KTH Live-In Lab

Annual report 2019

Contents

Summary

In 2019 KTH Live-In Lab finally transformed from a set of separate projects to a fully operational research centre with four active centre members: KTH, Einar Mattsson, Akademiska Hus and Schndeider Electric. That same year the number of project launches and staff embers doubled and KTH LIL was profiled on Swedish national radio (P1) and TV (SVT Rapport från 2050).

2019 was also the year of co-creation. In May, the Live-In Lab visited TU Delft, AMS Institute and Amsterdam University, and in October a team visited MIT and Harvard to learn and share experiences from living lab activities. In November, as a follow-up to the visits to other living labs, a workshop was held to discuss and develop methods to improve impacts from R&D carried out in living labs. This collaboration between academics and industry specialists hosted participants from the HSB Living Lab, TU Delft, the AMS Institute, MIT, Boverket, Schneider Electric, Akademiska Hus and many more.

"This facility enables industry and academia to work together and conduct tests in stages, from pilot tests in the four test apartments to larger tests using hundreds of apartments, and educational facilities."

By the end of 2019, 38 applications to use the test infrastructure had been accepted; of them, 18 are still in progress and 8 have been completed. The total value of ongoing projects is around 47 million Swedish kroner (approximately €4.5 million), divided into 11 million SEK (€1 million) in-kind and 36 million SEK (€3.5 million)in funding, mainly from Formas, Energy Agency and Vinnova. It is great to see that of the funding applications for KTH Live-In Lab projects last year, 9 out of 10 received funding from different agencies. This is proof that the KTH Live-In Lab concept works. This facility enables industry and academia to work together and conduct tests in stages, from pilot tests in the four test apartments to larger tests using hundreds of apartments, and educational facilities.

All this would not have been possible without engagement from the board, the executive group and the researchers and

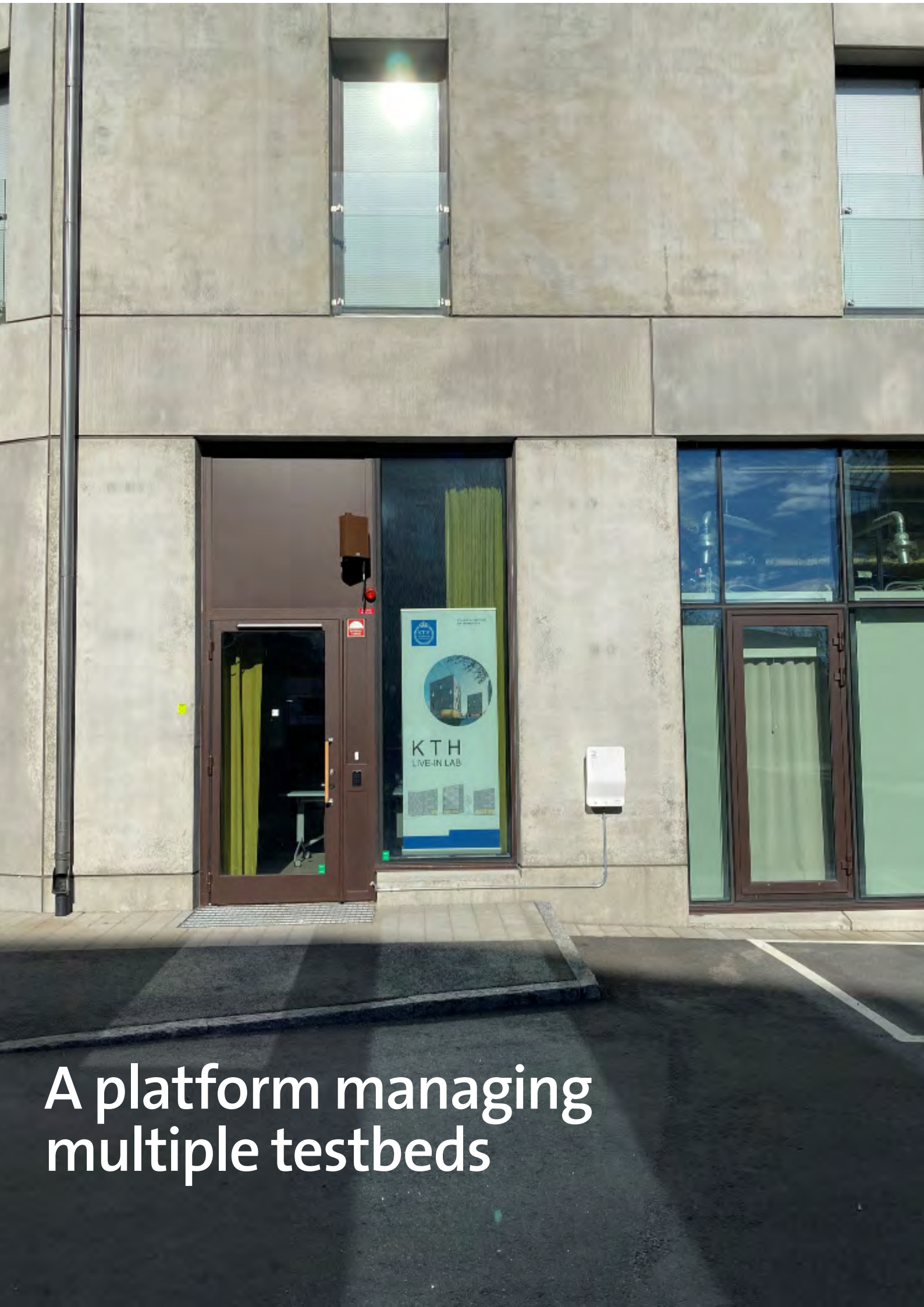
company partners working on individual projects. Together, academia and industry are pushing the boundaries of how to understand smart and sustainable buildings in order to minimise building-associated resource usage. We have also identified multiple use cases and created new services from single techniques/expenditures to maximise the perceived values for building owners, operators and – most importantly – users. In 2019, the Live-In Lab database also went from idea to fully functioning tool. It is now possible to access both real-time and historical data from Testbed KTH, Testbed EM and Testbed AH. Of course, in line with both research ethics and the EU General Data Protection Regulation, the database was developed through cooperative projects between KTH, Stockholm University and centre partners.

Research in KTH Live-In Lab

The number of projects – both in progress and completed – has increased, and the project portfolio now includes more projects than anticipated. An additional two projects have been accepted and will be launched in 2020, not to mention at least four larger-scale projects that are under discussion. The number of project applications to use the KTH Live-In Lab has decreased since the KTH Live-In Lab first opened; see Table 1. This probably due to a shift in focus from outreach in search of project participants to building test infrastructure and launching projects that have been accepted.

Projects	2015	2016	2017	2018	2019	Total
Applications	2	16	14	10	8	50
Started	2	0	3	8	8	21
Completed (by year- end)	0	0	2	1	8	11
Total in Progress (during whole year)					16	**16**

Table 1 – Projects at KTH Live-In Lab 2019



A platform managing multiple testbeds

Ongoing projects

There were a total of 16 projects ongoing during 2019. Almost all are collaboration projects between industry and academia. All projects have a reference number consisting in the application year and month.

1611

Smart Building Management systems

Project Managers
Marco Molinari & Davide Rolando
Companies/Organizations/Schools
KTH, Automatic Control, ACCESS and Energy Technology, Botrygg, Tovenco, Akademiska Hus)

1612

Improved borehole technology for Geothermal Heat Pumps development

(two project applications as part of one overarching project: 008 –Testbed for future borehole heat exchangers)
Project Managers
Alberto Lazzarotto & Willem Mazzotti
Companies/Organizations/Schools
ITM (KTH, Akademiska Hus AB, Avanti System Aktiebolag, Bengt Dahlgren AB, Climacheck Sweden AB, Einar Mattsson, Geobatteri AB, HP-borrningar i Klippan AB, MUOVITECH AB, Nowab AB, SINDEQ Borrteknik AB, SWECO Environment AB, Stures brunnsborrningar AB, Svensk Energi & Kylanalys AB, Triopipe Geotherm AB, Tyréns AB, Wessman Entreprenad AB, KTH Live-In Lab, Thermia Danfoss, Energimyndigheten, Brugg Cables, Asplan Viak, NTNU, WellPerform)

1702

Allergen free indoor environment with innovative ventilation strategies

Guro Gafvelin & Hans Grönlund
Companies/Organizations/Schools
Karolinska (Terapeutisk Immundesign, Inst för klinisk neurovetenskap, Karolinska Institutet, ITM ETT)

1712

Housing storage on demand

Project Manager
Sebastian Wiberg,
Companies/Organizations/Schools
Vinden AB

1713

Testbeds for accelerated innovation

Project Manager
Jonas Anund Vogel
Companies/Organizations/Schools
KTH, Akademiska Hus, Schneider Electric, Nordic Choice Hotels, Einar Mattsson

1718

Efficient kitchen ventilation with energy recovery

Project Manager
Jörgen Holmgren
Companies/Organizations/Schools
KTH, Tovenco AB, Fläktwoods, Camfil

1801

Occupant pro-environmental choice and behaviour

Project Manager
Agnieszka Zalejska Jonsson
Companies/Organizations/Schools
KTH ABE & UTS-University of Technology, Sydney

1803

Ensuring sustainability and equality of water and energy systems during actor-driven disruptive innovation

(3 project applications as part of one ongoing project: 003–Heat pump assisted heat recovery from wastewater: Performance of various heat exchangers and long-term effects and 023–Greywater recycling).

Project Manager

David Nilsson ABE & Jörgen Wallin ITM

Companies/Organizations/Schools

KTH ABE/ITM, Vattencentrum, Graytec AB, HSB Living Lab, Värmdö Kommun, Sthlm Exergi, Svenskt Vatten, Akademiska Hus, Einar Mattsson, Uponor, Familjebostäder, Stockholm Water and Waste company.

1806

Social and environmental sustainability through a local social network

Poject Managers

Hossein Shahrokni & Aram Mäkivierikko

Companies/Organizations/Schools

KTH ABE (KTH & Local Life)

1808

Service design for the sustainable behavior modeling: Smart schedule

Project Manager

Elena Malakhatka

Companies/Organizations/Schools

KTH ITM, Schneider Electric, Electrolux, Akademiska Hus, Ouraring

1809

Sound-proofing between flexible apartments

Project Manager

Jonas Christensson

Companies/Organizations/Schools

KTH, Saint-Gobain

1810

KTH Big Database

Project Managers

Anne Håkansson & Patrik Blomqvist & Jonas Anund Vogel

Companies/Organizations/Schools

KTH EECS, ITM and Admin

1901

Consequences of GDPR for ethical review of research on smart houses

Project Manager

Cyril Holm

Companies/Organizations/Schools

Stockholm University ,KTH, Akademiska Hus, HSB Living Lab

1903

Pilot study for reduced water consumption by non-invasive ultrasound technology

Project Manager

Thibault Helle

Companies/Organizations/Schools

Energimyndigheten, Vinnova, SSE Business Lab

1905

Efficient energy active envelopes (EAE) integrated into low-temperature heat and high-temperature cooling

Project Managers

Behrouz Nourozi & Qian Wang

Companies/Organizations/Schools

KTH ABE & Lowte, Peter Platell

1907

Co-living & Productive space usage

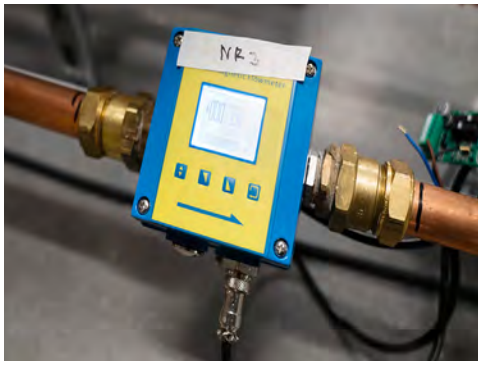
Project Manager

Linda Teng,

Companies/Organizations/Schools

Akademiska Hus, KTH, Schneider, Nordic Choice, Einar Mattsson

Read more: https://www.liveinlab.kth.se/en/projekt/aktuella-projekt/efficient-integration-of-energy-active-envelop-eae-with-low-temperature-heating-and-high-temperature-cooling-1.945267



Pictures from some of the ongoing projects.

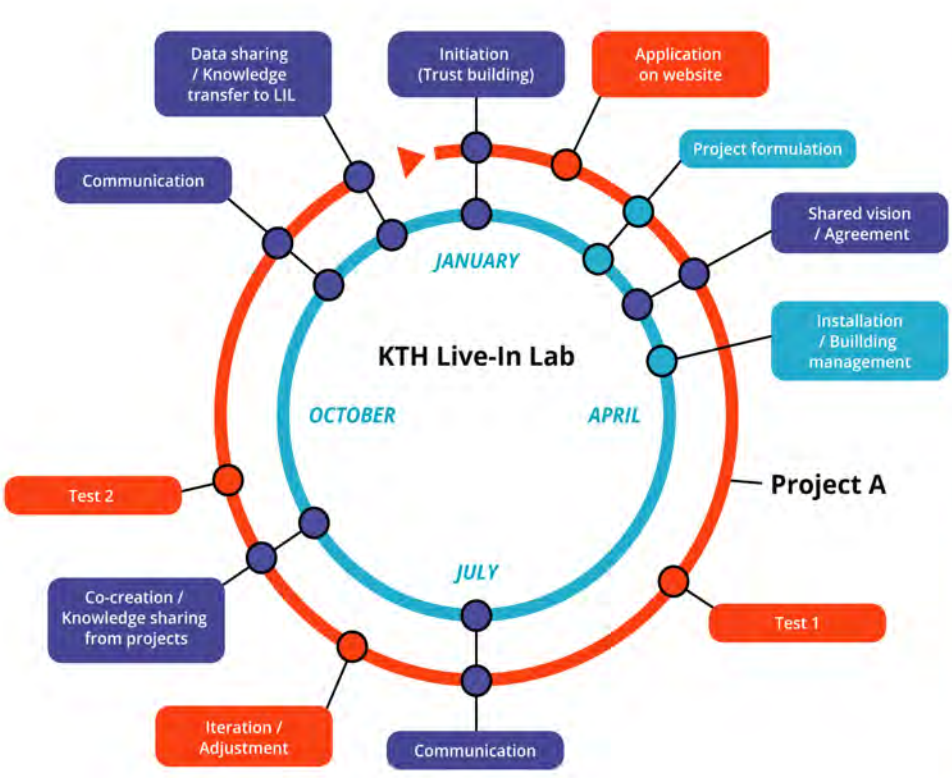
Planned projects

Projects starting 2020

Co-Kitchen: Investigating kitchens and bathrooms in co-living apartments.
Sara Ilstedt, Tove Malmqvist, Jonas Anund Vogel, Akademiska Hus, Savvy, TIP, Electrolux, Partab, Tovenco,

Nudges and Boosts: Investigating nudges and boosts in order to decrease resource usage.
Till Grüne-Yanoff

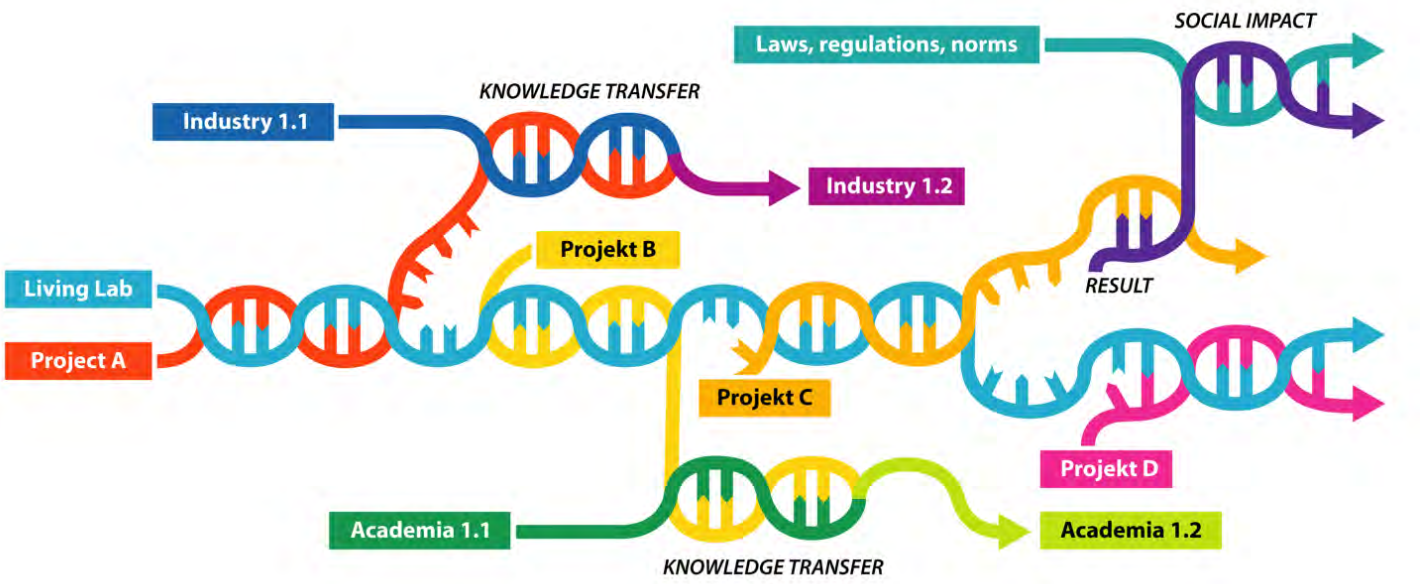
Structures and procedures are vital to reach impact, and to enable co-creation in cross-disciplinary projects. Projects in KTH LIL must always perform a handful of identified core activities, such as ideation, agreements, communication and, most importantly, collecting and storing data and results so future projects can pick up where the first one left off. Other activities are project specific. KTH LIL always supports projects with what they need.



Core activities
- Initiation (Trust building)
- Shared vision / Agreement
- Communication
- Co-creation/ Knowledge sharing
- Data sharing / Knowledge transfer

Supporting activities
- Project formulation
- Application for funding
- Team building
- Data management
- Installatio / Building management
- User contact for questionnaries
- Legal framework
- GDPR

Project specific activities, for exemple:
- Application
- Test
- Funding
- Time Planning
- Installation



KTH Live-In Lab has many projects, each of which learns as part of the collaboration and then brings this knowledge back to the mother organization (aca¬demia or industry). Competence achieved typically stays with project participants, and hence it is vital to create long-term, "sticky" relations¬hips and design projects that last for several years in order to maintain momentum.

Results from multiple projects are collected by KTH LIL. When combined, results might indicate that change is needed at the societal level. This is typically not handled within single projects, but KTH LIL together with multiple projects can use results to transform the built environment. It is therefore important that KTH LIL adopt an open stance and communicate its findings in order to change society.

Example of projects under discussion with industry and researchers

BIM and digital twins
Collaboration project with Tyrens, Telia, NTNU, Newsec and also Schneider and Equa.

Digitalization of property management
Collaborative project with CBE (Centrum för Byggeffektivitet KTH) and Stronghold.

General administration, common tools etc of Living Lab activities
General administration and common tools for living lab activities: Collaborative project within the ISCN (International Sustainable Campus Network) mainly involving Leender Verhoef (AMS Institute), Joy Lam (Hong-Kong University) and Julie Newman (MIT Office for Sustainability)

Results from projects performed in KTH Live-In Lab

1901-Legal aspects on the digitalization of construction

Rapid technological development enables us to produce buildings that are more energy-efficient. Those same technologies also make it possible to optimise designs based on analysis of how buildings and building components are used over time, a process that necessitates the collection of personal data. This raises a number of issues regarding security, integrity, responsibility and ownership of these data.

There is a need for increased basic legal competence and knowledge of this area. One of the main reasons is that digitalisation offers such valuable opportunities for monitoring and collecting data that it winds up challenging individual sovereignty and several legal basic principles.

This particular project studied these issues in order to better understand what kinds of information can be ethically and legally collected from smart houses.

The project found that:

- Working with optimisation (privacy by default/design) should create no direct problems in relation to the GDPR.
- Under the GDPR, there is a difference between building optimisation and the provision of services resulting from digitalisation.
- The GDPR has to be considered when developing new services for users.

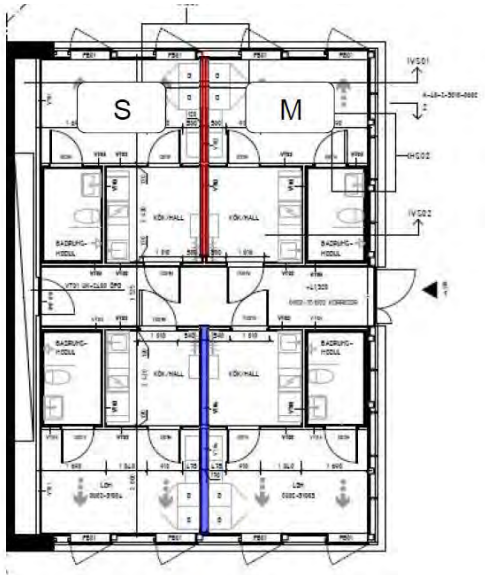
The full report is available at:

https://www.liveinlab.kth.se/polopoly_fs/1.901706.1557129444!/Slutrapport%20Juridik%20och%20digitaliseringen%20av%20samhallsbyggnadssektorn.pdf

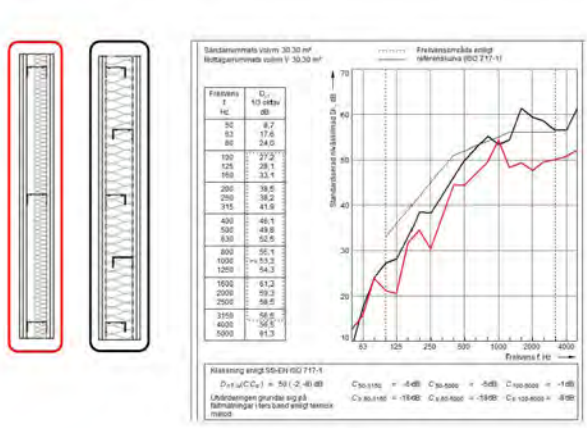
1809-Sound-proofing between flexible apartments

Sound-proofing between apartments is governed by regulations, with the Swedish National Board of Housing, Building and Planning Building Regulations (in Swedish, Boverkets Byggregler BBR) setting the current level for student apartments at 52dB. When creating the first set of apartments in Testbed KTH, the researchers and companies involved were interested in investigating sound-proofing in flexible structures.

Testbed KTH uses flooring from Lindner, an interlocking wall cladding system from Oneday Wall, and ceiling materials from Ecophon. The walls between the four apartments use two different construction methods: one where the wall studs are aligned (röd mätning/red measurement) and a more complicated and expensive method where the studs are offset in order not to transfer sound (blå mätning/blue measurement) (see figure 2 below).



The measured sound values were 41dB for the red and 44dB for the blue walls. None of the walls reached the BBR maximum level. However, the flooring material and ceiling construction have significant impacts on sound-proofing, and these factors are yet to be investigated. A 52dB sound-proofing level prevents loud speech from transmitting between apartments, but less stringent requirements such transmission is possible.



In this study, students were expected to spend 6 months in an apartment separated with a red wall system and 6 months in a unit with a blue wall system. However, because neither design allowed loud speech to be transmitted audibly, the students did not want to move. Interestingly, even those living in the red wall system, which achieves only a 41dB rating, did not want to move.

All the students said they were unhappy with the sound-proofing between the apartments. The interesting thing to note here is the trend toward producing co-living apartments, where there is no regulation of sound-proofing between single rooms in shared apartments except for 35dB for sleeping rooms. This very limited study suggests that it is important to also take sound-proofing between rooms in shared apartments into account when designing co-living concepts.

1713-Testbeds for accelerated innovation

Purpose and goal

The purpose was to expand the test infrastructure to more building types/functions/actors. The objectives were the creation of routines, documentation and installation of technical infrastructure to be able to carry out projects in different buildings.

As a result, (1) KTH LIL went from one testbed to a platform of multiple testbeds; (2) tests/studies can be performed simultaneously in the different testbeds, and different tests can be conducted successively in different environments; (3) KTH now has a server for the collection, handling and visualization of data from all testbeds.

Results

As a result of the project, (1) all documents, strategies and the website have been updated and revised; (2) testing and research strategies have been updated and financing offers and options have been revised; (3) a server for data collection, management and visualization was installed at KTH, linked to Testbed KTH, with integration with other testbeds in progress and expected to be finished in early October 2019; (4) existing agreements drawn up by KTH's lawyers were judged to be well-tuned, secure and not in need of revision.

The full report is available at:
https://www.kth.se/polopoly_fs/1.953419.1580111355!/190830_Slutrapport%20Multipla%20testbäddar.pdf

1702-Allergen free indoor environments with innovative ventilation strategies

Purpose and goal

Well-designed studies on the spread of allergens from pets are limited, and consequently we lack evidence-based advice on how to limit this problem. This feasibility study evaluated air sampling methods and developed analyses of allergens in air samples. At the end of the project, further analyses will be added and a methodological report will be compiled. Future studies can use our data as a basis to design suitable methods to study allergen spread and exposure. A full-scale study of health effects in a residential environment is not considered feasible at present.

Results

This feasibility study found that data on the spread of pet allergens is most reliable when studied under well-defined experimental conditions. Our study on methods for the collection and detection of allergens offers tools for such controlled studies to evaluate different measures for ventilation and air purification. For example, activity may be controlled by activity meters on animals and humans. Data on pet allergens in air samples can be used to create computational models of fluid dynamics to minimize allergen levels in indoor environments.

The final report is anticipated in spring 2020. It will be available at :
https://www.kth.se/en/2.88186/om-kth-live-in-lab/rapporter-och-vetens

Education

There is a large and growing interest in using the KTH Live-In Lab for academic courses and theses. So far, its involvement in courses has been limited to site visits, workshops and presentations/lectures. The aim is to develop course packages that can be included in already-existing courses at KTH, focusing on a cross-disciplinary co-creation group works where the infrastructure is used for problem-solving and development.

These are a few of the courses that have visited or used the KTH Live-In Lab as parts of their curricula:

MJ1141 Energy Systems and Sustainability
Per Lundqvist, ITM

MJ1150 Energy and Systems, Innovation and Entrepreneurship
Hatef Madani, ITM

MJ2460 Green Building - Concept, Design, Construction and Operation
Jaime Arias, ITM

ME2016 Project management: Leadership and control
Anna Jerbrant, ITM

AI1146 Fastighetsförvaltning
Agnieszka Zalejska Jonsson, ABE

AF2511 Building Service Technologies and Systems
Sasan Sadrizadeh, ABE

CYL-P Cyber Law
Cyril Holm & Stanley Greenstein, Stockholm University, Juridicum

Theses connected to the KTH Live-in Lab

A large and growing number of graduate students are interested in conducting thesis/dissertation projects using the KTH Live-In Lab facilities. The KTH LIL can use students and thesis projects as an initial connection point between industry and academia, and all thesis projects conducted at the KTH Live-In Lab should include a one-page statement on possible future collaborations between the KTH Live-In Lab and the company/researcher in question..

1.1. Nordin & Manfredh, 2019, A scalable web-based system handling sensor data from smart homes
A smart home is a building equipped with sensors collecting data about its environment. Data collected from smart home buildings can be used for research to improve home automation and develop smart cities.

A scalable web-based system can be used to handle the large quantities of data generated from smart homes. Previous studies have been conducted on the requirements of a system collecting sensor data from smart homes, however, information about the presentation of data is still lacking. Because of this research needs to be done on what kind of system handles and presents sensor data well. The aim of this degree project is to identify the requirements of a web-based system handling and presenting sensor data.

A scalable web-based system is developed based on the requirements identified from interviews and a literature study. The system shows that sensor data can be presented in a manner which facilitates research. Results show that a scalable web-based system can be used to display and download sensor data with associated information about the data.

1.2.Emelie Ekström, 2019, Use of biomimicry applications to improve energy performance in buildings
The purpose of this thesis is to answer the question which applications of biomimicry could improve the energy performance in buildings in Swedish and Nordic climate? This question is answered through three subqueries: Which possible applications of biomimicry to improve the energy

performance in buildings are there? Which potential European partners to KTH's project Live-in Lab are there? And what are the possibilities for the introduction of biomimicry in the Swedish construction industry?

To answer the thesis' questions, a literature study and interviews have been conducted. Several search engines and databases were used to find information for the literature study, and many articles and books based on the searches were studied. Three interviews were conducted for this thesis. The interviewees were a representative from a construction firm, a representative from the architectural profession and a representative from a real estate company. Furthermore, an investigation of the impact of biomimicry on the business model of a construction company as well as a SWOT-analysis have been made to further analyses the results from the literature study and the interviews.

The work has shown that there are many interesting applications of biomimicry to improve the energy performance of buildings. Everything from cones to the natural fossilization process has been mimicked in the search for the best biomimicry applications. The work has also shown that there are many potential partners for KTH's project Live-in Lab.

Many companies, universities and individuals come up with and develop biomimicry applications with the aim of reducing the energy usage in buildings. Finally, the work shows that there is a relatively good chance for a successful introduction of biomimicry in the Swedish construction industry.

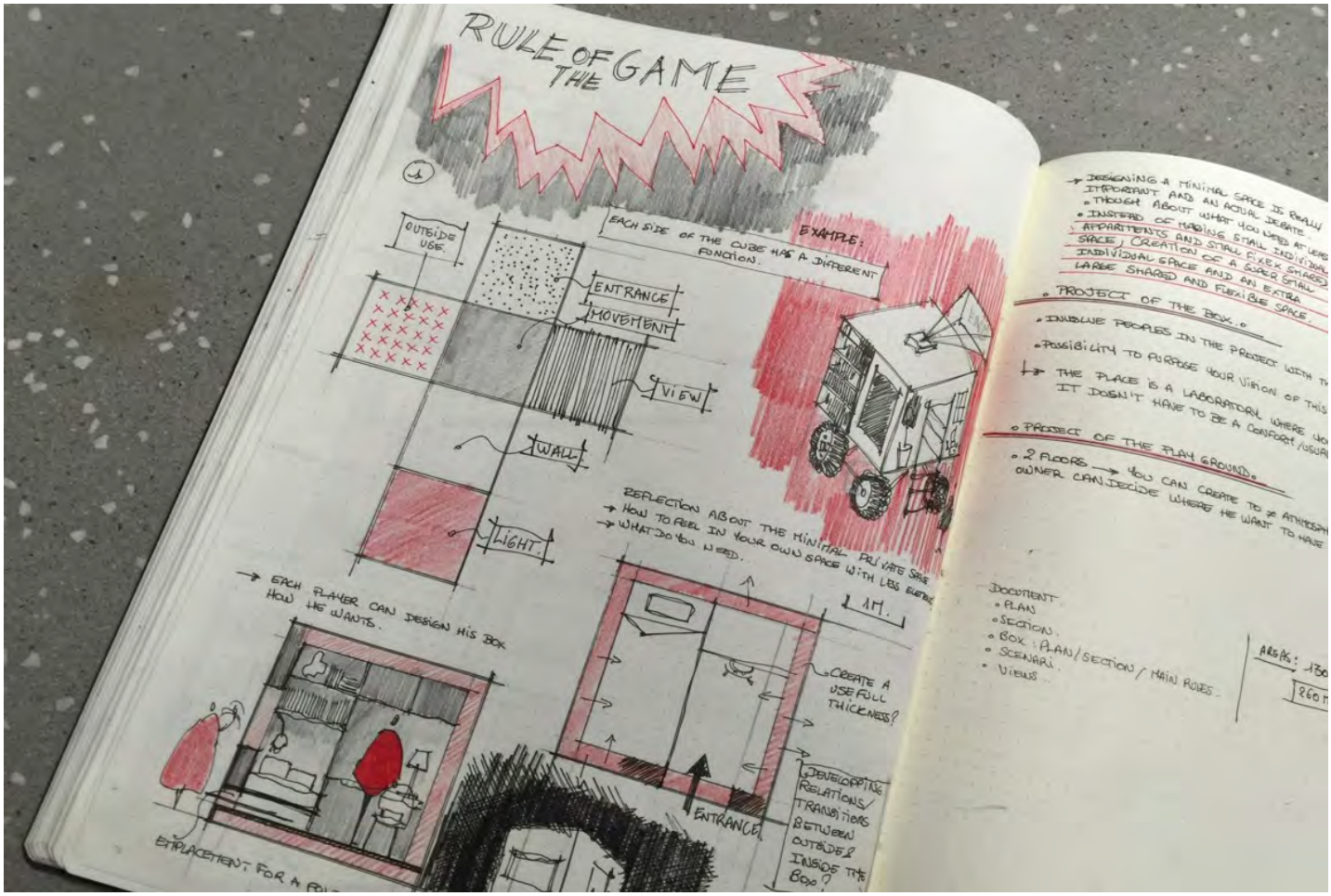


Illustration from the course Smart Living , @KTH ARCH

Infrastructure & Database

The KTH Live-In Lab platform consists of multiple test-beds that are designed with flexibility and adaptability in mind. This design seeks to be able to incorporate almost any product or service imaginable and, together with other solutions, comprise an integrated, real-life trial system.

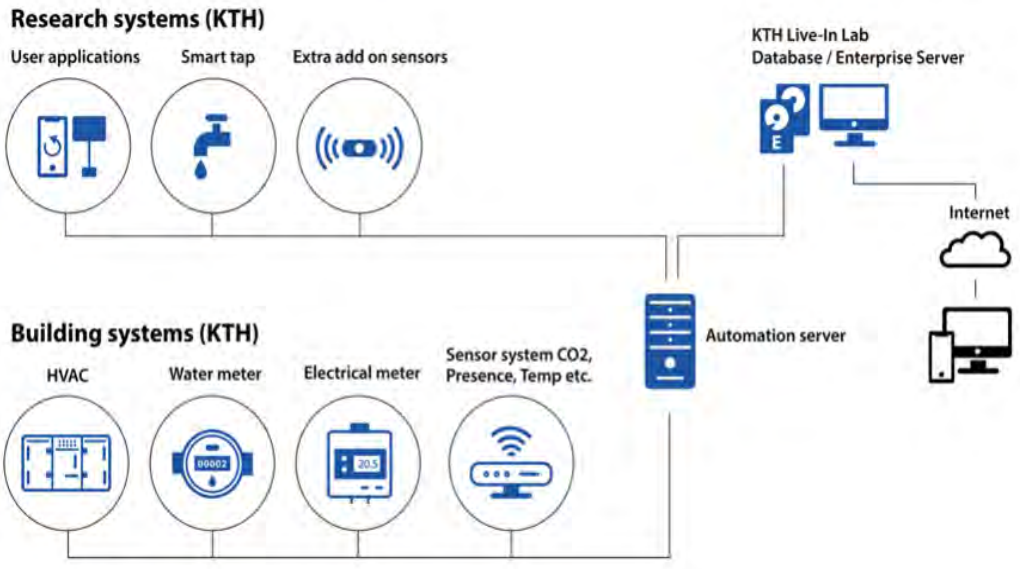
The KTH Live-In Lab testbeds are open to anyone who wishes to conduct research and tests on products, services or processes within an area associated with the real estate and construction sectors. Research on new business models and collaboration structures is also possible. There are currently three testbeds at the KTH Live-In Lab: Testbed KTH, Test-bed EM and Testbed AH.

Testbed KTH

This facility totals 305 sq.m, distributed into approxima-tely 120 sq.m of living space, 150 sq.m of service space and a project office measuring approximately 20 sq.m. Testbed KTH allows different apartment configurations to be built each year, which KTH will rent to students who apply to stay in the test apartments. The testbed is extremely flexible in terms of its geometry and facilities. It also has its own PV solar facility and its own borehole and ground source heat pump with a replaceable collector unit.

Different apartment layouts can be configured within the 120 sq m living space, depending on the projects currently in progress. The innovative environment is designed to accommodate any future technology, but the initial projects are seeking to provide insight into cutting-edge building technologies such as vacuum panels, low-voltage residen-tial micro grids, phase-changing materials, energy storage, 'tri-generation' (production of heat, cooling and electricity), vacuum toilets, smart lighting just to mention a few.

In addition to clean-product tests, the testbed can be used to study adaptive control and control systems, extended sen-sor installations and future IoT platforms to develop new services and processes related to user and property data.



In addition to clean product tests, the testbed enables adaptive control and control systems, extended sensor installations and future IoT platforms to develop new services and processes related to user and property data.

Testbed EM

Testbed EM consists of three buildings with concrete outer walls. The standard apartments are 19.5 sq m, and all have their own kitchen and bathroom.

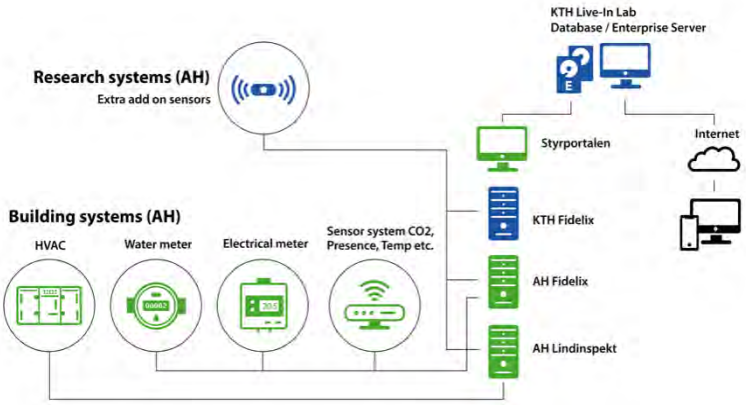
The buildings have a common laundry room and mailroom and are heated using preheated supply air. Hot water and heating are generated via heat pumps connected to 12 geothermal boreholes, each of which is 360 m long. A number of the holes also have fibre optics installed for longitudinal temperature measurement, in order to provide data for research. All the three buildings have Roof-mounted solar cells, totalling 1,150 sq m.

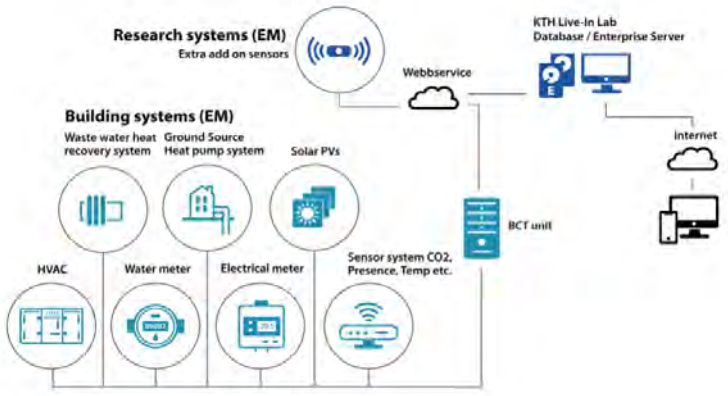
In addition, 50 wastewater heat recovery heat exchangers, both vertical and horizontal, have been installed. The air supply and extraction can be adjusted individually in all apartments. Each unit has measurement systems for hot water, electricity, CO2, and light, and the control systems can be manipulated for research purposes.
Measured annually, the buildings are considered 'plus energy houses' – generating more electricity than they use for all their systems

Testbed AH

The Undervisningshuset building was designed purely for learning and teaching; in it, the learning environments and educational methods of the future can be developed. The building contains flexible environments for different types of learning, ranging from lecture halls for teacher-led instruction to group and individual workspaces. The aim was to ensure the use of the best and latest pedagogy in a cutting-edge learning environment. The school is available for use by any program at KTH.

The building's hundreds of sensors measure electricity, water, air flow and CO2, as well as moisture levels and movement in different parts of the building. The building is in operation and generates a great amount of data that can be used by KTH Live-In Lab, as well as by students and researchers through the KTH Live-In Lab database.





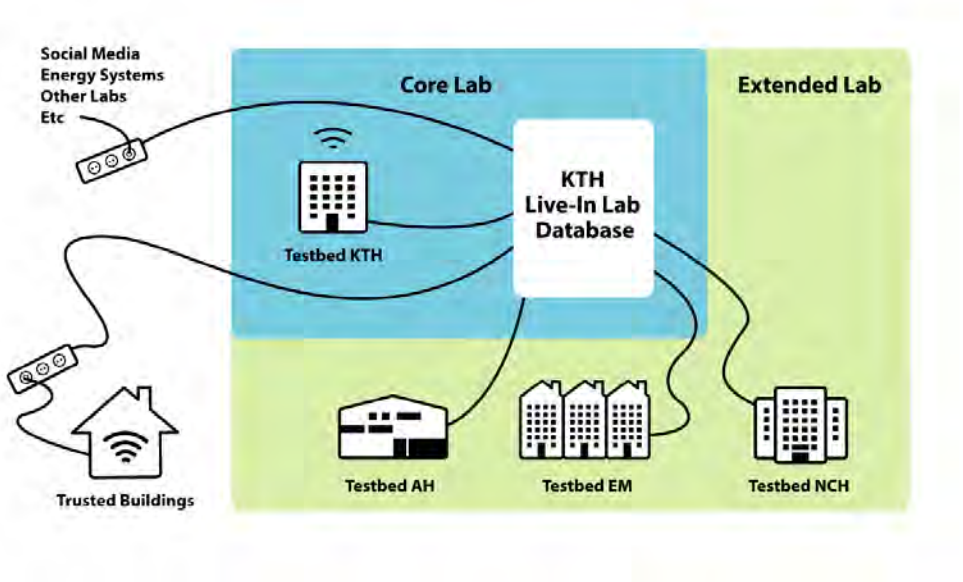
Database and data management

Linking several existing buildings to a single database/server required a solution that uses local automation servers in conjunction with a central server installed on the KTH network. The KTH Live-In Lab system for building automation, data collection and data storage is based on Schneider Electric's StruxureWare Building Operation system.

The system enables real-time monitoring and operation of all systems in Testbed KTH, including heat, water, ventilation, carbon dioxide level and windows. The system also collects and monitors data from the other three testbeds but does not currently control or operate those systems. The system also enables operational diagnostics, fault detection, maintenance and graphical display of data.

It is also envisaged that in the future the system will also enable customisable interfaces for user groups (students, industry and academia). A Schneider Enterprise server has been installed on KTH's network, which communicates with the three active testbeds. At Testbed KTH, the enterprise server reads data from the local building automation servers (Schneider Automation Server), and at Testbed EM and AH it reads data from web services. The automation server is used to coordinate all administrative functions, such as data collection, diagnostics and error detection.

The automation server stores images and history and can be used to create superior logic for timers, setpoints etc. An automation server is a property-specific server, while an enterprise server connects multiple automation services or external systems and either allows them to work together or simply collects data.
For example, a system consisting of a central server that communicates with local controls and control systems can be used to manage projects aimed at smart neighbourhoods and smart cities, performing functions such as load shifting, local energy storage/generation and so on.



Overview of test infrastructure at KTH Live-In Lab

Interview with Niccolas Albiz

“We innovate at a much higher rate than the industry thought possible”

Niccolas Albiz is a former Project Manager at KTH Live-In Lab, from the start of the Vinnova project to 2017.

How did you came in contact with KTH LIL?
Through my professor, Per Lundqvist, who saw a need for support on the KTH Live-In Lab team that they were putting together. I sat down together with him and Jonas Anund Vogel, and the three of us applied for a grant, secured funding from Vinnova and started working on their project as the first one for the KTH Live-In Lab.

What is your opinion on how will KTH LIL affect the construction sector?
The KTH Live-In Lab is a unique solution. It enables testing and research on technology, policies and behaviours. Some of these components are found at other testbeds, but none do it this way in the construction sector – particularly not as a neutral platform, which ensures credibility.

That a specific platform could be built for researchers and companies to collaborate, in an industry that does not invest much in R&D, is in itself an important contribution. It is very important that we show industry that it is possible to innovate and test to a much greater extent than previously thought.

Just the fact that the KTH Live-In Lab is a risk-free environment for companies and researchers to test in is a very important contribution that I believe will allow the construction sector to develop faster.
It will also allow regulations and similar structures to keep pace with innovation, something that can either help or hinder development depending on their ability to adapt.

What more do you would like to say to those who are reading this?
We know from research on the industrial transformation of sectors, and from historical examples, the level of knowledge must be increased in order to come up with better solutions; this is something the KTH Live-In Lab can contribute to.

Furthermore, we know that a recurring success factor for innovation clusters is openness and trust. If we can work more openly and create better dialogue around development issues, we can create better future solutions.
Finally, I just want to tip my hat to the amazing people who collaborate on the KTH Live-In Lab (companies, researchers and project managers). It is impressive that this testbed has managed to attract such high-quality people. What seriousness and competence there is! It’s something I truly came to see and appreciate during my time at the KTH Live-In Lab.

Impact & Outreach

Workshops

Conference "The Real Impact Factor – Methods for accelerating Innovation through Living Labs"

In November, the KTH Live-In Lab held a Conference/ Workshop to explore methods for accelerating innovation through the use of living labs.

The conference included presentations about different projects performed in living labs, as well as some thoughts on why these projects succeeded and had an impact or failed to do so. The presentations were followed by interesting discussions: for instance, the barrier that exists between academia and industry.

The agenda also included two workshops conducted by Lars Marmgren, in which participants were divided into groups in order to discuss two fundamental questions about the living labs concept:

1. What common factors seem to influence the use of results from Living Labs in a positive way?
2. What can we from Living labs do differently to create more impact?

The living Labs experts that made presentations:

- Jonas Anund Vogel - Director KTH Live-In Lab
- Leendert Verhoef - AMS Institute
- Emma Sarin - HSB Living Lab
- Ellen van Beuren - TU Delft

Site visits

There was enormous interest in visiting the KTH Live-In Lab in 2019, but it was not possible to accommodate everyone given the available resources. This was partly addressed by arranging a set of 'open-houses' to present the current status of the lab and its ongoing projects.
Nearly one company per week visited the KTH Live-In Lab.

Along with visits from the following actors, among others:

- Pharos University (February)
- AIT (February)
- Nacka Gymnasium (April)
- Interview for Swedish Radio P1, listen here: https://sverigesradio.se/sida/avsnitt/1290168?programid=2702
- Örebro Universitet, Alfred Nobel Science park, Örebro kommun (April & June)
- Enterprise Singapore (ESG) (May)
- IQS Board (June)
- "Första spadtag" Botrygg Uppsala (June)
- SVT films in the apartments for the show " Rapport från 2050" (August) view the show here: https://www.svtplay.se/video/25141886/rapport-fran-2050/rapport-fran-2050-boende?start=auto
- University of Cape Town (UCT), Cape Town, South Africa (September)
- Jiao Tong (3 Oct)

Field trips

During 2019 the KTH Live-In Lab visited a handful of similar testbeds/living labs. The first outing was a train trip to Amsterdam, which started by meeting René Tamboer at the TU Delft Green Village, an area outside of the campus used to test and demonstrate new technologies and methods (see https://www.thegreenvillage.org/). After that, the team (Jonas Anund Vogel, Per Lundqvist, and Cyril Holm) visited Willem van Winden at Amsterdam University to discuss the Knowledge Mile project, a project under the umbrella of Smart Amsterdam (https://amsterdamsmart-city.com/projects/knowledge-mile). This was followed by a full day at the Amsterdam Institute for Advanced Metropolitan Solutions, visiting Leendert Verhoef to discuss methods for achieving impact from living labs (https://www.ams-institute.org/about-ams/).

In October, the KTH Live-In Lab visited MIT and Harvard to discuss collaboration in general, as well as topics related to data (storing/sharing/accessing) to speed up innovation. A few highlights were visits to Harvard's "House Zero" (https://harvardcgbc.org/research/housezero/), a campus initiative to lower energy usage through nudging (pizza and

beer to those who saved a certain amount), and MIT Senseable City Lab that currently collaborates with KTH.

The year ended with a site visit to the HSB Living Lab and A Working Lab (Akademiska Hus) where we initiated yearly meetings in order to foster collaboration, to share results, and to plan for collective communication strategies.

Conferences Participations

Digitalize Stockholm

In November, the KTH Live-In Lab attended at Digitalize in Stockholm, a two-day event that allowed us to talk about how our platform works and at the same time network with research and innovation leaders and visionaries.

Malmö – Studentbostadsmässan Studbo 19

The KTH Live-In Lab and Akademiska Hus presented at Studentbostadsmässan in Malmö, where the main objective was to share an ongoing collaboration related to co-living and efficient space usage in student housing projects.

Uppsala – Fastighetsmarknadsdagen Digitalisering

KTH Live-In Lab also presented at Fastighetsmarknadsdagen Digitalisering in May, at Fastighetsmarknadsdagen Uppsala in October, and at the Swedish Energy Agencies "Lighting Week" in December.

Key performance Indicators

KPI - Research	Target 2019	Results 2019	Target 2020	Target 2021
Number of ongoing projects	10	16	10	10
Number of new larger projects	5	10	5	6
Number of new collaborations leading to applications involving KTH LIL	4	4	4	5
Number of projects initiated by the KTH LIL management group	1	1	1	1
Number of scientific publications made possible through the KTH LIL	2	4	2	3
Number of cross-disciplinary scientific publications	1	0	1	2
University-wide project collaborations	> 50%	67%	50%	50%
Number of spin-off projects.	1	3	1	1

KPI - Finance	Target 2019	Results 2019	Target 2020	Target 2021
Total amount of funding, both in-kind and, cash made possible through KTH LIL (MSEK)	10	35	15	15
Total Industry Co-funding (MSEK)	5	10	5	5
Number of companies/organisations associated with KTH LIL	10	73	10	10

KPI – Impact and communication	Target 2019	Results 2019	Target 2020	Target 2021
Public presentations (discussion articles, newsletters, and communication activities)	10	15	10	10
Seminars and workshops	6	8	6	6

Dollhouse view of our 3D Virtual tour at KTH Live-In Lab.
The full 3D virtual tour is available at : https://www.kth.se/en/2.88186/om-kth-live-in-lab/testbed-infrastructu/3d-virtu-al-tour-in-our-testbeds-1.984726

STUDENT INTERVIEW WITH CORENTIN CHAUVIN-HAMEAU

"Living here is a rare opportunity"

Student living in one of KTH Live-In Lab apartments. Corentin, the student on the right side of the picture, is a master student in Robotics and writing his master thesis about underwater robots.

How did you hear about the KTH LIL?
I am part of an association at KTH formula students and I knew Gianluca Villani, who was living here the last year

When Gianluca told you about the KTH LIL, why did you think it would be a good idea to apply?
I don't exactly know, but I remember that he was so excited about the place, how he liked living there, the environment, the other students, so it sounded like a good place to live as a student.

And by then did you under the concept of the KTH LIL exactly? Could you understand from Gianluca's perspective?
A little bit, like the broad outlines, I would say.

And now, after almost 5 months living here, do you understand more?
Yes, I fully understand the concept—the specific details of all the ongoing projects not as much.

What it is your opinion about KTH LIL?
My opinion is mostly very positive, it's just from the student's perspective we are not very involved, so it's more about just living there.

Do you like living there?
Definitely yes, the apartment is super nice, it's on campus, the people around are super nice to us, and the environment is good. I think you could use us more in the way of testing more, or to get more results, but of course it depends on what kind of project is underway.

What is your opinion on how the KTH LIL will affect the construction sector?
I think it's a hard question, because, as I said, we are not always very involved. From our perspective, I don't think it changes so much, because I am not very involved.
When comes to the data, I don't know if only with us 4 would give a good view, but with all the other testbeds with more standard apartments I think would give a more real view. But this is from our perspective as a student. Maybe from a researcher's point of view it's different. But from the concept perspective, I think it's really positive, since you have always people living in a real apartment. This platform will enable people to test things in a practical way instead of just having the hypothesis and simulations.

What more do you would like to say to those who are reading this?
I recommend that students live here; it's interesting from a sustainability point of view – energy consumption. It has to do a lot with personal interests. But I also think the fact that it's on campus also makes it more attractive, and a rare opportunity. But maybe it's good for you to have people that are actually interested in sustainability, research, and data.

Project Partners 2019

Akademiska Hus AB
Almi
Anders Byggare
Arkitektkopia
Asplan Viak
Avanti System Aktiebolag
Altered Stockholm AB
Bengt Dahlgren AB
Botrygg,
Boverket
Brugg Cables
Chalmers Tekniska Högskola
Climacheck Sweden AB
Connect Sverige
Danfoss
Ecophon/Sait Gobain
Einar Matssin
Energimyndigheten
Electrolux
Familjebostäder
FM Mattsson
Fläktwoods
Geobateri AB
Graytec AB
Grunditz Göransson Arkitekter
Gustavsberg
HP-borrningar i Klipan AB
HSB Living Lab,
IKANO Bostad
Invisense
ITM ETT
Karolinska institutet
Karolinska universitetssjukhuset
KTH Innovation
Labtrino
Life Air
Lindner Group
Muovitech AB
Nordic Choice
Nowab AB
NTNU
Ochno AB
OnedayWall
Ouraring Podcomp
Potter Clarkson
Saint-Gobain
Schneider Electric
Semrén & Månsson
Sindeq Borrteknik AB
Skandia fastigheter
Stockholm Energi
Stockholm School of Economics
Stockholm School of Entrepreneurship
Stockholm Water and Waste Company
Stockholms iuniversitet
Stures brunnsborrningar AB
Sweco Environment AB
Svensk Energi & kylanalys AB
Svenskt Vatten
Tosibox
Tovenco
Transfer studio
Triopipe Geotherm AB
Twin Mountain Group
Theori in Practice (TIP) arkitekter
Uponoir AB
Vinden
Vinnova
Wistrand
Värmdö Kommun
WellPerform
Wessman Entreprenad AB

This is a total of 64 heat exchangers installed to use energy from sewage water to preheat fresh water.

CENTER PARTNER

Einar Mattsson

At the KTH campus, Einar Mattsson has built 305 high-quality student housing units totaling 6,329 sq m. This is also the location for the KTH Live-in Lab testbed, which was built in collaboration with KTH, with primary funding from Einar Mattsson. Einar Mattsson owns and manages the housing units and leases them to KTH.

Student apartments

All apartments have their own kitchenette and bathroom and thanks to alcoves and built-in storage, each one of the 19.5 square meters are maximized. The students share laundry and mail rooms, as well as other common areas. There are also repair stations for bikes.

Generating energy

The housing block are characterized by high environmental goals and initiatives. Thanks to innovative building design and optimized energy systems the buildings can generate more energy than they need (individual electricity consumption not included) on a yearly basis.
The buildings are divided into 24 zones to enable optimization of the energy systems, for example in relation to the sun and shade throughout the day

Geothermal heating

The living areas are heated by preheated supply air and should have a temperature of at least 20 degrees Celsius. Both the supply air and hot water are heated by 100% geothermal energy.

The system has three 60kW heat pumps connected to 12 boreholes with a total length of 3 185 metres.

Solar panels

The roofs are angled towards the south and southwest to maximize the sunlight exposure, as they are equipped with solar panels. A total of 667 solar panels are planned to produce 217,000 kWh/year. The electricity is used to run heat pumps and other systems.

Energy from waste water

There is a total of 64 heat exchangers installed to use energy from sewage water to preheat fresh water. This is made in two steps in order to recover as much energy as possible. When the sewage water leaves the building, it has the same temperature as the fresh water supply.

Research

It is possible to collect data from the energy system to contribute to further research, development and innovation.

About Einar Mattsson

The buildings

- The first students moved in in September 2017
- 305 apartments
- 10 590 m2 (Atemp)
- Concrete exterior wall elements
- Outer wall: 0,11 W/(m2*K)
- Windows: 0,64- W/(m2*K)

The energy system

- Geothermal heating, 12 bore holes, 3 185 meters
- 3 heat pumps x 60kW
- 667 solar panels
- 4+1 ventilation units (FTX)
- 315 Building Controller Transmitters (BCT) for smart management of technical systems

CENTER PARTNER

Akademiska Hus

Akademiska Hus has built 230 student apartments at Teknikringen on the KTH campus in Stockholm offering room for more than 400 students. Stockholm has an enormous need for student housing, and housing availability is crucial to enhance the city's attractiveness in the future.

Undervisningshuset

Undervisningshuset at KTH Campus Valhallavägen is one of the testbeds within the KTH Live-in Lab platform. The house is equipped with hundreds of sensors measuring temperature, carbon dioxide, humidity, air pressure and energy consumption. It provides students and scientists with necessary information to study the building performance under various climate conditions and different user perspectives. The data can be used for research,development and educational purposes within KTH Live-in Lab

Akademiska Hus vision

More housing also contributes to a more vibrant campus with people's life during all hours of the day, something that Akademiska Hus and KTH work for. Akademiska Hus provides the Teaching House at KTH Campus as a test bed to enable tests and research in collaboration with KTH Live-In Lab. The Vinnovas initiative aims to make it possible for new competitive environmentally sound and sustainable products and services to reach the market more quickly. Akademiska Hus together with Einar Mattsson, Nordic Choice Hotels and Schneider Electric merge with KTH and enable an increase in the number of test beds within KTH Live-In Lab. Thus, in 2018, KTH Live-In Lab goes from being associated with a physical test bed to becoming a platform that handles multiple test beds.

Undervisiningshuset short facts

- Inaugurated October 2017
- Total area about 3500m2
- Designed according to the wishes of teachers and students
- Educational tool for aspiring architects and community builders
- floors, 363 study places + 6 exercise rooms + 11 group rooms & break-out areas
- Undervisningshuset is built according to the environmental certification Miljöbyggnad Guld, which is the highest ranking (Gold, Silver, Bronze).

Undervisningshuset is an educational tool, with visible constructions and installation technologies that allow students and visitors to visualize the functions of the building. There are for example meters installed for collecting data of the installations, also functions for turning off ventilation in rooms (for experimental purposes).

Undervisningshuset


Building Operation
Schneider System

CENTER PARTNER

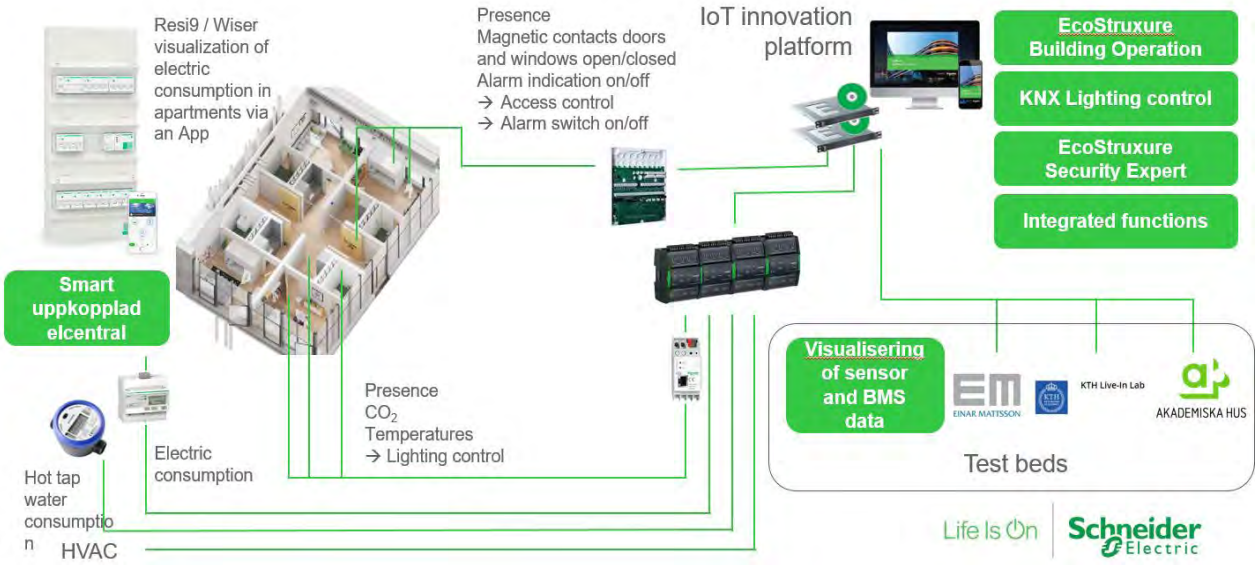
Schneider Electric

Schneider Electric wants to contribute to a more innovative construction sector and therefore expanded its cooperation with the KTH Live-In Lab in 2019. Schneider Electric will actively participate in research and development at the lab for three years by contributing consulting, services and technology.

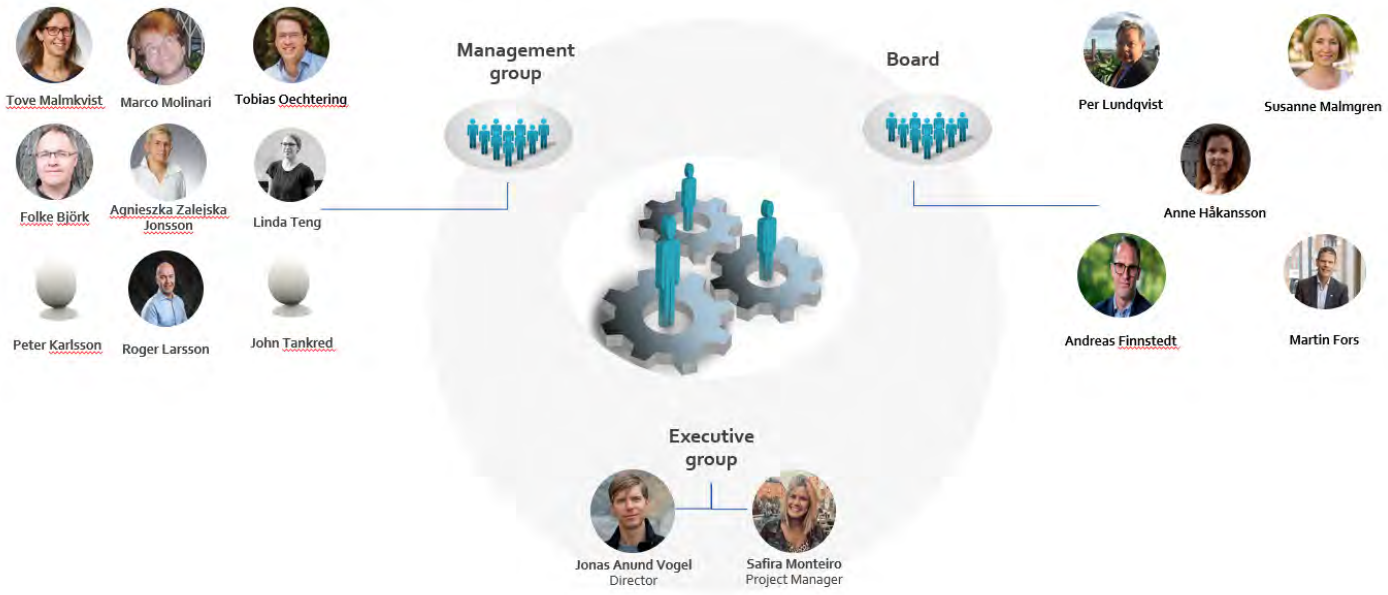
Schneider Electric Ambition

Our ambition is to contribute to this development and create tomorrow's buildings and projects that can meet new demands and needs. The KTH Live-In Lab is an opportunity for us at Schneider Electric to test new solutions, products and services that contribute to more-sustainable development. So far, Schneider Electric has installed smart home solutions (Wiser Energy, KNX); EcoStruxure™ Buildings Operation, an open, secure, and scalable IoT platform; the Security Expert connected security system; and the EVlink electric car charger. These installations are monitored and optimised and can be adapted by property owners, partners and residents.

"With an increasing world population, digitalisation and increased energy use, especially in buildings, the demand for innovation and sustainable solutions for buildings is greater than ever," says Andreas Finnstedt, Vice President and Head of the Digital Energy business area at Schneider Electric. "We need to collaborate and together create solutions for sustainable buildings and cities that utilize our resources in a smart way."



KTH Live-In Lab organization



Thank you all for the great year!

Newsletter

To get updates on current and coming projects, seminars and more, sign up for the newsletter here: (www.kth.se/en/2.88186/nyheter/nyhetsbrev-1.894666)

Annex 1

Projects Posters

Cost- and Energy-Efficient Control Systems for Buildings

Project managers: Marco Molinari, Davide Rolando

Schools: KTH-Department of Energy Technology

Collaborators: Botrygg, Akademiska Hus, Tovenco

Time frame: 3 years

Financed: This project is financed by the Swedish Energy Agency (Energimyndigheten) under the E2B2 program.

This project exploits high resolution data gathered in KTH Live-in Lab research testbeds through an advanced, modular and flexible monitoring set-up.

Background

Methods and demonstrations to move towards intelligent and smart buildings are needed. Monitoring data in buildings is currently collected without exploiting the inner potential for innovative solutions. This is typically due to, among other reasons, the lack of efficient and dedicated sensor network design and data structures.

Project description

This project exploits the high resolution real-time data gathered in the KTH Live-in Lab research test-bed through an advanced sensor and data infrastructure in order to evaluate the cost-effectiveness of smart buildings. Sensor measurements are used to identify common faulty settings in buildings ventilation and heating systems, estimating their impact on the energy use. Particular attention is dedicated to the user experience, the impact of the users on the energy use and visualization techniques to promote energy efficient behaviors.

Project Implementation

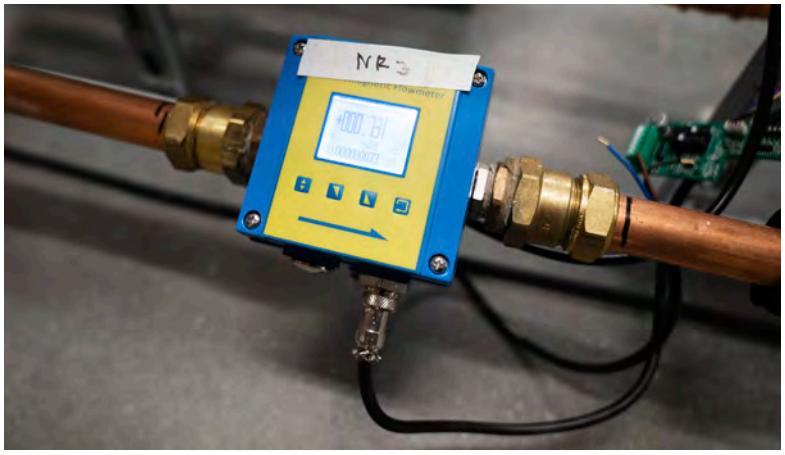
Three building facilities are used as implementation and prototypes: the KTH Live-In Lab Testbed KTH, the Undervisning Hus and the neighborhood of Uppsala Backe.

Project goals

- Assess the quality of data generated in the Live-In Lab testbeds, enhance existing features and improve the exploitation potential of existing databases.
- Understand the impact of behavioral patterns and faulty settings on the energy use.
- Test and implement of advanced and self-tuning control strategies in buildings.

Botrygg AKADEMISKA HUS Tovenco

Improved Borehole Technology for the Development of Geothermal Heating Systems



Project managers: Alberto Lazzarotto, Patricia Maria Monzo Carcel

Partners: Akademiska Hus AB, Avanti System Aktiebolag, Bengt Dahlgren AB, Climacheck Sweden AB, Einar Mattsson, Geobatteri AB, HP-borrningar i Klippan AB, MUOVITECH AB, Nowab AB, SINDEQ Borrteknik AB, SWECO Environment AB, Stures brunnsborrningar AB, Svensk Energi & Kylanalys AB, Triopipe Geotherm AB, Tyréns AB, Wessman Entreprenad AB, KTH Live-In Lab

Schools: ITM ETT, KTH Energy Technology

Time frame: 2–4 years

Boreholes with fiber optic measuring equipment makes it possible to evaluate thermal performance for boreholes of different lengths within the same borehole field.

Project description
The plus-energy houses are heated via a heat pump system with heat pumps and 12 drill holes totaling 3600 m. The geothermal installation design has some unconventional features that make the installation very interesting for research purposes.

The boreholes range from 100 to 350 meters and have been equipped with measuring equipment to be able to evaluate thermal performance for boreholes of different lengths within the same borehole field. The temperature along the boreholes is measured using Distributed Temperature Detection (DTS), a fiber optic technology, and linear temperature sensors. Fiber cables have been installed in five boreholes and provide measurement values of the borehole temperature profile during operation.

In addition to the areas of monitoring and measurement, drilling research in the KTH Live-In-Lab will also include innovative heat exchangers and borehole testing methods. For this part of the project comes a dedicated ”research drill hole” with a length of 100 meters and a coaxial design to be utilized. The concept behind this borehole is to provide borehole researchers with a highly flexible system to experiment with innovative ideas. For this reason, the pipeline is designed so that the fluid circulating in the ”research well” can be directed to a separate heat pump and operated with independent loads compared with the remaining part of the installation of the plus energy houses.

Implementation
The research heat pump system will be designed to accurately control heat supply and heat output to test the ground for a variety of load profiles with the aim of collecting valuable information to characterize short term thermal response for boreholes.

Allergen-free Indoor Environments Through Innovative Ventilation Strategies

Project managers: Guro Gafvelin, Hans Grönlund

Schools: KI Klinisk Neurovetenskap, ITM ETT

Collaborators: Lightair(f.d LifeAir) KI, KTH Live-In Lab, VINNOVA

Time frame: 2 years

A project initiated by Karolinska Institutet intended to test how airborne allergen from furred animals can be minimized in indoor environments.

Background

Furred animals are an important allergenic source in the indoor environment. In Sweden, about 15% are allergic to furred animals. Many pets stay most of their time indoors and follow their owners in the environments where they live.

Fur allergy, i.e. the particulate and airborne substances from animal fur that cause allergy, are spread both inside and outside the home and are found everywhere in society. It is therefore very difficult for people suffering from allergy to avoid exposure. Additionally, furred animals can also be found in households with allergies, as many people find it difficult to refrain from pets despite allergies.

Project description

The aim of the project is to design smart systems for measurement, control systems and ventilation / air purification with the aim of reducing the amount of allergen indoors.

The vision is to develop ventilation solutions that can be applied in residential and community planning to minimize the problems for people with fur allergy. This is done by reducing as much as possible the amount of fur allergens in residential and general indoor environments.

Project Implementation

In 2018, a preparatory project will be conducted to test measurement methods, perform modeling analyzes and investigate feasibility. Measurement methods and simulation techniques shall be designed to detect and map the airborne fur allergens. The methods are developed in experimental environment with controlled allergy supply and then applied to the KTH Live-In Lab where students with and without fur animals are invited to move in.

LIL – Multiple testbeds

Project managers: Jonas Anund Vogel

Schools: ITM ETT

Collaborators: Akademiska Hus, Schneider Electric, Nordic Choice, Einar Mattsson, VINNOVA

Time frame: 2 years

The four available testbeds are designed with flexibility and adaptability in mind to be able to incorporate almost any product or service imaginable.

Background

How do we convince decision-makers at every level – from politicians and officials, to project-developers and entrepreneurs – to invest in new resource-efficient technology, rather than options that will lead to a waste of resources? In order to enable this change, and to fulfil the environmental and energy goals, it is crucial for us to demonstrate – that new technology actually works and that installing it is economically viable.

In order to do that, we need to test the technology within current systems – with real users in real buildings. New technology is already being tested in ordinary buildings, but the testing process can take between 10 and 25 years to complete, depending on how often the buildings are renovated. It's now essential to increase the test frequency, standardise the way testing is carried out, and facilitate cooperation between different parties.

Project description

KTH Live-In Lab is a platform of multiple testbeds that is designed to accelerate innovation. Here we have advanced test infrastructure, including everything from technical systems and databases, to building users and operators. Here the new technology can be tested, developed and standardised in a whole range of contexts; from innovative apartments, to classrooms and hotels. The purpose is to accelerate the rate of innovation to make smart, sustainable buildings a reality within reach.

Project Implementation

The testing is carried out as a series of projects. And most of these projects involve a collaboration between academia, industry and society. Each project forms part of a big picture.

Efficient Kitchen Ventilation with Energy Recovery

Project manager: Jörgen Holmgren, David Södergren

Schools: KTH Energy Technology and KTH Building Technology

Partners: Tovenco, Fläktwoods, Camfil and KTH Live-In Lab

Research areas: Technical systems for DHW, heat or ventilation

Time frame: 1–2 years

A collaboration between KTH and Tovenco for more efficient ventilation in apartments through coordinated flow in the exhaust air ventilation and a developed kitchen hood.

Background

In Sweden, housing accounts for about 40% of total energy use. A large part of the housing's energy is used for heating and ventilation. Studies show that there are still great opportunities to save energy in buildings while increasing health and comfort. When inspecting air quality in apartments, air quality defects are frequently found due to insufficient ventilation.

Project description

The project aims to test and develop more energy-efficient and environment-friendly ventilation of buildings. This is done through a coordinated outflow to the exhaust air system through a new type of kitchen / cooker hood that provides more efficient energy recovery and reduces odors by means of a cyclone filter and a customized rotary heat exchanger.

The great potential of the project lies in the fact that by validating the effect of existing technologies in a real-life environment in KTH Live-In Lab, it can present technical solutions, assembly instructions and financial evaluations linked to both construction and operation, which can be used to enhance energy performance and improve the indoor environment in different types of buildings and operations.

Project Implementation'

Based on existing ventilation systems, an increased air flow is installed and tested using a developed kitchen / cooker hood in selected apartments at KTH Live in Lab. The project is monitored continuously through various checks of measurements and weighings.

Occupant pro-environmental choice and behaviour

Project managers: Agnieszka Zalejska Jonsson

Schools: KTH ABE

Research- / Development areas: Resident behaviour and communications

Time frame: 6-12 months

The project examines the factors that influence the residents' pro-environmental decisions and behaviors, including whether the building's properties make any difference for these decisions.

Background

The gap between customers' environmental knowledge and display of pro-environmental behaviour is an important and complex phenomenon that affects the housing market, the economy, society, climate and the possibility of achieving national and international environmental goals.

Many studies have been conducted with the assumption that information can change environmental attitudes and lead to pro-environmental behaviour. This approach has been proven to be insufficient to ensure sustainability choice or long term behavioural change.

Project description

This project is based on the results from my doctoral studies, which indicate that occupants initially pay little attention to the energy and environmental features of a building due to the inaccessibility of or low exposure to relevant information. Additionally, the difference between expectations and experience may contribute to the doubt towards pro-environmental choices. This disappointment is related to the dysfunction of 'hi-tech' technological solutions such as in-home displays that do not show accurate energy consumption information, operational problems with heating and/or the ventilation system and dissatisfaction with indoor environment quality, where, for example, temperatures are too low in the winter or too high during the summer.

Project Implementation

The intention is to use both quantitative and qualitative research methods. Together with the Stockholm School of Economics and the University of Technology Sydney, we will design and perform an experiment through which we can study whether the sustainable features of a building can encourage and support behavioural change.

Ensuring sustainability and equality of water and energy systems during actor-driven disruptive innovation – SEQWENS

Project manager: David Nilsson

Schools: KTH, Watercenter

Research areas: Technical systems for DHW

Time frame: 2-4 years

This project compares two types of non-coercive and non-incentivizing policies that aim to change households' energy

Background

A transformative shift in water and energy toward a low-carbon and resource efficient society is necessary for achieving the global sustainability agenda. Transformation of macro-scale infrastructures has already started, through for example, increased number of on-property installations for solar power generation. A new logic emerges within large-scale energy systems, spurred by decreasing renewable energy prices, which has very recently resulted in dramatically changing economic realities.

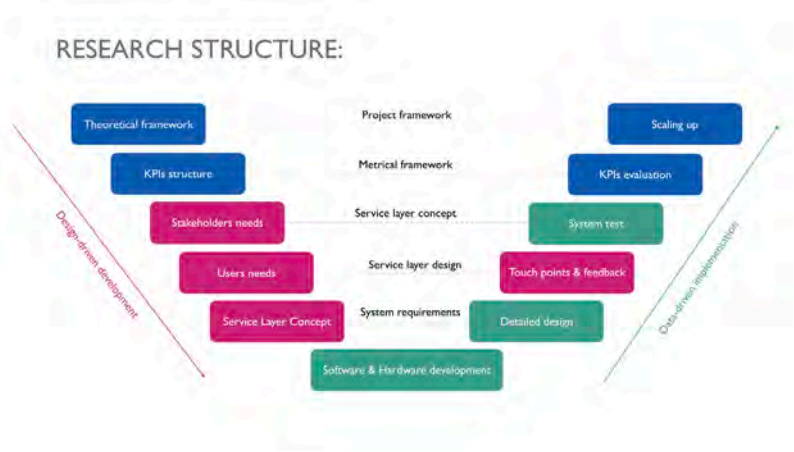
Project description

Essentially, the aim is to understand how different corporate actors influence the transition process of regional water and energy systems in the Swedish urban setting, and how their individual strategies create aggregated effects at the system level. This calls for a combined knowledge-set from energy systems and infrastructure engineering, sociology and innovation studies, as well as business management

Project Implementation

1. Explore and assess the state of the art in on-property water and energy reclamation through three case studies focusing on actors at meso-level and their strategies.
2. Build a system model of water and energy in Stockholm region to describe and assess the related system effects in a large urban Swedish city region.
3. Evaluate future scenarios, using the model to analyse the outcome for the various actors and assess possible system disruptions and social inequalities.
4. Initiate public-private dialogues on how to manage the societal transition process in the interest of all.

Service layer design for pro-environmental behavior in the built environment



Project manager: Elena Malakhatka

Schools: KTH

Collaborators: Schneider Electric, Electrolux, Akademiska Hus, Ouraring

Research areas: Resident behaviour and communications, Monitoring and steering

Time frame: 2-4 years

The project focuses on service design starting from the users' needs and experience, providing a systematic procedure that links data analysis to human-centered service design.

Background

The concept of connected environments and contextual data move beyond the "Internet of Things". Consumer expectations drive demand. That is why we have started to explore the concept of Living Services in KTH Live-in Lab – services that will be designed around the needs of individuals, as opposed to generic services defined by an organization for mass consumption.

Project description

By connecting the sustainable building operation with the end-users needs through living services, which are the middle layer between the building and end-user, we systematically increase of the users' motivation to behave more environmentally friendly and contribute into the more sustainable future.

Project Questions

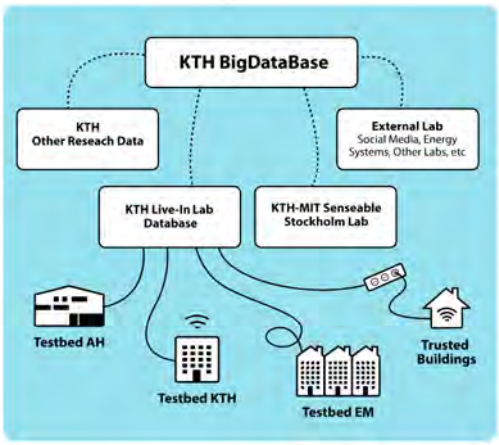
- SQ1: Which design methods are applicable at residents living services?
- SQ2: Which KPIs can measure the proposed services success?
- SQ3: Which data is available for the collection and which should be generated additionally?
- SQ4: Which data analyzing model can be applied to understand users' behaviors and its contexts without compromising with the privacy issue?
- SQ5: How proposed services could be adapted to other buildings of KTH Live-in-Lab platform?

Project Implementation

The project objectives are divided into four categories:

- Pro-environmental objectives
- User experience obejctives
- System requirement objectives

KTH BigDataBase and Enabling Data Sharing



Project managers: Jonas Anund Vogel, Anne Håkansson, Patrik Blomqvist, Anders Karlström

Schools: KTH, Stockholm University

Collaborators: Akademiska Hus, Schneider Electric, Nordic Choice, Einar Mattsson, VINNOVA

Time frame: 2 years

This project is founded by: Digitalization Platform

There is a great need from industry and academia to make cities, buildings and activities available for research, testing and education.

Background

Companies and organizations often also have large datasets stored, but relevant legal structures for how data can and should be used are usually lacking. In order to make better use of data and understand the use of cities, buildings and businesses, open and transparent data management is needed: an open database.

With the construction of an open database, questions about privacy and data security also follow. KTH Live-In Lab has already carried out a project on GDPR and Smart Buildings in collaboration with legal informatics at Stockholm University (SU), and a continuation project on ethical testing and smart buildings is ongoing. Talks are now also ongoing with SU about a national research database.

Project description

The project aims to set requirements and implement a database that scalably handles large amounts of data with an initial focus on real estate and user data as well as data from cities: It is about designing and developing a big-data database that collects data from other existing databases that, in turn, handle sensor data in different businesses. The database will also handle IoT and Artificial Intelligence technologies, such as machine learning to provide data to different stakeholdergroups, researchers, students, but also SMEs and property owners as they can enable innovations and thereby strengthen Sweden's competitiveness.

Project Implementation

The project is carried out in three parts:

- WP1: Requirements and identification of usecases (Q3-4 2019)
- WP2: Prototyping (Q1-2 2020)
- WP3: GDPR and data retention regulations (Q1-4 2020)
- WP4: Prototype test (Q3-4 2020)

Ethical and legal aspects of ”smart houses”

Project managers: Cyril Holm

Schools: SU, KTH

Collaborating Partners: Stockholms Universitet, KTH Live-In Lab, Akademiska Hus, HSB Living Lab

Time frame: 4-6 months

The possibility to collect personal data that comes with smart houses rises new ethical and legal issues. The project has focused on how the benefits of new technology and digitization can be balanced against the individual's integrity, something that has become even more important with GDPR.

Project description

The rapid development of technology enables the production of more energy-efficient buildings. The same technology also makes it possible to optimize designs based on analysis of how buildings and building components are used over time by collecting personal data. This collection raises a number of issues regarding security, integrity, responsibility and ownership of these data.

There is a need for an increased basic legal competence and knowledge in this area. One of the main reasons for this is that digitalisation has such great opportunities for monitoring and collecting data that the individual's sovereignty and several legal basic principles are challenged.

The development raises questions about

- Security,
- Integrity,
- Responsibility,
- Ownership of these data.

The project has studied these issues on the basis of what kind of information one should (ethically) collect in smart houses, and on the basis of what kind of information one (legally) can collect in smart houses.

The project was specially important because of the implementation of the EU's new data protection directive, GDPR.

Final Report

GDPR and Smart Buildings - A study of technology, individual and society in future smart buildings- Final report, april 2019

The focus of this report has been to show how to make it easy to build smart houses, and how to make personal data processing according to GDPR as easy as possible.

Pilot study for reduced water consumption by non-invasive ultrasound technology

Project manager: Thibault Helle

Project board members: Ramtin Massoumzadeh, Olle Henning

Collaborators: KTH Innovation; Connect Sverige; Stockholm School of Economics, Twin mountain group, Almi, Wistrand, ProvideU

Research areas: Housing behaviour and communication, Technical systems for hot water

Time frame: 1–2 years

Installation of Labtrino's water measurement technology provides improved knowledge of how measuring water consumption at the individual level can curb overconsumption

Project description

The project aims to investigate the possibility of reducing water and energy consumption in apartment buildings using Labtrino's innovative water measurement technology. In connection with this, significant knowledge of the measurement technology and consumption patterns of residents will be mapped, which can give rise to several new innovations, products or processes in the industry.

In the long term, there are hopes that the project will lead to a significant reduction in the consumption of water, reduced energy consumption and thereby a reduced environmental impact of multi-family houses.

The results of the project will also help to increase the interest of other players in the industry to work with other solutions to reduce water and energy consumption and strengthen the interest of users of the product to curb their overconsumption.

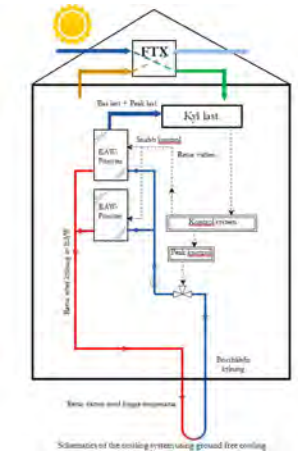
Project Implementation

The project is carried out as a major pilot study where the entire value chain from producer to customer is evaluated. The product is installed in homes in such a way that statistical significance of the evaluation can be achieved and used by end customers for a longer period of time so that data can be collected. The effects of the product on water consumption are evaluated.

Project updates and millestones

- Started production with a manufactering partner, ProvideU, in Estonia.
- Patent granted in Sweden, January 2020
- Product certification ongoing
- App for tennants in 2020

Efficient integration of energy active enve-lop (EAE) with low-temperature heating and high-temperature cooling



Project manager: Dr. Qian Wang

Main researcher: Behrouz Nourozi

Schools: KTH-ITM

Collaborators: Lowte AB, Department of Energy Technology, KTH, Depart-ment of Civil and Environmental Eng-ineering at the University of Alberta, Canada, KTH Live-in-lab

Research areas: Resident behaviour and communications

This project will investigate the technical possibilities and demonstrations of combining low-temperature heating (LTH) and high-temperature cooling (HTC) systems with

Project description

This investigation includes thorough dynamic simulations in both com-ponent level (EAW) and system level (combined EAW and LTH/HTC systems) as well as physical demon-stration and real time measurements of the suggested system;

This is in collaboration with the KTH Live-In Lab. LCA and LCC analyses are performed to provide feasibilities and cost-effectiveness validations for future large-scale implementations.

Project purpose

The aims of this research work are to prove the EAW concept by computer analytical investigations, study the feasibility of EAW integration with LTH/HTC systems in order to reduce peak heating/cooling demands, and cost/environmental impact effecti-veness (LCC/LCA) of the integrated systems.

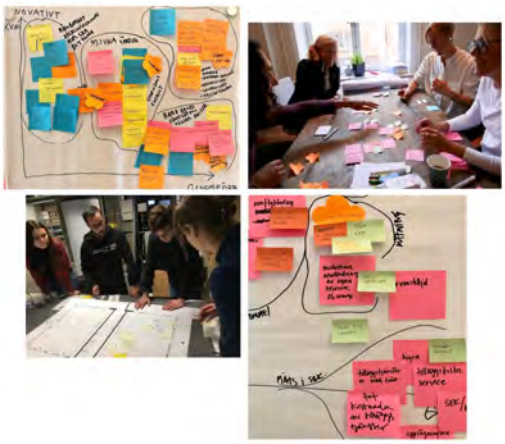
The performance of the integra-ted systems are evaluated both by dynamic simulations and real-time measurements at the KTH Live-In Lab.

Project Implementation

This integration will be studied in three stages:

1. Using an energy active window (EAW) to shave and shift the peak loads while LTH and HTC systems cover the required base heating/cooling loads.
2. Developing an optimal control scheme to efficiently synchroni-ze the performance of EAW and LTH/HTC systems in design conditions.
3. Evaluating the performance and contributions of the combined systems with comparisons to the reference system where passive envelopes are installed using LCC/LCA.

Co-living & Productive space usage



Project managers: Linda Teng

Company: Akademiska huset

Collaborators: KTH, Chalmers, KTH Live-In Lab, HSB Living Lab, Akademiska Hus, Nordic Choice/ Strawberry Living, Studentbostäder i Linköping AB, Tengbom, Semrén & Månsson, Zynka BIM, Grunditz Göransson Arkitekter AB, Arkitema.

Time frame: 2 years

In collaboration with HSB Living Lab, KTH Live In Lab and several industry colleagues, Akademiska Hus wants to run a collaborative project to get clearer answers on how we design the shared living and Co-living environments of the future.

Background

The entire construction and real estate sector needs to reduce its environmental impact and energy use. At the same time, there is a great need for more housing and premises. More and more people are living alone today at the same time as the housing shortage is increasing. How can we, by sharing more, reduce the need for resources and capital for new buildings? Can the collective use of our built environments be an answer to these questions, which contribute to sustainability in all aspects - social, ecological and economic? The answer is probably Yes, But then new incentives and studies are needed that can verify what works and what needs to change in order to be able to influence the current regulations in the right direction to enable increased use and more collective use of our buildings.

Project description

In collaboration with our project partners, researchers, consultants and other property owners, we want to study and analyse what has been built today regarding different types of shared living and collective lifestyles. The analysis should focus on both quantitative and qualitative aspects of the shared housing.

The selection of case studies - Is a mix of student/ research housing, Co-living living and both HSB – Living Labs housing cluster and as reference project KTH live-In Labs 305 individual compact student housing. The study aims to conduct a mapping and baseline study of newly built student and co-living residents who all experiment based on increased sharing of services, resources and functions in the shared shared home.

Project Implementation

- Analysis from a housing perspective
- The analysis of building design