocks cut from an existing structure – demonstrated that the process is technically feasible and could lead to a 70–75% reduction in global warming potential compared to new solutions. Studies on reused floor systems confirmed average carbon savings of 80%, which rises to 94% when steel elements are also reused. A historical analysis of concrete reuse, digital modelling, selective cutting, and reversible design are additional avenues that are being explored. This research will lay the foundations for circular construction practices based on the systematic reuse of concrete.

Integration of reused wood and steel elements into load-bearing structures

» Development of optimization software

Sitting on a gold mine

» Quantifying and qualifying the potential of Switzerland's urban building stock

Flagship project 2024

Characterization of the evolution of building stock and its material composition

» This project, which was completed in 2024, mapped and analyzed the embodied ecological impacts of load-bearing structures of Geneva building stock dating from 1850 to 2018. The research team developed 48 structural archetypes (e.g. masonry, concrete and steel) and applied these to 84,477 buildings using a weighted similarity function and a GIS database. The study found that the structural volume per square meter of floor space has shrunk by 37% over time. The mass of structural elements has risen by 10% and buildings that were constructed before the shift from masonry to concrete would generate 7% more transmissions today. The results also show that greenhouse gas emissions (by surface) from multi-dwelling units are 14% lower than emissions from single-family homes. This historical and typological approach offers a tool that could be used as a guide for sustainable renovation projects. It could also aid comparisons of old and new building stock, and improve the integration of the gray footprint of buildings in the urban planning process.

Recent publications

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Cleaner Environmental Systems, 100194.
DOI: 10.1016/j.cesys.2024.100194

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The Structural Engineer, 102, 32-37. DOI: 10.56330/ZMSY4716

Partnerships

» Morand Constructions Métalliques
» SIKA
» Antiglio SA
» Bluefactory SA
» Marti Construction
» Friderici Special
» SKAT Consulting
» UAWRA Recycling Association of Ukraine
» Eindhoven University of Technology (TU/e)
» HEIA-FR
» Penn State University (USA)
» Municipality of Ecublens (Switzerland)
» City of Lausanne
» Canton of Vaud

Institute for Swiss and International Construction Law

Legal innovation for sustainability, quality, absence of disputes, and security in the built environment

© dr

"The most effective way to make procurement sustainable is to strategically design the object to be procured."

Martin Beyeler
Head of LAW Group

In 2024, the LAW group (Institute for Swiss and International Construction Law) of the Smart Living Lab further consolidated its position as a reference point in construction law and critical infrastructure regulation, with a particular focus on sustainability, public procurement, project alliance contracts, and cybersecurity.

Since 2019, several Swiss public procurement law acts have been successively revised, and in some cantons. The LAW group closely follows and analyses this evolution, conducting in 2024 a landmark study on sustainability in public procurement. This contribution examines how ecological and social requirements are reshaping procurement procedures, bringing much-needed clarity to an area still in flux. In addition, a forthcoming monograph will address equality and equalization in tendering procedures, exploring the tensions between equal treatment and inclusion policies in public tenders.

Conventional design and construction contracts typically distribute risks and opportunities exclusively between parties, creating strong incentives for blame-shifting and inefficiency. In response, project alliance contracts were developed internationally to promote joint responsibility and constructive collaboration among stakeholders. The group contributed decisively to the development of project alliance contracts such as the SIA 2065 technical document, in collaboration with SIA, SSE, and suisse.ing. Published in 2024, this guidance offers a contract model adapted to Swiss law, designed to foster collaboration among stakeholders in the construction sector and to overcome the adverse incentives of traditional contracts. Following a comprehensive consultation and revision process, the document has become a milestone in Swiss contractual practice.

Contemporary societies rely on manifold physical infrastructures in order to enable and to maintain the way of life people have adopted as well as the activities they and their economy want to deploy. The functioning and the safety of such infrastructures has always been an important legal issue. The research of the group in this field has continued in the past years until today, with the focus on the legal protection of power grids against digital threats, contributing to shaping the regulation for energy transition and societal resilience.

Through these initiatives, the LAW group reaffirms its commitment to legal innovation in support of sustainability, quality, absence of disputes, and security in the built environment. Its academic research is closely linked to professional practice and teaching in continuing education programs (CAS), thereby building bridges between academia, institutions, and the private sector. In this way, the group actively contributes to preparing the legal and institutional foundations needed to address the challenges of ecological transition, digitalization, and collaborative practices in construction.

Key projects at the Smart Living Lab

Project alliance contracts

» The project alliance is a novel model for organizing construction projects in Switzerland. The alliance agreement is concluded between the client and the key actors in planning and execution. The parties commit to an integrated, collaborative approach, to jointly bearing project risks, and to a special compensation system that creates incentives for cooperation. The goal is the cooperative delivery of a high-quality project, completed on time and within budget.

A working group initiated by the SIA and supported by the SBV and suisse.ing, with participation from industry practitioners and the Institute for Swiss and International Construction Law, developed the SIA 2065 (2024) information sheet and a contract template (2025). The first infrastructure projects have already been tendered based on this framework. The Institute provided its legal expertise, clarified open legal questions, and contributed to the drafting of the information sheet and contract template.

Flagship project 2024

Sustainability of public procurement.

» The new Swiss procurement law, which came into force in 2021, explicitly recognizes the importance of the environmental and social components of sustainability in public procurement. Public contracting authorities are required, alongside economic considerations, to take these components into account in their procurement activities. In addition, they are provided with various tools to promote the ecological and social sustainability of their procurement.

This research project examines the specific obligations and opportunities that public contracting authorities have concerning the sustainability of their procurements. The different stages of the procurement process are considered separately, as the scope and effectiveness of sustainability-promoting measures largely depend on whether they relate to fundamental procurement strategy decisions or to the selection among specific bids in the tendering process.

Among the findings of the study is the insight that procurement law leaves considerable discretion regarding strategic decisions, which are particularly effective. However, during the tendering process itself, the applicable procurement regulations set certain limits and, in particular, do not allow a procurement necessary for fulfilling a public task to be instrumentalized to promote specific sustainability objectives that are not (directly) related to the sustainability of the procurement in question.

Recent publications

Beyeler, Martin
Sustainability of public procurement, Quelques thèses sur la durabilité des marchés publics
Bellanger/Bernard (editors), Le droit public face à la transition écologique, Zurich/Geneva 2024, pp. 121–249

Beyeler, Martin
Equality and equalization in public tender procedures
Gleichbehandlung und Gleichstellung im Vergabeverfahren; to be published

Simon, Clea
Cybersecurity law and power grids
PhD project; ongoing

Human-IST Institute
Understanding and Augmenting Human Comfort in Real Indoor and Outdoor Environments

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"Understanding users' perception of comfort and cultural differences with smartglasses."

Denis Lalanne
Head of Human-IST Institute

The Human-IST Institute applies its expertise in human-computer interaction (HCI) to develop methods and tools that help understand and improve human-building interactions (HBI). Using a user-centered design approach and computational tools, the institute observes occupants' behavior and develops human-centered, sustainable technology. This technology empowers building occupants to better control their environment, making it healthier, more comfortable, and more efficient and sustainable.

Over the past 10 years, Human-IST has developed alongside the Smart Living Lab (SLL), contributing to its interdisciplinary nature. Initial projects involved smart Human-Building Interaction devices, such as the Comfort Box, an interactive companion able to suggest comfort-preserving actions; the Insolight Luminaire – a ceiling lighting fixture which allowed users to orient its beam; and the MUBI App, which provided a mobile interface to recorded building data. More recent projects have grown in scale, involving several user experiments, some of which have taken place directly in the Blue Hall building or the CELLS pavilion.

The mains projects that Human-IST conducted within the scope of the SLL are all collaborative. AirSpecs is a collaboration with the MIT Media Lab and NUS Singapore to understand comfort into-the wild and across cultures, using wearables. The ComfortBox is a device to predict discomfort, resulting in a patent and a collaboration with Logitech. In the HBI experiment, recognized with two ACM CHI Best Paper awards, we tracked occupants in 20 office spaces, including collaborative and quiet zones, using distributed motion and comfort sensors to objectively derive user needs and behaviors. Another project, Lucideles, developed by Human-IST and Idiap Research Institute in Martigny (Canton of Valais), focused on human-centered light management, using simulations and machine learning to dynamically adapt lighting and blinds in real time.

Human-IST has participated in national and international projects with SLL partners, one of which is the SWICE project, involving 80 researchers across Switzerland collaborating to test strategies that encourage Swiss inhabitants to contribute to the 2050 energy transition. In this context, Human-IST is developing interactive research tools that can capture participants' activity and mobility behavior. At the international level, Prof. Denis Lalanne collaborate with Prof. Joe Paradiso at the MIT media lab and conducted several research projects

such as AirSpecs and workshops (on Human-AI teaming and distributed sensing). Human-IST also contributed to establishing the Swiss-South Korean ARC-HEST exchange program series, which recently concluded its third edition with EPFL, Unifr, HEIA-FR, EHWA, Hanyang University, and SungKyunKwan, resulting in longer term student exchanges.

Overall, the Human-IST institute is a key contributor to the Smart Living Lab, engaging in numerous collaborations and joint academic projects. In turn, the SLL is supporting Human-IST's development by providing excellent infrastructure and a context for initiating projects.

Key projects at the Smart Living Lab

ComfortBox

» The ComfortBox is a smart personal device designed to anticipate and prevent discomfort in buildings by monitoring lighting, sound, air quality, and temperature. It alerts occupants before issues occur, improving well-being and productivity. It integrates sensing with predictive algorithms, and its innovative approach led to a patent filing. An Innosuisse project with Logitech further advanced its integration into office environments. From this foundation, AirSpecs emerged as a more personal extension, in the form of smart glasses offering subtle feedback on discomfort, tested in Boston, Singapore, and Fribourg. Insights from ComfortBox also inspired the HBI experiment, where tracking in 20 offices provided objective measures of user needs. Finally, Lucideles translated these principles into adaptive light management, using machine learning to balance comfort and energy efficiency.

Flagship project 2024

AirSpecs

» AirSpecs are smart glasses designed to measure discomfort and provide non-intrusive feedback through subtle peripheral light. Developed at the MIT Media Lab, the system combines wearable sensing with ambient cues to help users become aware of environmental factors before they impact well-being. During her research visit to MIT, Sailin Zhong from Human-IST employed AirSpecs to compare comfort perception across three distinct contexts – Fribourg, Boston, and Singapore – capturing how cultural and climatic differences shape human responses to light, sound, air, and temperature. By extending comfort sensing into a personal wearable, AirSpecs opened new possibilities for studying subjective experiences in real time and across diverse environments, bridging laboratory research with everyday life.

Recent publications

Chwalek, Patrick; Zhong, Sailin; Perry, Nathan; Liu, Tianqi; Miller, Clayton; Alavi, Hamed Seiied; Lalanne, Denis; Paradiso, Joseph A. (2024)
A dataset exploring urban comfort through novel wearables and environmental surveys
Scientific data, 11, Scientific Data, 11, 1423.
DOI: 10.1038/s41597-024-04279-9

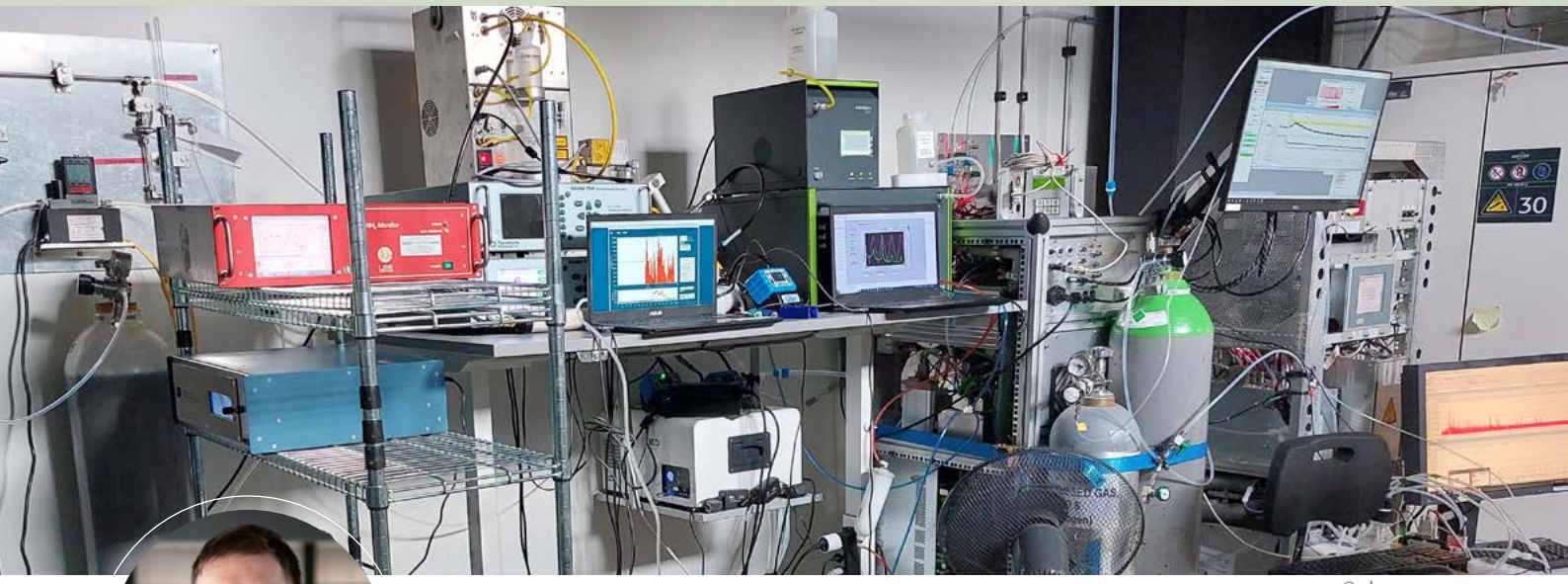
hong, Sailin; Chwalek, Patrick; Perry, Nathan; Ramsay, David; Miller, Clayton; Lalanne, Denis; Alavi, Hamed Seiied; Paradiso, Joseph; 2024
Sensors and Sensibilities : Exploring Interactions for Habitat Comfort with an Environmental-Physiological Sensing Eyewear in the Wild
SSRN. DOI: 10.2139/ssrn.4943028

Papinutto, Michael; Boghetti, Roberto; Colombo, Moreno; Basurto, Chantal; Reutter, Kornelius; Lalanne, Denis; Kämpf Jérôme H.; Nembrini, Julien; 2022
Saving energy by maximising daylight and minimising the impact on occupants : An automatic lighting system approach
Energy and Buildings, 268, 112176 (2022).
DOI: 10.1016/j.enbuild.2022.112176

Partnerships

» MIT Media Lab
» National University of Singapore
» Regent Beleuchtungskörper AG, Basel
» ZHAW, Institut für Nachhaltige Entwicklung
» ENERGY Institute, HEIA-FR
» TRANSFORM Institute, HEIA-FR
» HSLU, Hochschule Luzern
» Logitech
» Swiss Post
» La Mobilière
» SFOE (Swiss Federal Office of Energy)
» FOEN (Federal Office for the Environment)
» Prona
» Bluefactory SA
» EPFL
» Empa (Swiss Federal Laboratories for Materials Science and Technology)
» ETH Zurich
» SUPSI, University of Applied Sciences and Arts of Southern Switzerland
» UNIGE, University of Geneva
» Unil, University of Lausanne

HOBEL Laboratory Healthy Indoor Environments for People and Planet



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"At HOBEL, we see buildings as living systems that shape human health every day. Our mission is to generate science that not only explains how pollutants behave indoors but also delivers actionable solutions for healthier, fairer, and more sustainable built environments."

Dusan Licina
Head of HOBEL Lab

The Human-Oriented Built Environment Lab (HOBEL) at EPFL explores how buildings shape human health and well-being, with a strong focus on indoor air quality (IAQ) and energy efficiency.

Founded in 2018 at the Smart Living Lab in Fribourg, HOBEL investigates the complex interactions between people, pollutants, and buildings. Our mission is to ensure healthier and more sustainable indoor environments by advancing knowledge in four core areas: (1) sources and concentrations of air pollutants in buildings, (2) dynamics and fate of indoor pollutants, (3) human inhalation exposure, and (4) IAQ sensing and management.

Over the past decade, our research has delivered fundamental insights and practical solutions that bridge science, engineering, and policy. We were the first to quantify the impacts of WELL Building Certification on IAQ, conducted the largest Swiss study on air quality in schools and dwellings, and developed mitigation strategies for pollutants stemming from energy renovation. Our work uncovered new human-associated emission mechanisms, such as particle generation through skin–ozone reactions, and advanced methods for assessing exposure via the "personal cloud".

HOBEL also pioneered refined monitoring and control strategies, including low-cost sensor evaluation, video-based exposure proxies, and optimized IAQ sensing frameworks that informed ASHRAE guidelines. Importantly, our research extends beyond single buildings, linking outdoor air quality, urban environments, and energy use with indoor health.

To support this work, we established a world-class experimental infrastructure, including large-scale climatic chambers, a breathing and walking manikin, and a unique aerosol-generating coughing head. These facilities – rare globally – attract international collaborations and enable breakthroughs in building systems, exposure science, indoor air pollutant dynamics, and environmental monitoring.

Today, HOBEL continues to serve as a reference point for interdisciplinary, high-impact science on healthy and sustainable buildings, influencing global standards while training the next generation of experts.

Key projects at the Smart Living Lab

Environmental Climatic Chambers (2018–2021)

» Design and launch of world-class experimental chambers at EPFL Fribourg, enabling controlled studies on pollutant emissions, aerosol dynamics, and exposure with human participants.

Swiss School Air Quality Campaign (2019–2023)

» The largest IAQ investigation in Swiss schools, linking CO_2, particulate matter, and ventilation to health and learning outcomes. Findings shaped public health recommendations and highlighted the benefits of mechanical ventilation during and after COVID-19.

Human Emissions & Exposure Mechanisms (2018–2024)

» Unveiled the role of skin, clothing, and personal care products in generating indoor pollutants, including the novel discovery of particle formation via skin–ozone reactions.

SWICE (2020–ongoing)

» A Swiss-wide SWEET project on sustainable well-being in the energy transition, focusing on human-centered data collection and balancing IAQ, comfort, and energy.

INPERSO (2022–ongoing)

» A Horizon Europe project developing personalized renovation strategies and the ATLAS IEQ index for benchmarking indoor environments.

ICARUS (EPFL, 2024)

» This project explored how to balance effective infection control with energy efficiency in buildings by modeling and experimenting on the indoor dynamics of respiratory pathogens, leading to strategies for healthier and more sustainable ventilation systems.

Flagship project 2024

RENOMIZE (Horizon Europe, 2024–ongoing)

» The project introduces a fully integrated renovation approach that spans the entire building lifecycle – from assessment and planning to implementation, maintenance, and end-of-life deconstruction. Its goal is to reduce renovation time and costs by more than 25% while ensuring high indoor environmental quality (IEQ). The project develops digital decision-support tools, advanced spatiotemporal planning systems, modular façade and HVAC integration solutions, and robotic-assisted panel installations. It also explores factory automation to improve the quality and scalability of prefabricated renovation elements. Pilot renovations will be carried out in four demonstration buildings across Europe. Within RENOMIZE, HOBEL leads the evaluation of impacts on IEQ and ventilation through longitudinal field measurements, occupancy and ventilation assessments, and occupant surveys, ensuring the innovations remain both efficient and human-centered.

Recent publications

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European residential ventilation: Investigating the impact on health and energy demand
Energy And Buildings, 304, 113839.
DOI: 10.1016/j.enbuild.2023.113839enbuild.2023.1138399

Wu, Tianren; Müller, Tatjana; Wang, Nijing; Byron, Joseph; Langer, Sarka; Williams, Jonathan; Licina, Dusan; 2024
Indoor Emission, Oxidation, and New Particle Formation of Personal Care Product Related Volatile Organic Compounds
Environmental Science & Technology Letters, 1053-1061.
DOI: 10.1021/acs.estlett.4c00353

Altomonte, Sergio; Kacel, Seda; Martinez, Paulina Wegertseder Licina, Dusan. (2024)
What is NExT? A new conceptual model for comfort, satisfaction, health, and well-being in buildings
uilding And Environment, 252, 111234.
DOI: 10.1016/j.buildenv.2024.111234

Partnerships

» Honeywell (Givisiez and Rolle, Switzerland)
» Siemens (Zug, Switzerland)
» Estia (Lausanne, Switzerland)
» United States Green Building Council (San Francisco, USA)
» ArcSkoru (Washington DC, USA)
» CBRE Real Estate (Amsterdam, The Netherlands)
» Sensirion (Stäfa, Switzerland)
» WindowMaster (Trimbach, Denmark)

ICE Laboratory
Enhancing Building Energy Efficiency through Personalized Climate Control

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"Only by embracing a human-centric approach can we move beyond the outdated "one-size-fits-all" paradigm in building design and operation."

Dolaana Khovalyg
Head of ICE Lab

Heating and cooling account for as much as 20–70% of a building's total energy consumption, depending on the building type and climate conditions. As climate change leads to more frequent extreme weather events, energy demand for indoor climate control is expected to rise. Therefore, it is crucial to rethink building operations and develop solutions that balance energy efficiency with the well-being of occupants.

Indoor climates in buildings are typically designed and operated according to standardized conditions based on an "average person". This outdated one-size-fits-all approach, which also assumes uniform and steady-state conditions, often fails to deliver optimal comfort for all occupants. Consequently, it contributes to the persistent gap between predicted and actual energy use in buildings. Adopting a more personalized approach to indoor climate control represents the next milestone in advancing the ergonomics of the thermal environment. Therefore, the ICE lab research focuses on an occupant-centered approach to reduce the energy intensity of indoor climate control in buildings, while accounting for individuals' comfort and well-being through advanced design and control of adaptive and personalized thermal systems.

The ICE Lab's research brings together innovation and human-centered design across four core areas: Human Factors, Sensing and Modeling, Control and Operation, and Technology and Energy.

» **Human Factors:** we explore how people experience and adapt to changes in their thermal environment. Our research examines how personalized and localized thermal conditioning can improve comfort, well-being, and productivity, as well as how individuals adapt, both in the short and long term, to mild heat and cold.

» **Sensing and Modeling:** we design smart, non-intrusive sensing solutions for buildings. Using both physical and data-driven approaches, we model human heat generation and dissipation, and develop predictions for personalized and localized thermal comfort.

» **Control and Operation:** our work focuses on creating intelligent, occupant-centered control systems that make buildings more responsive and efficient. We develop multi-objective control strategies that optimize comfort, energy use, and well-being – paving the way for personalized, adaptive indoor climate control.

» **Technology and Energy:** we bridge research and real-world application through hands-on hardware development. This includes evaluating the performance of existing Personalized Environmental Control Systems (PECS) and designing next-generation concepts that deliver maximum energy efficiency and truly personalized comfort.

The ICE Lab combines experimental, computational, and data-driven methods across its research areas. At the core of our experimental work is a custom-designed climatic chamber,

which offers exceptional flexibility and modularity, allowing for the creation of a wide range of heating, cooling, and ventilation configurations. Using advanced instruments, we measure human physiological responses and thermal conditions in both indoor and outdoor environments. To extend our analyses, we also use simulation tools, including EnergyPlus, OpenStudio, TRNSYS, ENVI-met and human thermoregulation models. Our work spans both controlled laboratory experiments and real-world field studies, ensuring that our findings are both scientifically rigorous and practically applicable.

Key projects at the Smart Living Lab

Adaptations to cold environments: A comparative study of active nomadic and modern sedentary lifestyles

» This interdisciplinary study offers a holistic view of human adaptation to cold by integrating field and laboratory evidence across energetic, physiological, and behavioral dimensions. It quantifies the real-world energy costs of living in extreme cold, experimentally compares thermoregulatory responses between traditional nomads in yurts and sedentary individuals in modern homes, and identifies behavior as a central factor in thermal adaptation. Beyond physiological habituation, the nomads' activity patterns, clothing choices, and environmental interactions shape their thermal comfort and energy balance, revealing the tight link between behavior and physiology. The study sets a new benchmark for understanding how lifestyle and environment drive human resilience – providing valuable insights for improving comfort, health, and energy efficiency in a changing climate.

eCOMBINE

» Interaction between energy use, COMfort, Behaviour, and INdoor Environment in Office Buildings

DIET Controller

» Dynamic Indoor Environment using Deep Reinforcement Learning

BehaveLearn

» Reinforcement Learning for the occupant-centric operation of building energy systems: Theoretical and experimental investigations

VentAir

» Impact of the ventilated air-space behind traditional (passive) and BIPV (active) façades on the thermo-hydrodynamic performance of the building wall structures

Flagship project 2024

Prediction of dynamic human body energy expenditure using data-driven modeling

» This study presents a novel approach to predicting human body energy expenditure, taking into account not only physical activity but also ambient temperature and food intake. Using data from multiple wearable sensors on six individuals, we developed dynamic models utilizing Long Short-Term Memory (LSTM) networks to identify patterns over time. The models accurately predicted energy use, with errors of only 5–15% during low- to medium-intensity activities. In the improved version, the ensemble models, which combine LSTM with the Gradient Boosting algorithm, performed even better. Each model was personalized in terms of input parameters and features for each individual, demonstrating that customized approaches can predict human energy expenditure more accurately in daily life.

Recent publications

Perez Cortes, Victoria; Chatterjee, Arnab; Khovalyg, Dolaana. (2024)
Prediction of dynamic human body energy expenditure using Long-Short Term Memory (LSTM) networks
Biomedical Signal Processing & Control, v. 87, 105381 DOI: 10.1016/j.bspc.2023.105381

Cho, Eun Ji; Khovalyg, Dolaana; Nam, Sung Taeg. (2024)
Reframing "Primitive Huts" from Structural to Environmental Techniques and Their New Interrelationship in the Machine Age
Buildings, 14, 4072. DOI: 10.3390/buildings14124072

Younes Jaafar; Khovalyg Dolaana. (2025)
Rethinking Local Thermal Sensation Prediction: The Role of Heat Flux over Skin Temperature in Personalized Models
Building and Environment, v. 281, 113195. DOI: 10.1016/j.enbuild.2023.113581

Partnerships

» Empa (Swiss Federal Laboratories for Materials Science and Technology)
» Princeton University, USA
» Politecnico di Torino, Italy
» University of Fribourg
» greenteg AG

iTEC Institute
Supporting sustainable and circular construction through innovation

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"Our goal is to transform research into actionable solutions by combining resource efficiency, collaborative experimentation and deep local roots."

Fabienne Favre Boivin
Head of the iTEC Institute

Since joining the Smart Living Lab in 2019, the iTEC Institute at the HEIA-FR has embarked on an ambitious journey to reduce the environmental impact of the construction industry while improving the quality and resilience of the structures it builds. This "doing better with less" approach has paid dividends: iTEC has been behind a series of innovative projects that are firmly rooted in regional realities.

New-generation building materials is one of the research areas explored by iTEC. The TISLA and CIMI projects tested lightweight, bio-based concretes containing recycled or biomass components. This research has paved the way for more sustainable construction solutions that address the challenges posed by urban densification and carbon footprint reduction.

Other iTEC projects like Multivie and ReuSlab investigated and rethought the modularity and reuse of structural elements. They have led to successful collaborations with EPFL and even the creation of a start-up, a development that perfectly illustrates the pathways that lead from academic research to business innovation.

The integration of artificial intelligence in construction processes ushered in a new era for iTEC activities. The Orcademo and Ass4.2 projects, completed in 2024, developed automated diagnostic tools that recognise building materials and methods, thereby reinforcing building analysis and monitoring capabilities.

Finally, the Institute consolidated its commitment to using living lab methodologies with projects like LASOL and REUSE@Lab. LASOL is a collaborative project where iTEC joins with public and private stakeholders to explore the possibilities of integrating soil value in urban planning processes with a view to optimising soil use on construction sites. REUSE@Lab approaches the subject of circular construction through the lens of material reuse. Its work is further strengthened by the FriSource digital platform which facilitates reuse by sharing information on reusable building materials available in the Fribourg region. The Institute wants to be as responsive as possible to end user needs. This is reflected in its i2B project, a living lab that aims to develop prototypes that make it easier for the visually impaired to navigate urban infrastructures.

A mix of commonsense, innovation and cooperation has proved to be a winning formula for iTEC and has had a tangible impact on the construction sector. The Institute has become a major player in the Smart Living Lab and actively contributes to its mission of improving the sustainability of the built environment.

Key projects at the Smart Living Lab

REUSE@LAB – Facilitating the reuse of building components via the FriSource platform

» The REUSE@LAB project focuses on resource and energy consumption reduction through the reuse of building elements with minimum treatment. This approach, which promotes a circular economy, encourages all construction stakeholders – project owners, designers, businesses and administrations – to rethink the way they design, build and manage buildings. REUSE@LAB builds bridges between these stakeholders, which in turn facilitates a collaborative approach that a successful clean transition requires. The FriSource platform, which emerged from this project, enables these stakeholders to find and share information on building materials that are available for reuse and encourages them to opt for sustainable and innovative solutions for their future building projects.

TISLA 2DFX / CIMI

» Development of lightweight, bio-based concrete made from sawdust and recycled aggregates.

ORCADEMO / Ass4.2

» Integration of AI in systems used for the automated recognition of materials and construction methods.

ReuSlab – Prototype of a reusable modular slab

» Development of a modular, reusable and adaptable load-bearing system.

Flagship project 2024

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LASOL – Soil value integration in urban planning process via a Living Lab in Chamblioux-Bertigny

» The LASOL project aims to integrate soil value into land use planning processes. Such an approach is crucial for meeting the objectives of the Swiss Soil Strategy and the Sustainable Development Goals. To date, urban planning has tended to overlook the ecosystem services that soil provides. LASOL seeks to rectify this situation through the creation of a living lab that brings together key urban development stakeholders. The project focuses on the Chamblioux-Bertigny area in Fribourg and aims to develop methods for including sustainable soil management in urban planning projects, while ensuring uninterrupted information flows between project stakeholders throughout the process.

Recent publications

Estrella, Xavier; Muresan, Alex; Brütting, Jan; Redaelli, Dario; Fivet, Corentin. (2024)
RE:SLAB—a load bearing system for open-ended component reuse in building structures. Frontiers in Built Environment
Frontiers in Built Environment. DOI: 10.3389/fbuil.2024.1355445

Ston, Julien; Zwicky, Daia. (2024)
Exploration of lightweight binders and aggregates made from biomass waste
Proceedings of the International Conference on Concrete Sustainability (FIB ICCS), 11-13 September 2024, Guimarães, Portugal

Favre Boivin Fabienne; Vanbutsele Séréna; Riondel Julie; Falque Juliette; Cosandey Anne-Claude; Martin David. (2024)
LASOL: a Living Lab to help integrate soil protection into special planning and construction
2024 Proceedings of the ISSS celebrations, in press

Partnerships

» EPFL (Swiss Federal Institute of Technology in Lausanne)
» Innosuisse (Innovation Booster Living Labs for Decarbonisation)
» Fribourg Federation of Entrepreneurs (FFE)
» Construction Fribourg
» Canton of Fribourg
» City of Fribourg
» Progin SA
» Vial SA
» Durabilitas
» Stephan
» JPF SA
» Holcim
» Swiss Federation of the Blind and Visually Impaired

ETHOS Laboratory
Integrating social and environmental goals for a sustainable built environment

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"Understanding human-building interactions is key to advancing sustainable and people-centric cities"

Andrew Sonta
Head of ETHOS Lab

The vision of ETHOS is to leverage modern data and computing to design interventions across the scales of our built environment that simultaneously address social and environmental goals. Research at ETHOS focuses on interactions between people and the built environment, which can help identify pathways for more sustainable buildings, neighborhoods, and cities.

When we gain a clearer picture of how people – occupants, residents, users, pedestrians – interact with their built world, we can develop strategies for design and management that improve both our human experiences as well as environmental sustainability objectives. Here are some examples of how our research aims to accomplish this integration:

» Designing and using sensors and surveys to understand how people use building spaces and interact with each other can lead to simple suggestions or retrofits that save energy while promoting social interaction and collaboration.

» In an era of hybrid working, we can improve holistic building performance by gathering insights on how flexible working policies impact not only employee productivity and well-being, but also office building space needs and energy consumption.

» As we deploy more renewable energy sources, their intermittency makes balancing energy supply and demand a challenge. Demand response strategies – like building load shifting and shedding – can be made more effective when we use advanced smart metering to infer knowledge of building occupancy and potential risks to human comfort..

» At the urban scale, data-driven techniques can help us learn what makes a city walkable, and how such energy-efficient walkable design can also impact the ability of neighborhoods to form socially cohesive communities.

Key projects at the Smart Living Lab

15min Estates: Co-creating Spatial Strategies for Just and Sustainable Mobility in Large-Scale Housing Estates, Driving Urban Transitions/SNSF

» The 15minESTATES project looks at the nexus of (1) urban space, (2) transport options, and (3) people's needs and capacities as key dimensions for sustainable mobility transitions. With a specific focus on large-scale housing estates (LHEs), complex urban setting that houses large numbers of inhabitants all over Europe, the project aims to co-create locally adapted and accepted spatial strategies and interventions for just and sustainable mobility. The project employs a comparative case study approach, focusing on five LHEs in Bulgaria, Hungary, Germany, the Netherlands, and Latvia. ETHOS is leading the efforts to model and develop urban interventions that improve accessibility within the 15minESTATES.

UrbanTwin: An urban digital twin for climate action: Assessing policies and solutions for energy, water and infrastructure, ETH Joint Initiative

(Machine) Learning Economic Impacts of Green Residential Building Policies in Switzerland, Enterprise4Society

OptUSE: Optimizing the physical workplace for Urban Socio-Environmental performance, ENAC Fribourg Grant

» We have entered a new era of building use and work patterns. A plurality of workers in recent surveys have reported working in a hybrid format compared to office only or home only. We will develop models to aid in the optimization of flexible working policies that balance effectiveness of workplace interactions, building energy and spatial efficiency, and commuting costs. Leveraging multi-objective optimization, we propose to develop a decision-support framework for companies to tailor their remote working policies, ensuring a harmonious balance between employee well-being, environmental considerations, and operational efficiency.

Flagship project 2024

Capturing the social value of buildings with ambient sensing data, SNSF

» As commercial office buildings are intended to support effective work – in which human interaction is a fundamental component – we require empirical methods for capturing the interactions that are occurring in our buildings. Ambient sensors that are non-invasive have been underexplored for this purpose but may provide relevant information about human dynamics in buildings. If we can measure occupant interactions in a non-intrusive and privacy-preserving way, may be able to widely deploy sensing strategies that measure interactions. Doing so will not only enable characterization of interactions in existing spaces, but also the ability to test how spatial and organizational design interventions promote or discourage interactions.

Recent publications

Favero, Matteo; Carlucci, Salvatore; Chinazzo, Giorgia; Møller, Jan Kloppenborg; Schweiker, Marcel; Vellei, Marika; Sonta, Andrew. (2024)
Ten questions concerning thermal comfort statistical data analysis: common deeds and misdeeds
Building and Environment, 264,111903.
DOI: 10.1016/j.buildenv.2024.111903

Zhang, Yufei; Deng, Yang; Liang, Rui; Liu, Yaohui; Wang, Dan; Sonta, Andrew. (2024)
A data-driven framework for occupant-centric demand flexibility potential at scale
In Proceedings of the 11th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (BuildSys '24) Hangzhou, China
DOI: 10.1145/3671127.3699537Hangzhou, China

Shoji, Kanaha; Sonta, Andrew. (2024)
Data-driven urban walkability: developing an empirical understanding of walking behavior and urban form
Accepted for the proceedings of the ASCE International Conference on Computing in Civil Engineering 2024 (i3CE 2024), Pittsburgh, PA, USA

Partnerships

» Eawag (Swiss Federal Institute of Aquatic Science and Technology)
» Empa (Swiss Federal Laboratories for Materials Science and Technology)
» University of Lausanne
» University of Zurich
» University of St. Gallen
» Riga Technical University (Latvia)
» Delft University of Technology (Netherlands)
» Leibniz Institute of Ecological Urban and Regional Development, Dresden (Germany)
» Budapest University of Technology and Economics (Hungary)
» University of Architecture, Civil Engineering and Geodesy, Sofia (Bulgaria)
» National Institute of Technology, Tiruchirappalli (India)
» Villanova University (USA)
» Siemens Suisse SA
» Bluefactory SA
» SMG Swiss Marketplace Group
» Groupe E
» Services industriels de Lausanne

DIGITS Group Digital Transformation of Smart Living Environments

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"Applying business informatics methods in interdisciplinary collaborations for smart living environments."

Hans-Georg Fill
Head of DIGITS Group

The Digitalization and Information Systems Group (DIGITS) of the University of Fribourg contributes to the Smart Living Lab by conducting fundamental and applied research on the digital transformation of Smart Living environments. For this purpose, business informatics methods are used to enable interdisciplinary collaboration between different fields.

The DIGITS group participates in the Smart Living Lab since 2022. The group conducts fundamental and applied research on the digital transformation of Smart Living environments. One focus in the last years was to combine conceptual modeling – as a means for formally representing and processing knowledge – with augmented and virtual reality technologies. Thereby, knowledge expressed in conceptual models can be anchored in three-dimensional space in the real or the virtual world. In this context, the approach of "spatial conceptual modeling" has been developed, which integrates concepts of spatial computing into conceptual models on a meta level. Thereby, information originating from conceptual models can be anchored to objects in the real or virtual world in three-dimensional space. It is thus a foundational pillar for so-called "digital twins", which allow for the simulation and study of the effects of manipulating real objects in their virtual counterparts. Potential application fields include for example architecture, cultural heritage, or smart cities. First concrete realizations of this theoretical approach include the design of a modeling language for augmented reality (AR) applications known as Augmented Reality Workflow Modeling Language (ARWFML), which allows to create AR applications in a visual environment without the need to code, as well as the development and provision of the MM-AR open-source metamodeling platform, which enables the creation of 3D-

and AR/VR-based modeling languages. Further projects in this context include the creation of 3D videos for educational purposes, e.g., in collaboration with the EPFL HOBEL group and experiments based on data provided by the Building2050 group for augmented reality applications. In addition, first experiments have been conducted in collaboration with the Réseau Santé du Lac in Morat/ Murten (Canton of Fribourg) to investigate how virtual reality could be used in the context of well-being for elderly people. For supporting the digital transformation of actors in the built environment, the DIGITS group conducted a study for the company Hilti to explore the impact of recent developments in generative artificial intelligence on internal work practices. Further, members of DIGITS are regularly present at the Explora exhibitions of the University of Fribourg, demonstrating conceptual modeling, AR/VR devices, and robotics to the general public. Besides the continuous international publication of the group's research results, contacts with international partners in academia and industry have been established and maintained. Most recently, the DIGITS group started to investigate the application of spatial conceptual modeling to the field of robotics and to the domains of cultural heritage and smart cities.

Key projects at the Smart Living Lab

MM-AR Metamodeling Platform

» An open-source, web-based metamodeling platform for developing knowledge-based digital twins in spatial environments such as the built environment, architecture, cultural heritage. It is the first open-source platform that integrates 2D and 3D conceptual modeling according to spatial conceptual modeling principles and that natively supports AR and VR devices via the WebXR standard.

Flagship project 2024

Augmented Reality Workflow Modeling Language (ARWFML)

» A visual modeling language for creating augmented reality applications using a no-code approach. ARWFML has been developed in the PhD thesis of Fabian Muff and allows users to define augmentations and AR workflows graphically. It has been implemented and evaluated on the ADOxx and the MM-AR metamodeling platforms.

Recent publications

Muff, Fabian; Fill, Hans-Georg. (2024)
M2AR: A Web-based Modeling Environment for the Augmented Reality Workflow Modeling Language
Proceedings of the ACM/IEEE 27th International Conference on Model Driven Engineering Languages and Systems, ACM, 1-5, DOI: 10.1145/3652620.3687779

Muff, Fabian; Fill, Hans-Georg. (2024)
Multi-faceted Evaluation of Modeling Languages for Augmented Reality Applications: The Case of ARWFML
International Conference on Conceptual Modeling ER 2024, Springer, DOI: 10.1007/978-3-031-75872-0_5

Muff, Fabian; Fill, Hans-Georg. (2023)
Domain-specific visual modeling language for extended reality applications using WebXR
International Conference on Conceptual Modeling ER"2023, Springer, DOI: 10.1007/978-3-031-47262-6_18

Partnerships

» Réseau santé du Lac, Morat / Gesundheitsnetz See, Murten
» Università Politecnica delle Marche, Ancona, Italy
» Stanford University – Center for Design Research (CDR), USA
» Stanford University – Biomedical Informatics Research (BMIR), USA
» CONTAKT-EDV AG, Vienna, Austria
» Hilti AG, Liechtenstein

DS&OR Group
Advancing Solutions for Real-World Challenges in Transportation and Logistics

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"Our goal is to support complex decision making in logistics and transportation."

Bernard Ries
Head of DS&OR Group

The DS&OR group develops mathematical theories, models, and algorithms to support and improve decision-making in complex real-world contexts, especially in transportation and logistics. Its work bridges theory and practice, with projects conducted in collaboration with leading industrial and academic partners.

Organizations in transportation, logistics, and related fields face increasingly complex challenges that require algorithmic and computational methods. The DS&OR group addresses these challenges by modeling problems, designing algorithms, computationally solving them, and communicating results effectively. Its research blends fundamental advances with practical, adaptable approaches, strengthened through collaborations with industry partners.

One highlight is the ongoing collaboration with Electricité de France (EDF), funded by the PGMO program. Launched in 2023, the project focuses on the design of efficient algorithms, based on column generation techniques, to build and optimize routes for technicians performing maintenance on electricity distribution networks.

The group also participates as a partner in the COVER project, funded by the Staff Exchanges – Marie Skłodowska-Curie Actions, which was launched in 2025. Within COVER, the group is involved in two transportation-focused sub-projects: one on bus crew scheduling in Istanbul, in collaboration with Boğaziçi University and the Istanbul public bus authority (IETT), and another on street cleaning in Slovenia, in collaboration with the University of Primorska and the Municipality of Koper.

In the domain of airline operations, the group conducts research on crew scheduling and aircraft routing in collaboration with colleagues from Ecole Nationale des Ponts et Chaussées in France. The project examines the computational complexity of these problems to identify the main factors contributing to their difficulty and develops effective, adaptable algorithms that are tested on instances provided by Air France.

Further projects extend the group's expertise to diverse applications. These include the quay crane scheduling problem, which focuses on the efficient loading and unloading of ships in container terminals, in collaboration with colleagues from Hamad Bin Khalifa University in Qatar and Northeastern University in China. Another project, carried out with colleagues from Carnegie Mellon University in Qatar, investigates strategies for using mobile autonomous robots to efficiently survey large and initially unknown areas and construct spatial maps of attributes of interest.

Since joining SLL in 2022, the group has expanded its network of collaborations and diversified its research portfolio, while maintaining its dual mission: advancing fundamental research in operations research and transferring knowledge through partnerships that address practical challenges. Among its achievements, the group completed a project funded by Innosuisse, in collaboration with Schwendimann AG and iimt (University of Fribourg), on the waste collection problem. Another project, funded by the SBB Research Fund, focused on optimizing railway activity assignments to SBB staff depots. During this period, the group also welcomed Nour Elhouda Tellache in 2024, following the departure of senior researcher Vera Fischer.

Key projects at the Smart Living Lab

Optimization of railway activity assignments to SBB staff depots

» The group completed a project in collaboration with SBB, funded by the SBB Research Fund, which supports research on current challenges in the Swiss railway network. The project focused on assigning each activity segment – such as a portion of the Intercity 711 route from 7:42 in Geneva to 9:03 in Fribourg – to the various staff depots from which crew members start and end their daily tours. The goal was to analyze SBB's current assignment system and identify opportunities for improvement and strategic decision-making. The results indicate a potential 19% reduction in personnel requirements using algorithms developed through this research.

Decision support for efficient and sustainable waste collection

A column generation approach for the routing of electricity technicians

Optimizing Air Transportation Operations: Crew Scheduling and Aircraft Routing

COVER: (C)ombinatorial (O)ptimization for (V)ersatile applications to (E)merging u(R)ban Problems

Flagship project 2024

A column generation approach for the routing of electricity technicians

» In 2023, the group secured funding for a one-year project, later renewed for a second year, in collaboration with the Research and Development Department of Electricité de France (EDF). The project focuses on optimizing technician routes to maximize the interventions covered while considering multiple constraints, including technician skills, intervention time windows, capacities, and travel times. It is part of the Gaspard Monge Program for Optimization, Operational Research, and their Interactions with Data Science (PGMO), which supports research in mathematical areas identified as crucial by industrial partners.

Recent publications

Fischer, Vera; Paneque, Meritxell Pacheco; Legrain, Antoine; Bürgy, Reinhard. (2024)
A capacitated multi-vehicle covering tour problem on a road network and its application to waste collection
European Journal of Operational Research, 315 (1), 338-353. DOI: 10.1016/j.ejor.2023.11.040

ElHouda Tellache, Nour; Meunier, Frédéric; Parmentier, Axel. (2024)
Linear Lexicographic Optimization and Preferential Bidding System
Transportation Science, 58, n°3. DOI: 10.1287/trsc.2022.0372

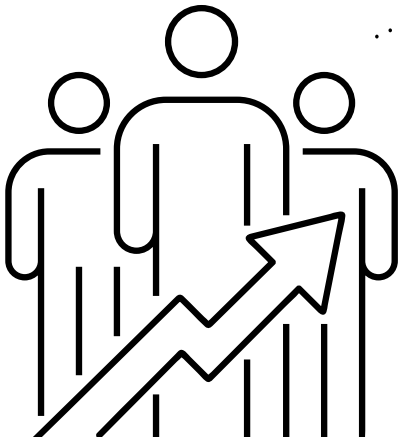
Fischer, Vera; Legrain, Antoine; Schindl, David. (2024)
A Benders Decomposition Approach for a Capacitated Multi-vehicle Covering Tour Problem with Intermediate Facilities
In Lecture Notes in Computer Science (pp. 277–292). Springer Nature Switzerland. DOI: 10.1007/978-3-031-60597-0_18

Partnerships

» Electricité de France (EDF)
» System-Alpenluft AG
» Schwendimann AG
» iimt Unifr
» SBB CFF FFS

Facts and figures

Workforce



When the Smart Living Lab set up in its temporary building in 2015, around forty people were working there. By the end of 2024, the number of people active at the Smart Living Lab had risen to 129. They are affiliated with EPFL, HEIA-FR, or the University of Fribourg. This community stands out for the diversity of its skills and scientific disciplines as well as its cultural backgrounds, with 26 nationalities represented. This richness helps foster innovation and research excellence.

129 Collaborators

26 Nationalities

	EPFL	HEIA-FR HTA-FR	UNI FR
Number of FTEs (full-time equivalents) at the end of 2024	**32,25**	**27***	**7,36***
Number of employees at the end of 2024	**37**	**74***	**18***

*The staff of HEIA-FR and the University of Fribourg is spread across the Pérolles and Bluefactory sites.

Research

1180

» publications published over 10 years

In 2024, the 12 research teams within the Smart Living Lab published more than 70 research papers, bringing the total number of SLL publications (research papers, books, conferences proceedings, academic dissertations etc.) over the last decade to around 1,180. Publishing research is very important because it brings the inputs generated in Fribourg to the attention of the international scientific community and industry.

Doctorates

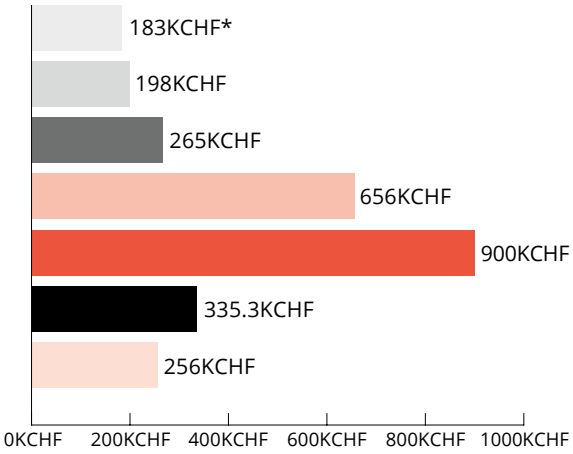
2 in 2020 (the first)
7 in 2024
20 in total at the end of 2024

External funding

Over the last 10 years, research groups within the Smart Living Lab have successfully sought funding from a wide range of public and private institutional stakeholders. The below list features some of the most high-profile sources of SLL project funding between 2014 and 2024.

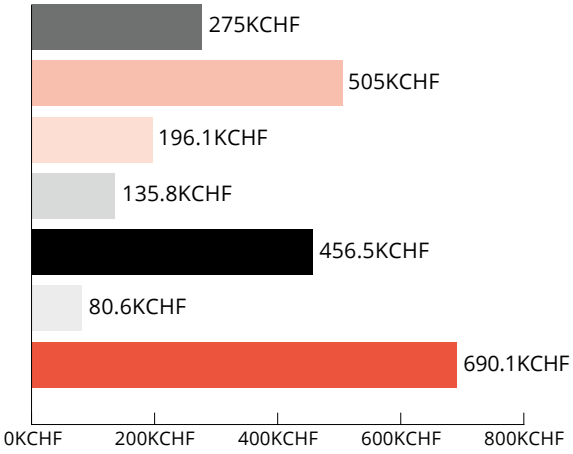
EPFL

- Swiss Federal Office of Energy, 2019
- Horizon Europe, 2019
- SFNS, 2020
- SFNS, 2020
- Horizon Europe, 2022
- SFNS, 2024
- SFNS / Horizon Europe, 2024



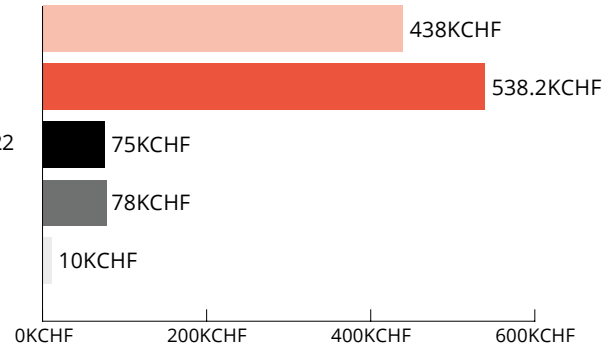
HEIA-FR
HTA-FR

- NPR, 2014
- NPR – Losinger Marazzi, 2014
- NPR, 2021
- NPR, 2022
- Innosuisse, 2023
- Swiss Federal Office of Energy, 2024
- SFNS, 2024



UNI FR

- Swiss Federal Office of Energy, 2022
- Schwendimann, 2022
- Swiss Federal Office of Energy, Regent Lighting, 2020-2022
- Swiss Federal Office of Energy, 2024
- Hilti, 2024



*Amounts are expressed in thousands of Swiss francs (KCHF)

Communication

Number of followers on social media

Instagram
1259 (13 August 2025)
471 in 2018

LinkedIn
4356 (13 August 2025)
851 in 2018

As soon as the Smart Living Lab was created, it put in place an internal and external communication strategy. Internal members are kept up-to-date via newsletter, while those outside the organization will find information on the SLL's extensive, regularly updated website and social media accounts. Follower numbers have increased sharply since the accounts were first activated.

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