NEST – Exploring the Future of Construction

Research – Industry – Society

A flagship project of Empa and Eawag in collaboration with the ETH Domain

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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eawag
aquatic research

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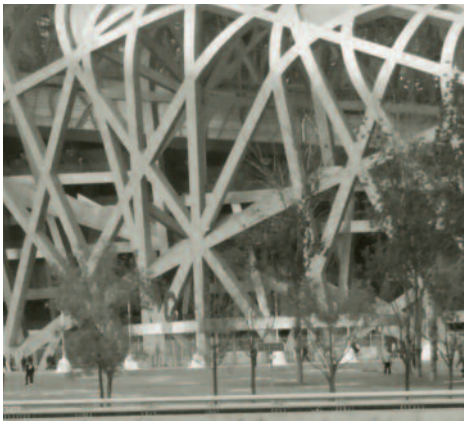
Materials Science & Technology

What is Your Contribution to the Future of Construction?

The built environment is a key element of our society. The quality of living and working spaces are influencing our well-being and our performance. The infrastructure for transport, energy, media and disposal facilitate mobility, communication and wealth.

At the same time we face new challenges: the depletion of natural resources caused by the construction and operation of the built environment has to be drastically reduced; especially energy, building materials and use of land. Additional pressure is created by the world's growing and aging society – a challenging but perfect situation for pioneering companies with new and innovative ideas.



Bird's Nest Beijing, Herzog & de Meuron Architects

However, there is hardly a sector that has greater difficulties in adapting new ideas and concepts and bringing them to the market than the building industry. High investment costs and long amortisation periods are reducing the readiness to take risks. Moreover, the vast amount of building regulations is creating additional barriers for innovation.

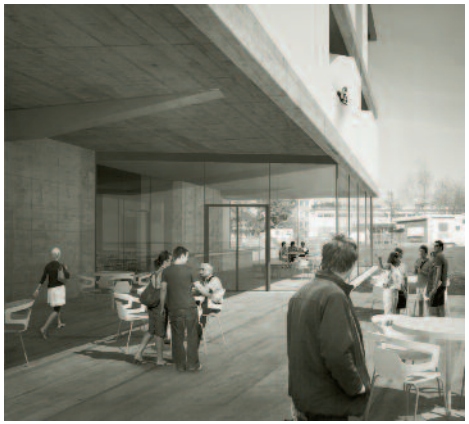
A new material or system has to proof practicability before it is launched on the market. Pilot and demonstration projects that allow a scientific evaluation under realistic operational conditions are suitable instruments to close that gap. This will exactly be the goal of the NEST experimental building.

NEST – A "Living Lab" with Lots of Synergies

Empa and Eawag are developing with support of the entire ETH-Domain the research and technology platform NEST – a test bed for future building technologies. The project will involve leading partners from industry and several national and international universities.

The vision of NEST is to foster the development of innovative building technologies in order to enable the construction of sustainable – and affordable – buildings, in which occupants feel "at home" and which exhibit the following features:

- marginal demand for energy or no demand at all,
- negligible emissions of greenhouse gases,
- a highly efficient wastewater purification system.



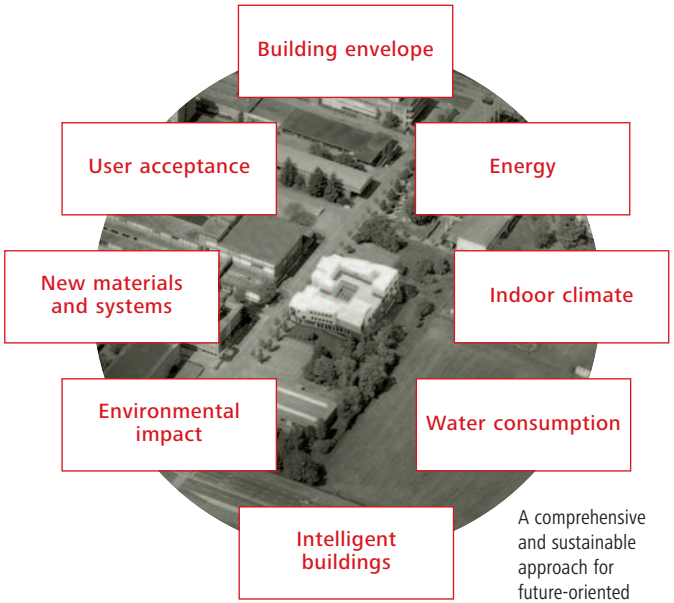
Many innovations are ready to boost the building industry and to create new business opportunities. The project will create a unique large-scale research facility to address these challenges. NEST will provide a flexible research and innovation platform for the development and evaluation of sustainable solutions for the built environment and for their transfer to market. The final goal is the development of self-sufficient buildings.

NEST will also serve as an academic guest house for researchers at Empa and Eawag from all over the world. They will create a truly living lab that also includes user aspects and practical user experience.

Why could Your Company become Innovation Partner?

NEST is aiming to support innovative companies to bring new ideas onto the market. It offers ideal conditions to achieve this goal, and it contributes state-of-the-art knowledge from scientific research and development. Empa und Eawag are both institutions that aim to close the gap between research and practical application.

NEST is a “protected site” where industrial partners can test their new ideas and it offers an international showcase to promote visions and innovations.



A comprehensive and sustainable approach for future-oriented building solutions

Partnership with the private sector takes place on four levels:

- Implementation Partners commit themselves to support the realisation of thematically focused living or working units, the so-called research and innovation units
- Technology Partners support the implementation of advanced cross-sectional technologies that are installed in the whole building
- Research Partners are directly involved in NEST-related research and development projects and profit from their outcome
- Supporters are supporting NEST with special products and services

The specific conditions and contributions of each partnerships are summarized on the following pages. A more detailed description is available in the “NEST Collaboration Model” brochure.

Research – Industry Partnership

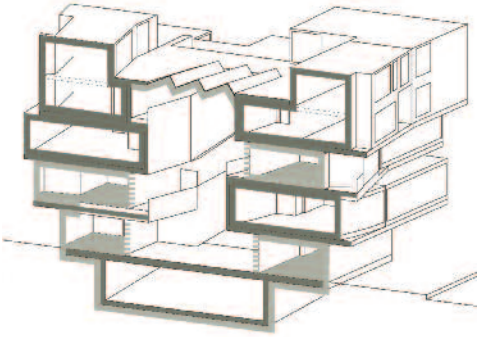
- Pilot and demonstration projects
- Research and development projects
- Industry support with selected products and services

Partnership Conditions

	Implementation partner	Technology partner	Research partner	NEST Supporter
Partnership				
Exclusivity of partnership*	●	●	●	
Consultation during design and realisation*	●	●		
Jury membership for international calls*	●			
Regular information exchange between Implementation and Technology Partners	●	●	●	
Information about planned research and development projects*	●	●	●	
Mentioning as official NEST partner or NEST supporter (in NEST building)	●	●	●	●
Media				
Official designation as project partner incl. company logo	●	●		
Company related naming of research and innovation unit	●			
Company related information brochure with company logo	●	●		
Company related NEST homepage (d/e)	●	●		
Audio-Presentation of partnership	●	●		
Link to company homepages	●	●	●	
Information in media in press kit	●	●	●	
Company link in specific press articles	●	●	●	●
NEST use				
Company events in NEST*	●	●	●	
Unlimited access to presentation material (photos, texts, articles)	●	●	●	●
Empa sabbaticals for company collaborators*	●	●		
NEST visits with business partners	●	●	●	●
Presentation of company/product information at NEST events	●	●		

* For detailed conditions see “NEST Collaboration Model” brochure

NEST – A Flexible Platform for Future Building Technologies



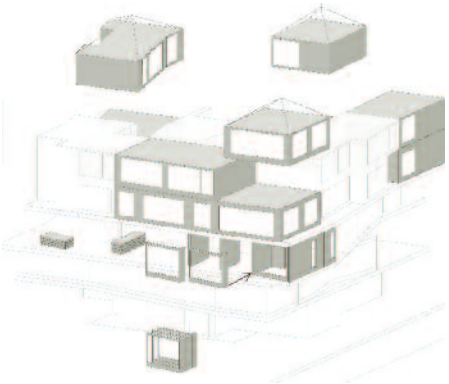
NEST consists of a basic grid (“the backbone”), which provides the load bearing structure and access to services and media (electricity, water). This “backbone” offers flexibility for the installation of single components or even entire living and office spaces (“research and innovation units”). The fact that NEST is also a guest house with a frequent change of tenants will facilitate this ongoing transformation of the building.

The research and innovation units are clustered in thematic areas with different topics that will be addressed. This should allow to tackle the hot topics of construction.

Thematic subgroups should allow to focus on the ideas of Implementation Partners and to launch international design competitions among research and industry groups in order to attract the brightest ideas for each research topic. They will cover both construction technologies for new buildings as well as technologies and processes for building refurbishment.

NEST Infrastructure – the “backbone”

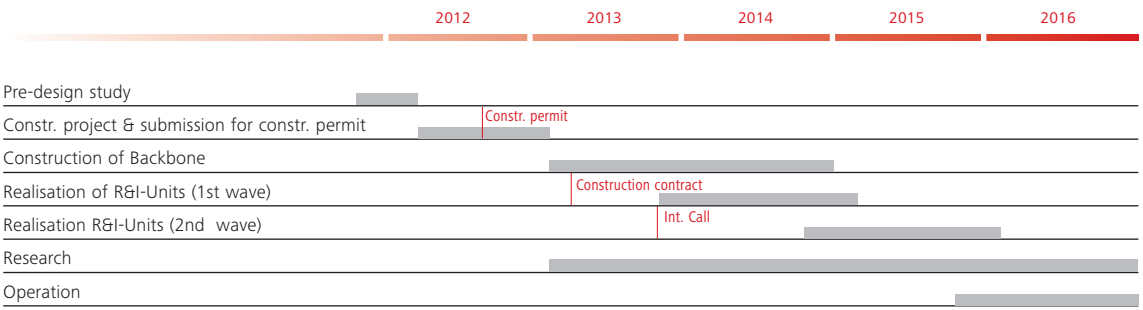
NEST experimental living and working spaces – the “ Research and Innovation Units”



Backbone – The NEST Infrastructure

The backbone provides a flexible infrastructure that guarantees the implementation of the Research and Innovation Units. It contains:

- The Empa reception and lobby, conference and meeting rooms (at ground level)
- An attractive central access to NEST, the fire escapes and spacious, well accessible technical installation zones
- A supporting structure for the 6-9 m wide demonstration platforms with an overall area of more than 3000 m^2 for research and innovation projects on three different levels with the option for double floor constructions on the rooftop
- Specially designed presentation rooms for guided tours and events on each floor
- A basement for extensive technical installations (water treatment, central air handling, energy hub)



The backbone provides an infrastructure similar to the one of a future urban neighbourhood. This will allow to realise different building types under one roof. Technologies that can benefit from a building network will be installed in the backbone including water treatment, an energy hub and partially also the implementation of solar devices.

The concept and design of the backbone that allows the flexible implementation of Research and Innovation Units is being developed by Gramazio & Kohler Architects GmbH (professors at the department of architecture, ETH Zurich).

The contributions of the Technology Partners for the central infrastructure still have to be defined. They focus on cross-sectional technologies such as:

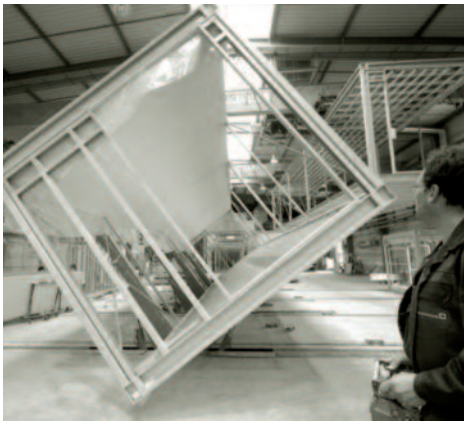
- Water and waste water management
- Energy hub based on renewable energy sources and waste energy
- Intelligent building control and management

Research and Innovation Units

The experimental living and working areas are thematically focused in order to set specific development and demonstration goals and to define the boundary conditions for international design competitions.

The selected themes should allow to compare different trends and lifestyles. Currently, the following thematic priorities have been identified (they may be adapted to changing needs):

- Working environment of the future – Future office spaces that foster creative and cross-linked cooperation
- Glass architecture – Intelligent application of glass as future oriented building material
- Lightweight construction – Great flexibility and efficient use of natural resources
- Modular homes – Compact constructions for high urban density
- Natural construction – Healthy living with natural resources
- Smart homes – Intelligent technology for future generations



Source: Kleusberg Building Module

These topics will be used for international design competitions that include several living units or an office area. The most innovative design teams will be mandated to realize their design. The Implementation Partners will be members of the jury that will select the best proposals.

The proposed topics are described on the following pages.

Office of the Future

The working environment is changing. Networking and information and communication technology (ICT) are becoming ever more important. Flexibility, creativity and effectivity are important factors for success.

However, it is not yet clear what kind impact this trend will have on future working spaces:

- Will it really improve inter- and transdisciplinary working?
- Will it further increase the demand for space, equipment and energy?
- Which working and collaboration models will stand the test of time, which ones will also consider human needs?
- How can modern technology contribute in a sustainable way? What is the role of audiovisual communication and information management?

Future Office Project (Ars Electronica Futurelab)

These questions should be covered by three different design teams. The results will be scientifically evaluated and communicated in collaboration with the Implementation Partners.

Additional research and development aspects are:

- Energy consumption of future offices
- Optimized thermal, visual and acoustical comfort, smart control, lighting
- Networking and forms of collaborative working, advanced ICT, paperless office
- Multifunctional work spaces and office relaxation zones

3 office areas with 660 m² total working space for creativity and efficiency

Implementation Partners
are interested in future working environments with flexible, energy-efficient and comfortable office spaces, in communication and visualisation.

Research Partner are the University of Applied Sciences of Lucerne and the Swiss Federal Institute of Technology in Lausanne, but also teams that are selected based on an international competition.

Members of the Design Teams are:

- Office and lighting designers
- IT specialists
- Working physiologists
- Energy specialists, technical installation engineers, building physicists

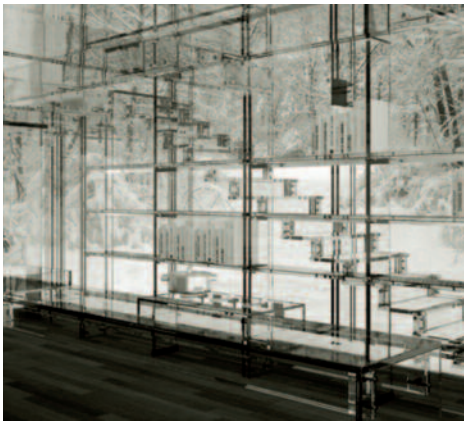
Glass Architecture

No other building material can be used as widely as glass. There seems to be hardly any limitations. However, designers and contractors are extremely challenged:

- How can glass be extensively used without restraining comfort and energy consumption?
- How can glass architecture provide comfort and functionality during a full day and all year round?
- Where are the present and future limits of glass architecture? And which developments are still possible?
- How can the differing needs for daylighting, transparency, comfort and energy be best combined?

Creative international teams shall study these topics and realise ten apartments, a 100 percent solar wellness and fitness zone and an event lounge for receptions. These solar areas on the rooftop, 20 m above ground, will certainly become a NEST highlight, not only due to the numerous innovations it harbours but also due to its attractive design.

Derk Thijs, A new building for the succulent plant collection of Zurich, www.studioplek.eu



Glasshouse by Santambrogiomilano

Additional research and development aspects are:

- Challenges and opportunities of solar architecture, optimized daylight, solar gains and thermal comfort
- Intensive daylight, light control, switchable glazing, adaptive solar protection,
- Natural ventilation, solar cooling
- PV integration, functional layers, smart control
- Heat recovery

Zero-energy and solar living on the rooftop:

- 10 apartments
- 200m² recreation area
- Executive lounge

Implementation Partners are innovative glass producers and processors, manufacturers of integrated solar solutions

Research Partners are Empa, the Swiss Federal Institute of Technology in Lausanne (EPF Lausanne) and international design teams that are selected based on an international competition.

Members of the Design Teams are:

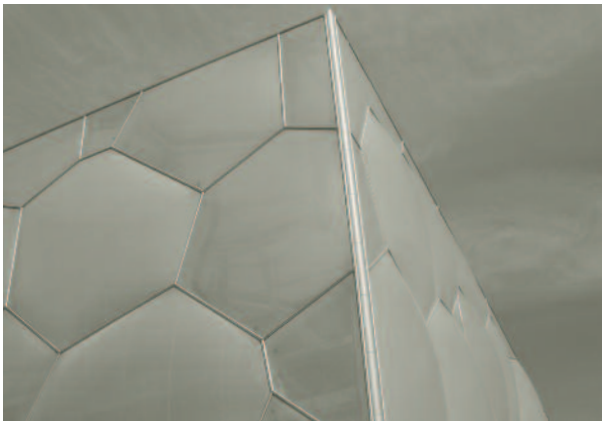
- Glazing engineers
- Specialists for daylighting and artificial lighting
- Energy specialists, technical installation engineers, building physicists

Lightweight Constructions

Traditional construction is often characterized by massive building materials and large quantities of natural resources. New options are possible with lightweight constructions that do not only minimize the use of renewable building materials but also offer new processes for production and construction.

Lightweight construction is a rather recent technology that has by far not reached its limits yet, neither in materials efficiency nor in architectural expression. New composite materials and production processes create a huge potential for innovation. In particular renewable raw materials from wood, natural fibres or biocompatible polymers offer nearly unlimited new possibilities.

- Which are the architectural possibilities to create new shapes and spaces?
- What is the innovation potential of new production and construction processes? What are the chances to create exportable products?
- How long can the service life of lightweight constructions be, how sustainable can they be? What are suitable solutions for noise protection, fire protection, maintenance and recycling at the end of life?



Beijing Swimming Hall by PTW Architects

Ten lightweight duplex apartments are planned for NEST. They could be completely pre-fabricated and lifted onto the roof. These lightweight apartments should not only proof their efficiency and capacity for materials savings, they should also demonstrate innovative production processes and new types of interior spaces.

Additional research and development aspects are:

- Lightweight building materials, optimized composite materials
- Functional layers, textile and polymer membranes, adaptable constructions
- Noise protection, fire safety, comfort control

10 low-energy duplex apartments built with lightweight structures that reduce embodied energy and CO_2 emissions.

Use of new materials and forms that create new architectural spaces for living and working.

Implementation Partners are mainly modern timber-construction companies, producers of composite materials, builders of textile and membrane constructions.

Research Partners are Empa, TU Munich and EPF Lausanne. Additional teams are selected by international competition.

Members of the Design Teams are:

- Architects
- Building physicists, civil engineers
- Materials and textile engineers

Modular Living

Growing need for living space and demographic change require dense and at the same time flexible living spaces at moderate costs. Modular building construction could be a solution to this problem:

- Compact building types with well-planned types of use
- Combination possibilities that offer flexibility and individual design
- High quality at low costs achieved by standardisation and pre-fabrication

The continuously growing demand for urban living space creates a large potential for modular construction. Intelligent use of space, modular equipment and modern technology offer a unique opportunity for new businesses and export.

Up to 20 energy-efficient modular living units will demonstrate in NEST the possibilities modular construction can offer. The units will preferably be pre-fabricated and connected to specified docking stations of NEST.

Source: Sanjay puri architects, offices' 63

Additional research and development aspects are:

- Digital design and construction processes
- Standardizations, modular and changeable, lexible, multifunctional
- Fully prefabricated units in plug and play mode
- Prefabricated high quality modules
- Modern, service friendly building materials, functional surface layers, intelligent control, advanced repair kits
- Standardized media interface

20 pre-fabricated compact low-energy living units that use modular concepts to increase flexibility and standardisation for affordable living spaces.

Flexible concepts for easy adaptation to various needs of our society.

Preferred **Implementation Partners** are innovative and internationally active home builders with a high degree of industrialized construction processes.

Research Partners are interdisciplinary teams that are selected based on an international competition.

Members of the Design Teams are:

- Architects
- Industrial designers
- Energy specialists and technical installation engineers, building physicists
- IT specialists

Natural Home

The growing degree of technical installations should always be critically reviewed. There is no proof that lots of technical equipment improve sustainable construction and operation of buildings. Often it is quite the contrary – construction, operation and maintenance are becoming more complex and comfort is not always improving.

There is also an understandable wish to avoid technical installations whenever possible and to use more natural building products. This approach is not really new, however, there are strong arguments to question the present technology trend and to search for alternative solutions:

- How much technology is really needed?
- Can eschewal also mean a higher living quality?
- Are natural building materials also practical and easy to maintain?

Source: Archivi Architects & Associates, Wakura Japan

NEST is offering the unique possibility to compare such "natural" solutions with technical solutions and to evaluate them scientifically with a representative number of different users.

Additional research and development aspects are:

- Which passive strategies are sufficient for an optimal heating, cooling and ventilation comfort with minimal energy consumption?
- Is it possible to achieve a better level of comfort with natural cooling and natural ventilation with less energy consumption than mechanical systems?
- How could natural material resources be used in a modern and functional way?
- How sustainable can natural building construction be? How can the materials used be recycled or reused?

10 low-energy and low tech apartments built with natural building materials and minimized technical installations.

Implementation Partners are supporting natural building construction and passive control strategies. They are interested in a neutral evaluation of advantages and disadvantages of natural construction concepts.

Research Partners are interdisciplinary teams that are selected based on an international competition.

Members of the Design Teams are:

- Architects
- Specialists for natural materials
- "Feng-Shui" experts
- Experts for life cycle analysis (LCA)

Digital Living

Technology-based concepts can be considered a counter position for concepts of natural living. Along with the global trend towards increasing urbanisation and mega cities, technology is becoming ever more pervasive. Virtual reality and technological/digital "assistants" have already become part of our everyday life.

Pros and cons of these new technologies should be compared to more natural life styles. Promising aspects of the future potential of these technologies should be investigated, such as:

- To what extent can virtual reality replace or even improve our quality of living?
- To what extent can living and working be merged in a modern household? Can digital technology create multifunctional spaces?
- How can technological/digital "assistants" contribute to a high quality of living?
- To what extent can a private household keep pace with technological change?

Future Office (Bay Integrated Marketing)

Questions like these will be treated by two to three Design Teams, which design and develop multifunctional living and working spaces and demonstrate and critically evaluate the potential of future solutions.

Additional research and development aspects are:

- Advanced application of digital information and control system
- Investigation of digital screens as future visual communication instruments
- Sustainability aspects and energy efficiency of future IT environments
- IT-based life aids for elderly, handicapped people or people with infirmities

10 high-tech apartments with controllable indoor environment.

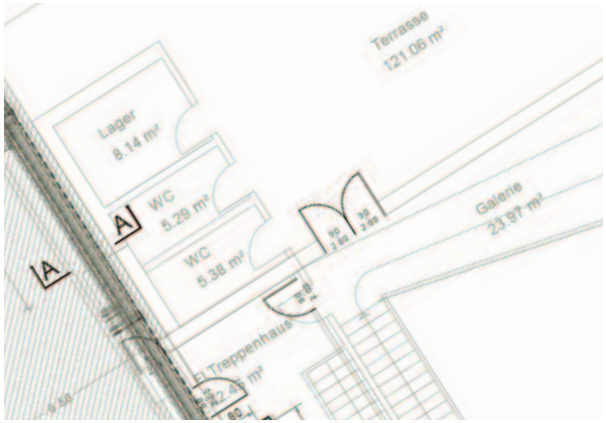
Implementation Partner are leading providers of IT and home automation technologies.

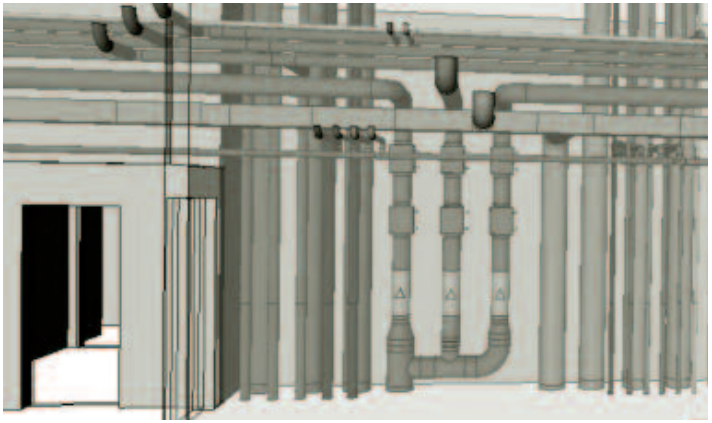
Research Partner are EPF Lausanne, ETH Zurich, international teams that are selected based on an international competition.

Members of the Design Teams are:

- Architects
- IT and communication specialists
- Building control engineers
- Working physiologists
- Artificial lighting designers
- Energy specialists and technical installation engineers

Cross-sectional Technologies





A number of cross-sectional technologies play an important role in the NEST building. They are part of the «backbone», the infrastructure that allows the plugging of various topical areas with research and innovation units. These technologies are representing technologies that might become crucial in future neighbourhoods for connecting single buildings to an urban network.

Three examples of cross-sectional technologies are described on the following pages. The list of technologies is not exhaustive.

- Urban water and waste water management
- Solar energy hub
- Intelligent building control

Cross-sectional technologies are technologies at the core of optimized building networks of future. The are mainly part of the "backbone" of NEST.

Technology Partners are leading companies that are providing advanced technologies for linking groups of buildings.

Research Partners are Eawag, Empa, ETH Zurich and EPF Lausanne.

Members of the Design Teams are:

- Water and waste water specialists
- Energy specialists and technical installation engineers
- IT Specialists

Urban Water and Waste Water Management

From a global perspective the issue of water use is as important as the sustainable use of energy. Thus, the potential of minimizing water consumption in buildings and neighbourhoods will also be studied.

Concepts for multiple usage of water and waste water will be developed and tested under the lead of Eawag, the Swiss institute for aquatic research. NEST should contribute to the further development of promising solutions for reducing water consumption and the re-use of waste substances in waste water.

Technologies of high priority are:
- Modern, environmentally friendly, water saving toilets
- Waste water treatment
- Local waste water reactors
- Flexible piping systems for simplified waste water systems

Additional research and development aspects are:
- Development of innovative waste water treatment and separation methods
- Use of rain and recycled grey water
- Extraction of reusable material from waste water
- Energy from grey and waste water

Technology Partners are leading companies dealing with water supply and treatment and with the use of recyclable materials from waste water.

Research Partner is Eawag.

Members of the Design Team are:
- Water and waste water specialists
- Plumbing engineers
- Chemical engineers
- Energy experts

Solar Energy Hub

It is obvious that energy optimization should not be limited to individual buildings. Various promising technologies are only useful for a larger group of buildings, and the fact that energy demand varies in time offers yet another possibility for optimizing energy flow: One building might have an energy surplus, while another building may require energy.

The various living and working areas of NEST represent a group of independent buildings, which are interconnected through thermal and electrical grid. At the core is an energy hub to control energy flows and to provide intermediate storage capacity.

The relevant research and development tasks are:

- Which energy services should be centralised in low energy-building areas?
- How can energy supply and energy use be ptimally coordinated? How far can heat recovery go?
- What is the optimal design for a central energy storage?
- How can networks continuously be adapted to changing needs, e.g. if new energy resources become available?
- Which control and management tasks have to be tackled on the thermal and on the electrical side?

Technology Partners are leading companies that deal with heat recovery, with renewal energies (thermal and electrical), thermal and/or energy storage and distribution.

Research Partners are Empa, ETH Zurich und EPF Lausanne and PSI.

Members of the Design Team are:

- Energy and electricity engineers
- Energy simulations specialists
- Solar and PV specialists
- "Smart grid" specialists

Intelligent Building Control

State-of-the-art energy management in buildings, but also energy optimisation strategies, require more and more complex control systems. This is true for the control of thermal and electrical circuits and, increasingly, also for safety and maintenance issues.

In many cases building users have lost track of the installed control algorithms and are frequently surprised by the “odd” behaviour of technical components. At the same time, specialists are also confronted with an increasing complexity and growing number of control systems, which often lack compatibility. In the past, not enough attention was given to the growing energy consumption of controllers and actuators.

Siemens Building Technologies

NEST should be an ideal platform for testing new control concepts. It should work with an open system that can demonstrate how future control systems could develop and improve.

The relevant research and development tasks are:

- Allocation of complex control issues in central and peripheral systems
- Definition of the role of the user and his possibilities to interfere
- Potential for control system extension
- Linking of control systems with communication and information systems
- Minimizing of energy demand of control systems

Technology Partners are leading building control and IT companies, that are dealing with optimized thermal and electrical energy management in buildings.

Research Partners are Empa and ETH Zurich.

Members of the Design Team are:

- Energy planners
- Electrical and thermal engineers
- Instrumentation, control and automation engineers
- Software engineers

What thrills me about this joint initiative is the unique opportunity it offers to our partners from industry to test, evaluate and optimize their innovations for future living and working concepts in a real-world setting. It is really a "one of its kind" platform for development and technology transfer in the building sector."

Gian-Luca Bona, Director Empa

With NEST, the institutions of the ETH Domain join forces to bring together their smartest and brightest in the area of materials science, building technologies and systems integration. We do not aim at developing a single innovation here or there – we want to make real progress in the realm of sustainable buildings."

Patrik Aebischer, President EPF Lausanne

In the context of increasing urbanization, population growth, and climate change, new approaches to urban water management are needed that link resource conservation with reuse and recovery for water, energy and nutrients and, at the same time, avoid long-term investment in inflexible infrastructure. NEST provides a unique platform to test innovative on-site technologies designed for local as well as global markets."

Janet Hering, Director Eawag

NEST will allow us to develop energy-efficient, CO_2-neutral buildings offering a high level of comfort and convenience to its users. This project fits well into the Sustainable Building Initiative of ETH Zurich."

Ralph Eichler, President ETH Zürich

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