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SUN, PEOPLE AND THE ENVELOPE

VELUX EDITORIAL

SUN, PEOPLE AND THE ENVELOPE

Light from the sun travels 150 million kilometres to reach the Earth's surface. Whether it also touches our skin and eyes, our soul and senses depends on our ability to filter and harness it with the envelopes that we use – be it clothing or buildings.

The relationship between the sun, people and the envelope is the theme of this issue of Daylight/Architecture. Starting with the cover image, we invite you on a journey from the soul to the sun and back again. The photographic essay by Susanne Wellm and Torben Eskerod illustrates the intimate relationship that both our inner and our outer world have with the light and energy of the sun, the essence of our lives as well as a source of mental and spiritual well-being.
What is the purpose of architecture? The Roman architect Vitruvius answered this question with *"firmitas – utilitas – venustas"*, which can be translated into strength, utility and beauty. The building envelope serves to protect people from cold, wind, and rain (*firmitas*), to give people a comfortable and healthy indoor environment (*utilitas*), and to enrich people's sensual perception (*venustas*). Furthermore, the building envelope interacts closely with the light and energy of the sun, and with people living in the house. Based on this premise, the current issue of Daylight/Architecture features the relationship between people, the sun and the building envelope as it evolves in the creation phase of buildings, during the operation of buildings, and in the evaluation of the experiences made when inhabiting a building.

For millennia, human beings have developed building envelopes to control and harness the sun's light. By now, we tend to think we know everything about the building envelope and how it supports our health and well-being indoors. But how much do we really know? In the 19th century, it was uncommon for houses in most of Europe to be warmer than 16–18°C during winter. Today, most people seem to prefer temperatures of 22–23°C. In other parts of the world, the situation is different. "Most people in my country will consider it comfortable if the temperature in a room is five degrees or more below the outdoor temperature," says architect, Diébédo Francis Kéré. In Burkina Faso, where he was born, 'comfort' can thus be achieved at 30 degrees Celsius or even more, depending on the season.

Three architects – Diébédo Francis Kéré, Thomas Herzog from Germany and Peter Stutchbury from Australia – are portrayed in this magazine. They explain how their buildings, relate people to the sun and the local climate by means of intelligently designed building envelopes. These buildings employ the forces of nature in an intelligent way – and while providing protection, they connect the inhabitants to their outdoor environment and the sun. Rather than relying on air-conditioning for comfort, the three architects allow the indoor climate in their houses to fluctuate with the seasons. And recent science is proving them right; people in 'free-running' buildings have a much larger tolerance range in terms of temperature than in purely air-conditioned ones. They also suffer less from the symptoms of 'sick-building syndrome' – and, needless to say, buildings without air-conditioning also consume far less energy.

Still, the question remains: do naturally ventilated and passively-cooled buildings actually provide the degree of comfort that their designers intended them to? With these questions in mind, the VELUX Group has participated in the design, construction and evaluation of more than 20 demonstration buildings and Active Houses during the last decade. In the meantime, we have evaluated most of these in detail, taking a closer look at both energy consumption and indoor comfort, as well as the interaction between buildings and users. This magazine presents an overview of the lessons learnt from the projects. The evaluations show that it is indeed possible to build 'tomorrow's houses' today, i.e. carbon-neutral buildings whose envelopes harness the sun for the sake of people can be designed and built using readily available technologies, products and processes.

Enjoy the read!
The VELUX Group

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FROM THE SOUL TO THE SUN

Silhouettes in the evening sun, a clean white shirt, a burning house and a sunset over the ocean – these are all part of the photographic dialogue that Susanne Wellm and Torben Eskerod have conducted for Daylight/Architecture.

On all scales, the two artists have visualised the manifold ways in which the light of the sun interacts with the human body and soul, as well as our senses and our environment.

PHOTO BY IWAN BAAN

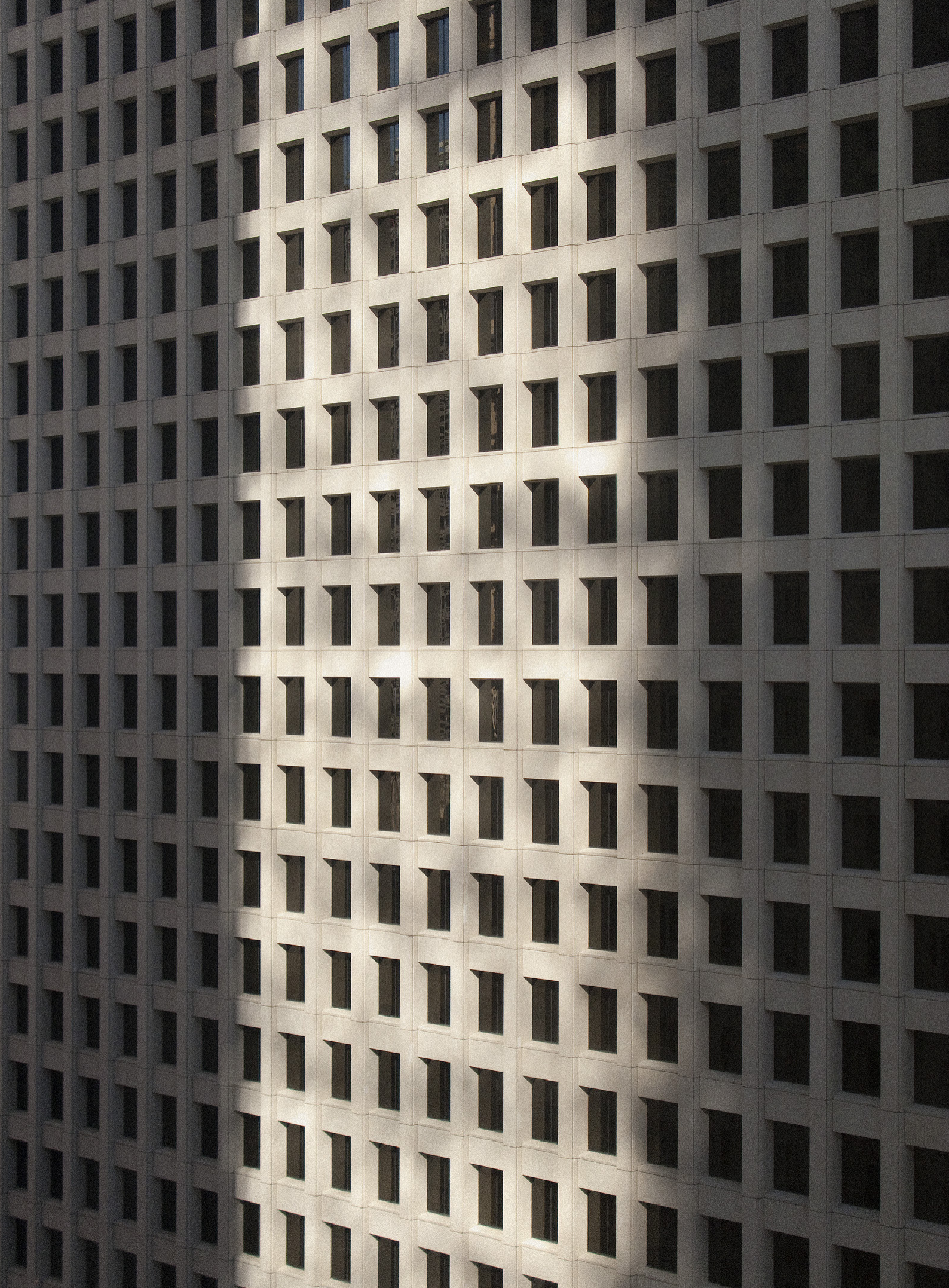
"Friends, neighbours, acquaintances and parents like to come when they see the weather is good. Then they call – and our telephone now rings much more frequently."

FROM THE SOUL TO THE SUN

It takes the light of the sun around eight minutes to reach our skin and eyes. But does it also reach our soul and senses, and what reactions does it prompt there? How does daylight give life to the world inside and around us?

These questions formed the starting point of the following photographic essay, which Torben Eskerod and Susanne Wellm have created for Daylight/Architecture. The sequence of images can be read as a dialogue between the two artists that grew over time, with each photograph being taken in response to the preceding one. Altogether, the images form a visual journey from the soul to the sun and beyond, across different dimensions, at different speeds, and through all the diverse layers that exist between our innermost self and the star that keeps us alive.

A photo-essay by
Susanne Wellm and Torben Eskerod



DIALOGUE WITH THE SUN

Thomas Herzog – researcher and architect

PHOTO BY RICHARD SCHENKIRZ

Previous spread: **On a narrow plot in north Munich, Thomas Herzog + Partners built this ensemble of four row houses in 1979–1982. Behind their sloped south facades is a series of winter gardens, which can be shaded by means of interior textile awnings. With the integration of evacuated tube collectors and photovoltaic panels into the glazed envelope, the architects pioneered the active use of solar energy in this building.**

Below: Wings of Glass **is the title of a book about Thomas Herzog's buildings, published in 1991. It was doubtless inspired by this single-family house that Herzog had built twelve years earlier in Regensburg and that was to become a prototype for many 'active solar' buildings throughout Europe in the 80s. The greenhouses underneath the sloped glazing in the south can be connected to the living spaces behind them by means of sliding doors.**

PHOTO BY RICHARD SCHENKIRZ

Few other European architects have managed to build bridges between modernism and the 21st century as successfully as Thomas Herzog. It was he who revived the idea of 'form follows function' for the era of ecology by looking for new solutions on all levels of architecture – from urban planning to the individual details of facades. What's more, he made a decisive and influential contribution to a holistic understanding of the building envelope – as a filter between different climates and as a tool that enables human beings to harness the energy of the sun.

By Jakob Schoof

"REINVENTING the art of building in order to save the planet". This phrase, ascribed to Thomas Herzog, illustrates what is still driving the 72-year-old architect and retired professor today. But, in contrast to many self-declared starry-eyed idealists, Herzog bases what he does on fundamental knowledge of his material, knowledge that he acquired and passed on to others in decades of designing and teaching.

Thomas Herzog reinvented many things in the course of his 40-year career as an architect. His very first residential building, which is located in Regensburg and which he designed at the end of the 1970s, diametrically contradicted the generally accepted notions of what single-family houses should look like. It was neither a desire for prestige nor the prevailing fashion at the time that determined the design of the house but three very specific variables, which, right up to today, have remained the cornerstones of Herzog's work: people with their comfort needs, the forces of nature, and the building envelope that mediates between the two.

These three aspects, namely people, nature and building envelopes, are also the subject of the following article. The best way to understand Thomas Herzog's approach to architecture is to begin with the source of all life and (almost) all the energy we use on the earth today: the sun.

SUN

In 1996, 30 architects attending a conference in Berlin approved the "European Charter for Solar Energy in Architecture and Urban Planning". The list of signatories reads like a Who's Who of architecture in the 1990s: Norman Foster, Richard Rogers, Nicholas Grimshaw and Michael Hopkins from Great Britain, Henning Larsen from Denmark, Renzo Piano from Italy and Françoise-Hélène Jourda from France.

The author and initiator of the charter was Thomas Herzog. His handwriting is apparent in the paper, which is an official document supported by the EU. The message of the charter is rational instead of radical, and speaks to the here-and-now rather than to a distant future. Above all, however, the charter gives voice to a holistic point of view. Almost all the important issues involved in sustainable building today are summarised in just a few pages: from the reference to the climate of the site to the deployment of building materials that can be recycled; from the use of renewable forms of energy to the renovation of existing buildings for greater energy efficiency.

The energy of the sun is something that Thomas Herzog has concerned himself with on all levels of scale. Concurrently with drawing up the European Charter, he collaborated with Norman Foster and Richard Rogers to develop the Solar City in Linz, probably the most ambitious example of solar-energy use and energy-efficiency enhancement in urban planning in the 1990s. Previously, Thomas Herzog had done pioneering work in the development of solar building components. As early as the 1980s, he had the first photovoltaic system installed in one of his residential buildings and, just a few years later, installed geothermal heat pumps and transparent thermal insulation in his buildings. In the 1990s, this was followed by insulating glazing with integrated light-directing elements and aerogel insulation. These experiments were always associated with considerable

Thomas Herzog was born in Munich in 1941. He studied architecture at the Technische Universität in Munich, where he set up his own architectural practice in 1971. From 1974 to 2006, Thomas Herzog was a university professor, firstly in Kassel, later in Darmstadt and Munich. Since 2003, he has been teaching as a visiting professor at the Ecole Polytechnique Féderale de Lausanne (EPFL) and at Tsinghua University in Beijing.

PHOTO BY DIETER LEISTNER/ARTUR

Pevious spread and right **How should a house look in which all rooms receive daylight and warmth through the southern facade? Guided by this question, Thomas Herzog designed two extremely narrow semi-detached houses in Pullach, south of Munich (1986–1989). Like many of Herzog's buildings, the houses were technically ahead of their times, with translucent thermal insulation, heat pumps and a ventilation system with heat recovery.**

PHOTO BY DIETER LEISTNER/ARTUR

"I had understood that the building envelope is the causa prima of building. Referring to the load-bearing structure, we talk of the primary construction but the basic idea is protection against the exterior climate."[29]

risk and expense. "It's not worth it" was one of the repeatedly-heard objections from other architects. However, according to Herzog, "We also knew that we were entering territory in which there would be a huge amount of interest, at least in the medium-term."[1]

PEOPLE

Creating a home, the most primordial and needs-relevant construction activity of human beings, was a focal point of Thomas Herzog's career from the very beginning – and it has remained so up to this day. In the course of the decades, his office developed a wide range of building concepts that contradicted the preconception that energy-efficient buildings should be as compact as possible. In the first monograph of his work in 1992, Herzog divided his designs into four categories: 'wings of glass', 'diagonal cubes', 'two-zone houses' and 'slender buildings'.

In the 'slender buildings', all rooms received daylight via the south-facing facade. The 'diagonal cubes', in contrast, were compact and divided into different temperature areas on the inside; the (warmer) living areas were in the south-west and south-east parts, the (cooler) bedrooms were on the north-west and north-east sides. A similar concept underpinned the 'two-zone houses'.

However, what first gained Herzog international renown were his 'wings of glass': residential buildings with unheated conservatories added to the south side, many of which featured inclined glazing. For his first residential building, completed in Regensburg in 1979, he received the first-ever Mies van der Rohe Award in 1981. He remembers some of his colleagues asking at the time, "Is that the solar house type? Will buildings slope to the south in future?", and replied, "I never considered this to be the only possibility." Thomas Herzog never strove to be recognised primarily by the shapes of his buildings, but by other qualities. It is not without pride, therefore, that he recalls the prize-giving ceremony of

PHOTO BY CHRISTOPH REHBACH

the Mies van der Rohe Award in 1981. On this occasion, Mies's daughter Georgia remarked that the house in Regensburg had certain similarities with her father's Farnsworth house. Both, she said, were based on the goal of presenting an entirely new theme in architecture, and on providing an exemplary solution to it in a small structure.

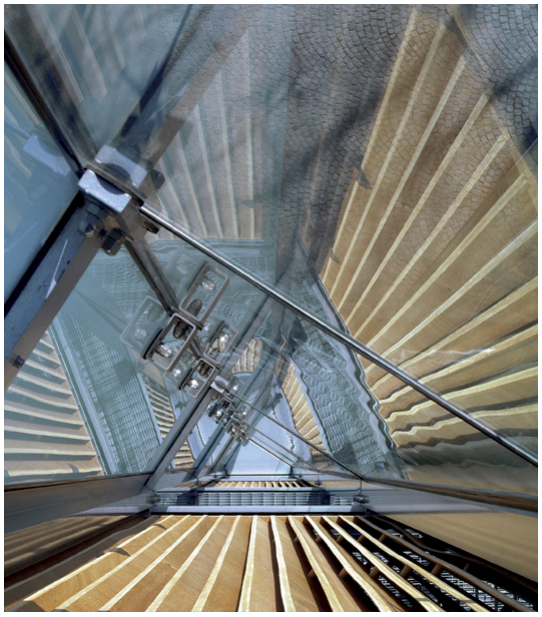
Design goal: well-being

To create a comfortable indoor climate is the – implicit rather than explicit - goal of all of Thomas Herzog's designs. Achieving this goal while making sparing use of resources is something he sees as his mission in life. "There is no fundamental civil right to burn oil, coal or gas. People simply want to be warm or cold enough, that's all there is to it. To this end, we must develop appropriate technical means of construction and combine them harmoniously"[2]. However, in order to do this, says Herzog, "there must be more openness and tolerance when it comes to definition of the conditions that enable and ensure comfort. [...] From my point of view, a lack of flexibility in dealing with these issues and a kind of formal fixation [...] lead to a completely exaggerated use of technical installations that is disproportionate to the necessary effect."[3]

Herzog has always maintained a critical distance from the increasing propagation of 'intelligent' building automation. "The more I automatically resort to measurement and control technology in reaction to changing influences, the more I become dependent on it. One is at the mercy of technology, while one's own perception of the effect of wind or temperature decreases because we are lulled by the degree of comfort thus achieved. We would do better to increase our sensitivity to our environment."[4] He also demands that "the electronic systems in a building must serve as points of orientation for people but should not automatically [...] bring about changes in the area of the building envelope."[5]

"I advocate [...] that technology/ technical systems in architecture should be shown and not hidden so that people will understand the processes involved and can therefore be persuaded to think about energy consumption in the building, for example."[30]

Previous page and below **The Oskar von Miller forum (2010) serves as guest accommodation and event space for the Technical University in Munich. Glass facades that can be opened up connect the apartments to the green interior courtyard. Towards the noise of the street, in contrast, the building is protected by a folding glass curtain wall. Behind this, sliding timber panels are located to provide shading.**



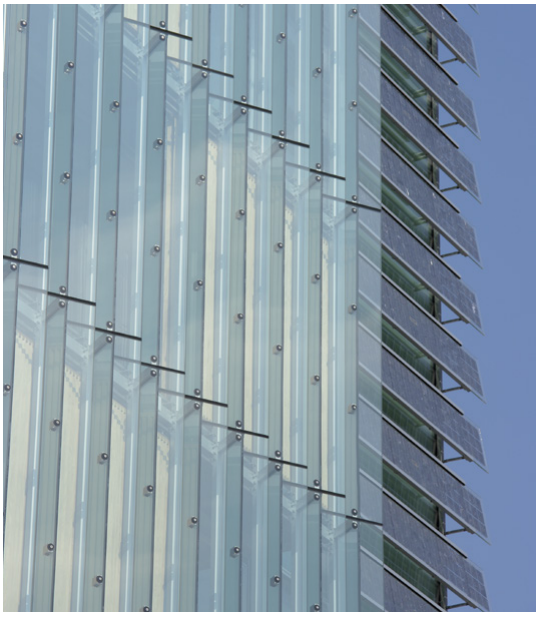


PHOTO BY VERENA HERZOG-LOIBL

Building in networks
When asked what people influenced him most at the beginning of his career, Herzog mainly names engineers and architects who had an 'engineering' approach to their profession: Buckminster Fuller, Frei Otto, Jean Prouvé, Pier Luigi Nervi, Konrad Wachsmann and Fritz Haller. In 1972, he wrote his doctoral thesis on 'Pneumatic Constructions', inspired and supported by Frei Otto. This thesis was the start of Herzog's lifelong interest in the energy balance of buildings. "As a result of this preoccupation, it became clear to me that environmental energy can and must be utilised and that the appearance of the envelope is then defined accordingly."[6]

A few months later, as a young professor in Kassel, Thomas Herzog joined a working group with the title 'Energy, Food, Housing'. It encompassed around a dozen different specialist disciplines, from civil engineering to agronomics. From the 1980s onwards, he worked intensively with the Fraunhofer Institute for Solar Energy Systems (ISE) in Freiburg. "What has recently been propagated as 'integrated design' has already been a completely normal working situation for us for many years", said Herzog 20 years later. "It is important that the parties involved do not simply resolve an isolated problem that they have been assigned but that they understand the entirety of all the other relevant problems."[7] The reason being that "projects, particularly complex projects, lead an existence located among a diverse range of disciplines [...]."

Consequentially, Thomas Herzog also warns against a one-sided focus on only some aspects of building. "Most of the problems we have regarding the shortage of natural living resources are due to one-sided improvements, the effects of which in other areas of life have not been sufficiently considered."[8]

According to Herzog, this necessary holistic view of problems is primarily a task for architects. They have to be in control of the entire design process of buildings – and beyond. "The profession is very demanding and also very difficult but it is one that must always consider things holistically. This is extremely important for society. Architects should insist on performing this leadership role."[9]

Thomas Herzog, architect and teacher
When Alvar Aalto, the great Finnish architect, was asked questions concerning the principles or theory of architecture, he used to reply, "I answer by building".[10] Many other architects thought, and still think, in a similar way. Thomas Herzog, on the other hand, has always built and published. Like few other architects who teach at German universities, he has practiced the 'classical triad of scientific work'11 consisting of experience, experimentation and theorisation.

In education, manual work and mental work must be closely interlinked with each other, according to Herzog's credo; workshops are as important as lecture halls for budding architects – "If the hands do not know something, mental work is not much use."[12]

At the same time, Thomas Herzog always knew how to generate synergies between his teaching work and his designing. The university offered him the freedom to develop components and systems that he later tried out in his buildings. This is one of the reasons why Herzog concentrated on single-family houses at the start of his career. "If you are prepared to experiment, you need someone who is prepared to pay. As a result, one begins with buildings for private clients, for in this area the scope and outcome of experiments are on a manageable scale. In addition, with a private client you have an immediate, personal partner with whom you can enter into a dialogue."[13]

BUILDING ENVELOPES
For Thomas Herzog, the building envelope is the causa prima[14] of architecture – rather than, for example, the load-bearing structure. As regards designing this envelope, he remains true to the Vitruvian triad of firmitas, utilitas and venustas. "In one respect, I am very conservative. In our understanding, architecture continues to stand on three legs: technology, usage and beauty.""[15] Starting from the principles of modernism, Herzog redefined two of these – technology and usage – and, as a consequence, arrived at a new aesthetics.

In Thomas Herzog's buildings, technology mainly referred to the new efficiency and energy technologies in whose development he was involved. For him, the definition of usage was derived from the building envelope's role as mediator between the exterior and interior climate. Representative in this regard is Herzog's view of what can be learned from the study of historical buildings. "They allow things to be studied that are a lot more important than architectural styles. [There] is something far more important to study in this context than just styles of building. [...] What interests me about these buildings is how craftsmen coped with the various forces, what the lighting conditions are, and how the indoor climate develops."[16]

Taking modernism forwards
When Thomas Herzog started his first job as an architect in 1965, nothing pointed towards this redefinition. "In our work, we oriented ourselves to the technological possibilities, whereby the idea of replacing material with energy was extremely fascinating for us, and we consciously accepted energy losses in favour of an exposed but attractive load-

"Unless we want to stunt our mental and spiritual development, it will be necessary now and in the future to strive towards a situation where people are able to use all their senses to perceive their environment – which also includes the artificially created environment – instead of manipulating virtual space with a few joysticks."[31]

This atelier house in Bavaria (1994) was designed by Herzog + Partners as a ‚three-zone house', the inner structure of which is clearly legible in the facades. The ventilation openings are covered by wooden louvres, whereas the smaller rooms are clad in aerogel-filled insulating glazing. The (partly double-storey) ateliers are outfitted with a transparent stick-type facade.

"The location's distinctiveness alone makes every building, every piece of real estate, unique. This results in the need to work together iteratively, to try things again and again to see what happens when individual parameters are changed in the overall nexus. This holistic approach [...] is what makes architecture so demanding. 'Componere', the composition, is what really matters.""[32]

bearing structure. At that time, no-one gave thought to the fact that resources were limited and that it was necessary to use them sparingly."[17]

Nevertheless, Herzog still acknowledged these roots 25 years later. "Modernism is not dead but has become more complex, more multi-facetted in its goals."[18] Basically, Herzog's way of working is much more indebted to the principle of 'form follows function' than was the case among many of the main representatives of modernism. "Adopting a prefabricated idea of form simply because a certain aesthetics would have interested me was something I never did. I was, and still am, someone who is seeking solutions that are coherent and plausible with regard to the characteristics of the task in question."[19]

Thomas Herzog describes such solutions as 'efficient functional forms'. This term originally comes from Hugo Häring, a main representative of German expressionist architecture of the 1920s. However, while Häring was primarily concerned with "providing a spatial framework for the life processes of occupants"[20], Herzog feels that the location and its specific climate are the starting points of architectural work. The architectural historian Winfried Nerdinger characterises this approach as follows – "Thomas Herzog defines efficient functional form by drawing an analogy to evolutionary development, where the form that is best adapted to the prevailing conditions asserts itself and where, nevertheless, an immense array of 'forms' comes about."[21]

Efficient functional forms emerge deductively rather than inductively. Herzog therefore argues that only design goals should be set for architects and that no specific solutions should be prescribed. "The job of the architect is to cut a slice out of the world and create an envelope in which we can live. In this endeavour, no solutions should be prescribed by law because this puts a brake on opportunity."[22]

Sustainability must be experienced

As the building envelope has to mediate between two variables – the external climate and the well-being of the occupants – it has to be changeable itself. Thomas Herzog grasped this at an early stage. "I think [...] of the example of a tulip that opens and closes every day, or a reaction such as that which can be observed when living organisms change their behaviour in relation to local weather conditions."[23]

With this attitude, Thomas Herzog distances himself from the practice of designing buildings – particularly office buildings – as hermetically sealed glass boxes. He is just as sceptical about the tendency to cover houses with a thick 'pullover' of thermal insulation. These misgivings concern functional as much as aesthetic matters. As regards the 'composition' – he prefers this term to 'design' – of building envelopes, two things are essential to Herzog: firstly, technical components must fit seamlessly into the overall appearance of the building; and secondly, they must be visible in order to convey their function to the observer and occupants.

This stance is simultaneously very old and very modern. On the one hand, Herzog invokes the ancient-Greek term techné, the skilled use of materials. Art and technical work or technique, according to Herzog, were one for the ancient Greeks. "Only someone who confidently masters the technical aspects can tell others what to do and how they should do it and has the opportunity to create something that is artistically sophisticated [...]."[24]

On the other hand – and here his thinking is eminently contemporary – Herzog insists on turning sustainability into a real-life experience, as this is the only way to change people's lifestyle habits. One of the key sentences in the 1996 solar charter reads, "new design concepts must be developed that will increase awareness of the sun as a source of light and heat; for acceptance of solar technology in construction by the general public can only be achieved by means of convincing visual ideas and examples".[25]

OUTLOOK

Since 2003, Thomas Herzog has been teaching at Tsinghua University in Beijing as a visiting professor, and has created several buildings in China during this period. As a reason for his commitment there, Herzog cites the significance "that the country has for energy consumption as well as for the effect of combustion emissions. Whatever is done there rightly or wrongly has much greater effect than the same action occurring in our small European nations".[26]

This speaks of Herzog's willingness to assume social responsibility – an important mainspring of his work for many decades. "Carrying on in the same way is obviously not possible. Sustainability is a serious and a fundamental issue that goes to the roots of our profession.[...]"[27]

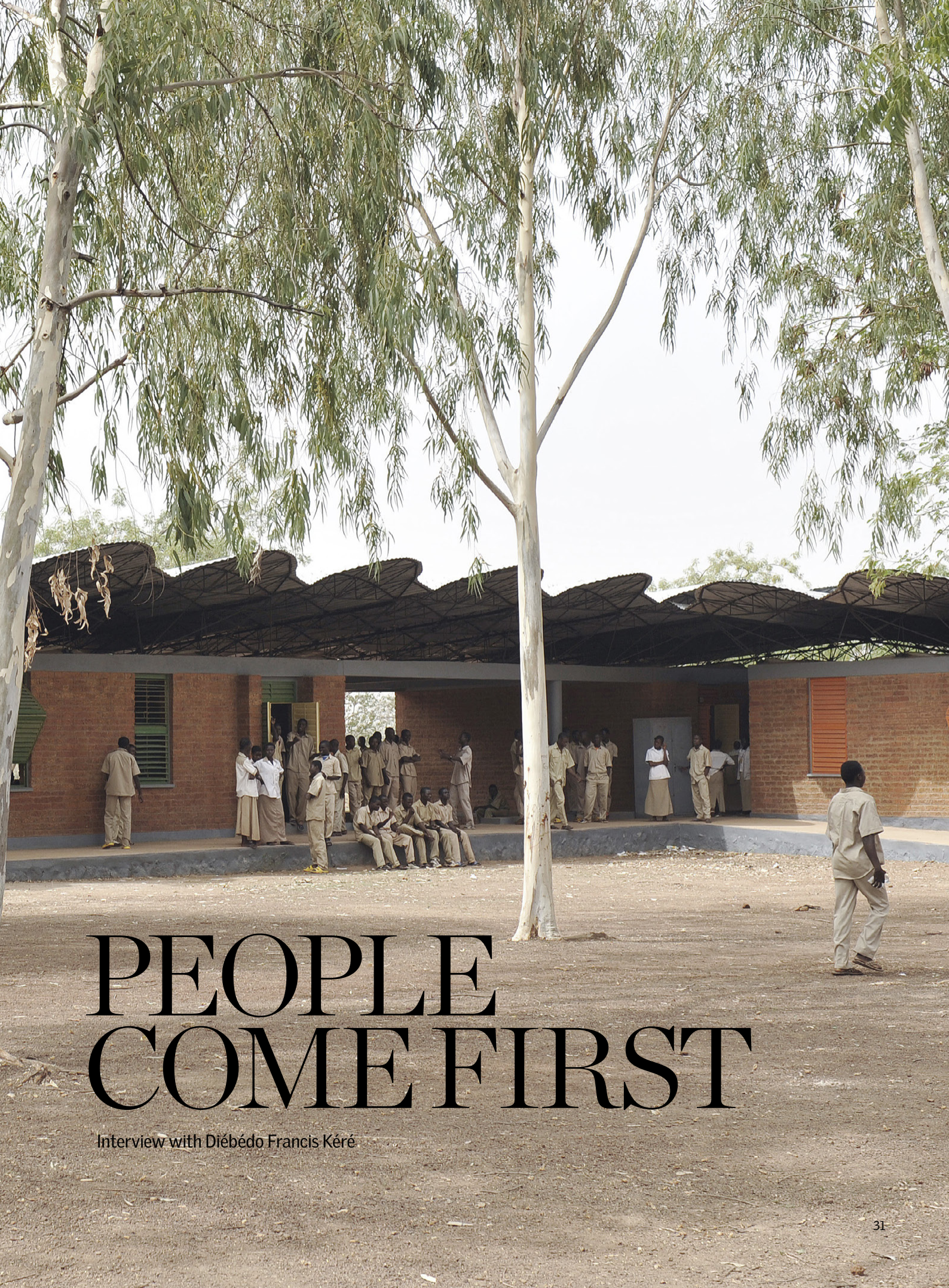
But even if they wanted to, do architects today still have the power to exercise their social influence? Herzog himself raised this question in an interview in 2009 – and left it hanging in the air, unanswered. After all, architects are neither politicians nor economic decision-makers; and even in their core area of competence – building –, they are increasingly constrained by controllers and project supervisors. Herzog is nevertheless confident. "I very much believe in the power of the example. Anyone who does not fight will achieve nothing at all. We must use our knowledge and competence to get the right ideas accepted and show the way to go forward successfully with the help of well-designed examples. Then, no longer will anyone be able to say – it can't be done".[28]

PHOTO BY PETER BONFIG

Notes.

1. Thomas Herzog talking to Jana Revedin, 2009 (unpublished).
2. "Es gibt kein bürgerliches Grundrecht, Öl, Kohle oder Gas zu verbrennen." Interview with Thomas Herzog in Baumeister B7/2009.
3. Architektur und Verantwortung. Interview with Thomas Herzog in: Aktivhaus. Vom Passivhaus zum Energieplushaus. Munich 2012.
4. "Es gibt kein bürgerliches Grundrecht, Öl, Kohle oder Gas zu verbrennen." Interview with Thomas Herzog in Baumeister B7/2009.
5. Thomas Herzog: Reflexionen über die eigene Arbeit. In: Die ökologische Herausforderung in der Architektur. Tübingen 1999.
6. Energien gestalten. Thomas Herzog talking to Nikolaus Kuhnert and Angelika Schnell. In: Arch+ 126, 1995.
7. Werdegang und Hintergründe. Thomas Herzog talking to Werner Lang. In: Thomas Herzog Architektur + Technik. Munich/Berlin/London/New York 2002.
8. Thomas Herzog: Schneller, höher, weiter, 2010 (unpublished).
9. Thomas Herzog talking to Jana Revedin, 2009 (unpublished).
10. Quoted in: Kirmo Mikkola. Der Denker Aalto. In: In Berührung mit Alvar Aalto. Jyväskylä/Helsinki 1992.
11. cf. Winfried Nerdinger: Ars sine scientia nihil est – Thomas Herzog: Architektur und Wissenschaft. In: Thomas Herzog Architektur + Technik. Munich/Berlin/London/New York 2002.
12. Energien gestalten. Thomas Herzog talking to Nikolaus Kuhnert and Angelika Schnell. In: Arch+ 126, 1995.
13. Thomas Herzog talking to Mathias Schreiber. In: Thomas Herzog Bauten/Buildings 1978-1992. Stuttgart 1992.
14. cf. Interview with Thomas Herzog in: xia intelligente architektur 07-09/2012.
15. Energien gestalten. Thomas Herzog talking to Nikolaus Kuhnert and Angelika Schnell. In: Arch+ 126, 1995.
16. Thomas Herzog talking to Mathias Schreiber. In: Thomas Herzog Bauten/Buildings 1978-1992. Stuttgart 1992.
17. Energien gestalten. Thomas Herzog talking to Nikolaus Kuhnert and Angelika Schnell. In: Arch+ 126, 1995.
18. Thomas Herzog talking to Mathias Schreiber. In: Thomas Herzog Bauten/Buildings 1978-1992. Stuttgart 1992.
19. Aller Lasten Anfang. Interview with Thomas Herzog in: xia intelligente architektur 07-09/2012.
20. Sabine Kremer: Hugo Härung zum 100. Geburtstag. In: AIT 3/1982.
21. Winfried Nerdinger: Ars sine scientia nihil est – Thomas Herzog: Architektur und Wissenschaft. In: Thomas Herzog Architektur + Technik. Munich/Berlin/London/New York 2002.
22. "Es gibt kein bürgerliches Grundrecht, Öl, Kohle oder Gas zu verbrennen." Interview with Thomas Herzog in Baumeister B7/2009
23. Energien gestalten. Thomas Herzog talking to Nikolaus Kuhnert and Angelika Schnell. In: Arch+ 126, 1995.
24. Architektur und Verantwortung. Interview with Thomas Herzog in: Aktivhaus. Vom Passivhaus zum Energieplushaus. Munich 2012.
25. European Charter for Solar Energy in Architecture and Urban Planning. Munich/Berlin/London/New York 2007.
26. Architektur und Verantwortung. Interview with Thomas Herzog in: Aktivhaus. Vom Passivhaus zum Energieplushaus. Munich 2012.
27. "Es gibt kein bürgerliches Grundrecht, Öl, Kohle oder Gas zu verbrennen." Interview with Thomas Herzog in Baumeister B7/2009.
28. Thomas Herzog talking to Jana Revedin, 2009 (unpublished).
29. Aller Lasten Anfang. Interview with Thomas Herzog in: xia intelligente architektur 07-09/2012.
30. Aller Lasten Anfang. Interview with Thomas Herzog in: xia intelligente architektur 07-09/2012.
31. Thomas Herzog: Reflexionen über die eigene Arbeit. In: Die ökologische Herausforderung in der Architektur. Tübingen 1999.
32. Aller Lasten Anfang. Interview with Thomas Herzog in: xia intelligente architektur 07-09/2012.

PHOTO BY ERIK-JAN OUWERKERK



PEOPLE COME FIRST

Interview with Diébédo Francis Kéré

Previous spread **The high school in Dano (2007) shows many characteristic traits of Francis Kéré's climate-responsive architecture. The wide projecting corrugated steel roof shades the brick-and-concrete building underneath it and also casts shadows on the immediately adjoining spaces. The roof structure is made of rebar, which was easy to produce and process. The classrooms are ventilated through unglazed window openings, with exhaust air escaping through slits in the roof.**

Below and next spread **For the school library in Gando (under construction), Francis Kéré used rooflights for the first time. Like many elements in Kéré's buildings, these were made in an extremely simple and straightforward manner – by cutting away the bottoms of earthen jugs and placing these inside the formwork of the roof before pouring the concrete.**

Diébédo Francis Kéré is one of a new generation of architects who are currently developing a new African architecture for the 21st century. Strongly influenced by the ideal of social sustainability, these architects take the local climate and resources as their starting point for each project. Diébédo Francis Kéré builds with and for the local people. Using simple tools and locally available materials, he creates pleasantly cool, airy buildings that serve as popular meeting places for the local community.

Interview by Jakob Schoof

GANDO is a village in eastern Burkina Faso in the middle of the Sahel region; the 3,000 villagers live in scattered clay huts. The average annual temperature is around 30 degrees Celsius; in winter there may be no rainfall for several months. From June to September, however, there can be torrential rains that weaken the walls of the clay huts. Nevertheless, the villagers are completely dependent on the rainfall – most of them live from subsistence farming. More than three quarters of the villagers cannot read or write.

Gando would probably still not be marked on any map today if an architecture student who studied in Berlin 15 years ago had not had a persistent dream: to give his home village a school. In 2001, Diébédo Francis Kéré completed the first primary school in Gando. Since then, an extension to the primary school, housing for teachers and a library have been built, all based on Kéré's plans; a secondary school is currently under construction. Many of the villagers who trained as builders on Kéré's building sites have gone on to earn good money elsewhere. In the meantime, other villages in the region have begun to copy the 'Gando model'. Right from the start, the climate was a decisive factor in Kéré's buildings. The clay walls and deep, overhanging roofs together with the ingenious ventilation system keep the rooms pleasantly cool. The people living in the region refer to the teachers' houses as 'wonderful refrigerators' – the highest praise for a house in Burkina Faso.

SUN

Mr. Kéré, you come from Burkina Faso, have studied in Berlin and, for some years, you have been mainly designing buildings for your home country. What does the term 'sustainability' mean for you in an African context?

For me, sustainability means creating added value with my architecture. You can often achieve that quite simply by creating buildings that are built to last and that offer people a certain level of comfort. You need to bear in mind that many traditional clay buildings in Burkina Faso are very susceptible to heavy rainfall and damp.

At the same time, sustainability means using regional resources, where possible, rather than imported products, because this will make it much easier for people to maintain their houses themselves.

Fossil energy resources should be used as sparingly as possible in Africa as well. This means, above all, that buildings should manage without air conditioning if possible. If creating a pleasant climate indoors using local materials and purely passive methods is feasible, then we will have achieved a lot.

Is there also a cultural aspect to sustainability?

Of course. It doesn't make sense to squander our limited resources in an effort to emulate the industrialised countries and copy their culture. Instead, we should learn from other cultures and use this to develop our own culture further. This

Diébédo Francis Kéré was born in Gando, Burkina Faso and studied architecture at the Technical University Berlin. He founded the association "Schulbausteine für Gando e.V." (School Building Blocks for Gando) in Berlin and, in 2005, he set up Kéré Architecture. Diébédo Francis Kéré teaches at Harvard and Mendrisio and has received numerous awards for his buildings, among them the Aga Khan Award for his primary school building in Gando.

PHOTO BY KÉRÉ ARCHITECTURE

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Builders on the way to the new school library in Gando. In all his buildings, Francis Kéré employs as many local people as possible, many of whom are untrained. As a result, several hundred people have received training on the job and become skilled craftsmen.

requires knowledge, information and reflection. If, for example, during a building project I can impart knowledge and teach manual skills to local people that will allow them to build their own infrastructure independently later on, then this is sustainable.

You talked of a comfortable indoor climate in buildings. What sort of requirements do people in Burkina Faso have in this respect?
When I went to school, my classroom had a floor area of around 7 × 6 metres and I shared it with about 150 classmates. The building was a simple cement shack and the windows were much too small to let in enough fresh air. You cannot imagine the temperatures in that that room!

Given those conditions, in Burkina Faso a building is considered comfortable when it is pleasantly cool inside – and 'cool' in this context may mean no more than a temperature difference of, say, 4°C between inside and outside, as long as the room has additional cross ventilation.

What relationship do your buildings have to the sun as the source of light and heat?
Providing enough daylight is not usually a problem – you only need relatively small openings to admit sufficient light into buildings. The most important thing is to keep the heat out of the building's interior. I use large eaves overhanging the buildings to achieve this. They ensure that the fresh air that flows into the building first cools down a little in the shade of the projecting roof. I also make use of a simple law of physics inside: if there is a draught in a room, people feel that the air is cooler, even if the temperature has not actually changed.

What do you think of initiatives that propose the electrification of Africa using solar energy? After all, large areas of the continent would appear to be predestined for this?
I am sceptical – at least, as long as solar energy is viewed as the sole 'remedy' for Africa and people are willing to accept

that all the technology used is imported from China or Europe. This only creates dependencies for under-supplied communities and results in the limited money available being funnelled abroad. Using solar energy in Africa would only make sense if there were a real possibility of manufacturing the technology locally.

PEOPLE

You have emphasised how important it is to educate people and expand their knowledge. How does that tie in with your own biography?

When I was a child, we had neither electricity nor running water at home in Gando. Many of my friends never reached adulthood – simply because their families did not have enough money to spend five dollars a day to combat malaria.

Today, we still don't have electricity and there is too little clean water, but we do have a primary school – and we are building a secondary school for around 1,000 pupils. And all of that only because I was able to go abroad and study. I think that sufficiently illustrates how important education is for us in Burkina Faso.

Who influenced you during your study of architecture, and what knowledge obtained during your studies has been useful to you for your work in Africa?

One example was Thomas Herzog; his theories of solar building fascinated me – but there were many other architects as well who experimented with methods of passively cooling buildings at the time. In Germany, I gained above all scientifically-informed knowledge about climate and ventilation. I learned how to plan and construct but also how to think in a bigger context.

In Burkina Faso I then acquired completely different skills and knowledge: for example, how to select a particular type of clay for a specific type of construction, and how traditional clay floors are made. I also learned how to prepare building clay using traditional methods in such a way that it can also be used for modern residential buildings. But above all, I have learned to involve the local people in the building work.

How important was studying traditional means of construction for you to learn from them?

Very important – although my concern was always to develop these traditions further to serve a purpose. The traditional clay huts in Burkina Faso are an example of this: they form compartmentalised modular structures that can grow with a family but that can shrink again if a member of the family dies. This ensures the longevity of these buildings and makes them sustainable in the best sense of the word. Similarly, my school buildings are also composed of many small units – except that I try to bring them together under a single common roof.

The millet granaries in rural areas are another example. They are also made of clay but they are mounted on pillars to prevent damp and vermin from reaching the grain. The Togu na in Burkina Faso and Mali are also very interesting – they are the meeting houses of the men and consist of an open timber structure covered with a thick layer of straw. They are open on all four sides, allowing the wind to flow through. I learned a great deal from that during the construction of my roofs.

Why is it so important for you to involve the local community in the construction process?

There are three main reasons for that. First of all, buildings can be erected far more cost-effectively if local people are involved because, in our country, human labour is much cheaper than using machines. Secondly, there are almost no skilled craftsmen in my country, meaning that, in any case, I had to train new workmen for each project. And thirdly, I build together with people because it is their project. It gives them a job – and they are also the ones who will have to accept and value the building afterwards.

In the projects you have implemented to date, you have been able to impart manual skills and training to several hundred people. Have you seen them passing on their knowledge since then?

Many of the people who learned their skills at my building sites in Gando now hire themselves out as builders in the capital city Ouagadougou, or even abroad, and earn their own money. This is enormously important. But I have also organised a sort of transfer of knowledge myself. This means that my employees working locally on site must train up craftsmen themselves and, for example, teach them how to build with clay.

"I build together with people because it is their project. It gives them a job – and they are also the ones who will have to accept and value the building afterwards."

Were you welcomed with open arms when you returned from Germany to Burkina Faso?

Quite the contrary – my fellow countrymen were initially very sceptical. My father had been one of the village elders of Gando, but at that point it did not help me at all. Just imagine: Francis, who has been studying in Germany for years, has come back to his native country with a really stupid idea – he wants to build houses made of clay! But everyone in Burkina Faso knows that mud buildings do not last very long and are often washed away during the next torrential fall of rain. I had to overcome this image of clay as a 'material used by poor people'. Because clay buildings can last a long time – if they are built right.

How did you convince people?

I talked with them a lot, but even more importantly, I built models and carried out experiments. For example, I arranged for a mud shear wall to be erected and left it exposed to the elements and the weather; I did this for several years to show that it would hold up. Another time I commissioned the building of an arch made of clay bricks, nine metres long and one metre high. We then climbed onto it together with a whole group of workmen to prove that it could withstand the load.

While still studying in Berlin, Francis Kéré founded the non-profit association *Schulbausteine für Gando* (School Building Blocks for Gando).

His first building was the primary school in his home village, Gando (finished in 2001), for which he received the Aga Khan Award for Architecture in 2004.

PHOTO BY KÉRÉ ARCHITECTURE

It was not easy for Francis Kéré to convince his compatriots of the advantages of building in clay. For the new high school in Gando, the architect is using this omnipresent material in a novel way – mixed with cement and poured into a formwork in order to produce large, prefabricated wall elements.

BUILDING ENVELOPES

What strategies do you use for your buildings to react to the African climate?

An important element is the double roof: the lower layer is made of clay bricks or cement stone and the upper layer of corrugated steel. The stone serves as a thermal mass, the metal roof as protection against the rain and provision of shade. In Gando, the steel structure between the two roofs consists of simple rebar as it is used in reinforced concrete – because it was available locally and could be made relatively easily. In Burkina Faso, wood is a rare and valuable resource; for that reason we rarely use it in our buildings. The roof construction is open on either side, allowing the air to flow through it and to minimise the surface it offers to the wind. That in turn promotes the circulation of air inside the building, because air vents are also located in the roof. These can be slits or circular skylights like the ones we have used in the new library in Gando.

How did you develop clay construction further in order to create larger, permanent buildings using clay?

The important thing was, first of all, to create a solid foundation for the buildings, to give them stability and protect them against rising damp from the ground. In general, the foundations of our buildings are not made of concrete but of natural stone.

For the secondary school in Gando, we have attempted to streamline the process of construction. We no longer build using individual clay bricks but with ceiling-high wall elements cast in a casing. We mix concrete with the clay to help the material set more rapidly – but we use only relatively small amounts of cement, around two full bags per element. The walls still look like clay walls – and their most important raw material, the clay, is obtained just 600 metres from the building site.

PHOTO BY SIMÉON DUCHOUD / AGA KHAN TRUST FOR CULTURE

Glass is used only for prestigious buildings in Burkina Faso; Francis Kéré therefore mostly uses unglazed window openings for his buildings. In the teacher's houses in Gando (2004), a lattice of clay bricks protects the interior spaces from sunlight and views.

Due to their pleasantly cool indoor climate, the houses are also known as 'Gando fridges' among locals.

"I always used to run home from school – and always from the shade of one tree to the next. Walking slowly or waiting for the others was simply impossible at temperatures of 45 degrees Celsius. And now you have to imagine what an enormous 'tree' my school represents, with its shade in the savannah: as a schoolchild, you wouldn't want to go home either."

For the school library in Gando, you used circular skylights for the first time to bring daylight into the building. What are the advantages of this type of construction?
The numerous small openings allow the hot air to escape quickly from the room and keep the prevailing temperatures relatively stable. The openings bring additional light into the room so that I was able to keep the vents in the building's walls very small. They now only serve as a supply of fresh air for the building and are located close to the ground to let in air that is as cool as possible.

In addition, the construction has the advantage that it can be manufactured easily. The skylights are made of earthenware jugs like the ones used by the local people at home to store grain or water. We cut away the bottoms of the pitchers and then placed the pitchers in the roof sheathing before pouring the concrete mixture.

You recently completed a museum in Mopti (Mali) where you used glass windows. You hardly ever use this material in your buildings elsewhere. Do glass windows offer any benefits in Africa's hot climate?
That depends on the size of the glass pane and what the building is used for. A museum is a public building and therefore has relatively large rooms. We use the windows to bring in more daylight into the general areas without letting in unnecessary warm air. That is why we also separated the functions in this case: the glass windows serve to let in natural light and to create a visual connection to the outside. The air enters through smaller, separate vents near the floor of the rooms.

How do you evaluate your buildings? How do you determine whether they create the pleasant indoor climate you hoped for?
I listen to what the local people tell me. Some of the teachers, for example, told me that when school is finished they literally have to ask the pupils to go home. Otherwise they would stay there the whole day!

The reason for that is relatively simple: it's a long walk to school – and hot. I still remember that, when I was a child, I always used to run home from school – and always from the shade of one tree to the next. Walking slowly or waiting for the others was simply impossible at temperatures of 45 degrees Celsius. And now you have to imagine what an enormous 'tree' my school represents, with its shade in the savannah: as a schoolchild, you wouldn't want to go home either.

And all of that has a positive impact on the pupils' academic achievements. Before I started building in Gando, nobody had heard of my village. Today, the place is famous throughout the country – and Burkina Faso has 16 million inhabitants – for having some of the best schools in the country.

OUTLOOK

Have you seen others now following your example?
Formal training to become an architect is still lacking in large parts of Africa. There is only a single university for architecture for the entire French-speaking region of West Africa – in Togo with around 200 students.

On the other hand, I have noticed an enormous interest in my work among architects and at universities in Europe and North America. Even in Africa, news of my work has now got around, and the response I experience there gives me strength – because I have found that what I started to do in all naivety in those days, without any textbook knowledge, really works.

What was the reaction in the first years when you started building for Gando?
At the time, colleagues in Berlin tended to be somewhat patronising. I was also told that I should wait before starting my work – also, that I needed to be a qualified architect before I could be permitted to build. But I didn't want to wait, I wanted to give something back to my country! Think about it: the average life expectancy in Burkina Faso is 47 years. I am already 48 – so I don't have any more time to lose!

You have since taught at numerous universities, among them Harvard and Mendrisio. What is the message you give to your students?
I use the opportunity to debate with them, because I have had the experience that young people are more receptive to new ideas. They are unbiased – and that is the most important prerequisite for creativity and innovation. I encourage students to go new ways in our oversupplied world, because that gives them the opportunity to discover new things. We cannot all be brilliant designers like Zaha Hadid, Herzog and de Meuron – or distinguished university professors like Thomas Herzog – but we can be inspired by their approach and then create something new ourselves.

PHOTO BY ERIK-JAN OUWERKERK

Interview with Peter Stutchbury

EDUCATED BY NATURE

With their large expanses of glass, sliding panels and parts of the envelope that fold up or outwards, the buildings of Peter Stutchbury closely connect their inhabitants to their natural environment. Yet to the Sydney-based architect, nature does not merely serve as a decorative background of his architecture, but rather as a kind of didactic tool; the experience and understanding of the site and its climate will, he hopes, lead people to a more responsible way of inhabiting the planet.

By Jakob Schoof
Photography by Michael Nicholson

Previous spread **Contour House (2006–2011) is located on a hillside in the mountains of Berry, south of Sydney. A massive, tubular access corridor shields the building from hot winds and bushfires from the west. All the elevated, partly-glazed living spaces open towards the valley in the east.**

Left **"Touch the Earth lightly" – this old aboriginal proverb is exemplified in the design of Paddock House in Tarago (2006), not far from Canberra in the hinterland of New South Wales.**

AT FIRST GLANCE, the houses that Peter Stutchbury has designed throughout the 35 years of his career remind us of the modernist villas to be found elsewhere in the warm temperate climates of the world, such as in California or along the Mediterranean Coast. With their immaculate detailing and stripped-back construction, they may well seem like typical lifestyle choices of affluent, post-materialist, cultural elites. Yet Stutchbury's architecture is, to a large extent, informed by real scarcity. "Survival was part of our vocabulary," recalls Peter Stutchbury of his childhood, which he spent on a sheep farm in the barren outback of Australia.

This upbringing led him to design buildings that achieve maximum comfort with minimal means. In the climate of New South Wales, which has mild winters but hot summers, Peter Stutchbury generally seeks to avoid air-conditioning in his houses. In most cases, he succeeds in doing so by cleverly using the forces of nature. According to the Norwegian architecture critic, Ingerid Helsing Almaas, his buildings appeal to much more than just the sense of seeing, and can hardly be captured in images: "You cannot photograph moving air. You cannot photograph the effect of a 20 degree drop in temperature in the scorching heat of the outback; the image will not show the relief of shade in an Australian mid-summer day, the coolness of concrete or the hot breath lifting the air beneath a sheet of corrugated steel."

SUN

Mr Stutchbury, what – or who – has shaped your approach towards resource saving and climate-responsive architecture? When did you first feel the need to consider these topics?

I suppose these ways of thinking have to do with our own origins. My father, for example, was brought up in the Depression. He used to recycle everything – the plastic around the newspapers, the newspapers themselves, the rubber bands, the jars that the vegemite came in, everything in his garage was recycled. He wasted nothing. Furthermore, as an engineer, he built things to last, and he constantly reminded us of how much time and energy was involved in maintenance. I have never met anyone with the pursuance of quality that he demanded. Everything had to be perfect and when I asked him why, he'd say, "If it's perfect, you respect it and only do it once".

On my mother's side, we were farmers, but of a particular kind. Our farm was a big property of more than 40,000 hectares in the semi-arid desert. Here water is a precious resource. As a child, I clearly remember only being allowed to have a bath once every two to five days depending on whether it had rained or not. The bath was shared with my siblings and you rotated who was first because for the last person the water was very dirty, and only about two inches deep. So water as a resource is something we learnt from day one.

Sydney-based architect **Peter Stutchbury** graduated from Newcastle University in 1978. Today, he is a professor at the same university. He has held professorial chairs in South Africa, USA and South America. He is a founder of and has been teaching at the Glenn Murcutt International Masterclass since 2001. In 2008, his firm won the International Living Steel Award in Russia and, since 1995, Peter Stutchbury Architecture has won 46 AIA (Australian Institute of Architects) awards, including both of the nation's major awards in 2003 and 2005. In 2012, he was made an AIA life fellow.

Terrace of Paddock House in Tarago. Massive walls act as a thermal buffer. The lightweight roof construction protects the building from the sun's heat; the water pool provides cooling and reflects low sunlight into the house.

Then, when you farm the desert, you can't farm insensitively, otherwise you destroy the land that's producing the food you sell. So if you cut trees down, for instance, the land becomes parched and erodes, and it's no longer sustainable. If you take a natural windbreak down, the land, which consists of fine sand, blows away. If you put a fence line in and you don't carefully select where it goes, you might end up having kilometres of fence in rock. So when you're brought up in the desert, you have to think carefully about everything you do. You can't just manage a day-to-day activity by habit, you've got to perceive the day as a moment by moment consideration.

With my children, I see that their attitude to sustainability comes through our personal environment; they've never had to live it day by day. Anyone younger than 30 years old has never truly experienced lifestyle hardship. I recall visiting the supermarket with my mother and going through the price of every item we were buying in order to get the most economical. We grew tomatoes in the backyard because we couldn't afford to buy them. We were brought up with an understanding of economics as part of our vocabulary.

So would you say that in order to understand and value sustainability, one has to live it, or even be forced to live sustainably? In order for you to truly appreciate the values of sustainability, you need to understand its complexities – and I'm not sure you can understand patterns unless you've experienced their logic. You need to be on the farm in 45 degree temperatures with no water. You need to see dead animals on the ground. You need to see the erosion gullies created by bad water management. You need to see paddocks of trees and vegetation die. We have just come out of a winter, and do you know what we had last weekend? Bush fires. On the edge of winter! This country is so unpredictable.

The reason why there are only 20 million people in Australia and not 300 million as in the U.S., which has a similar land-

mass, is that we just can't sustain more people. We are the driest continent in the world, and anyone who steps out of their door in this country and looks around, should reach this inevitable conclusion. We get announcements on the TV and radio: "There's a water restriction. You can't water the garden or wash your car for the next three months." When you are brought up like that, you tend to respect resources.

How would you describe the relation of your buildings to the sun, having experienced this as something very strong and very dominant in your country?
I think Australia has the highest incidence of skin cancer in the world. Unlike your country, quite simply, we need shade to protect us from the sun. Nonetheless, we do enjoy the sun outside our harsh months, when it is safe and manageable to be exposed to it. We don't get snow in Sydney, we don't have to wear warm overcoats or anything similar. There are no air locks on our buildings and we don't even require double glazing.

The light management in our buildings is quite different from natural light management in Northern Europe. We manage the sun by creating refuge from it. This can be through screening or through vegetation or through solid mass. Daylight in Australia is rather similar to the Scandinavian light. It has a bluer hue, particularly on the coast, because we get so much light off the ocean, which is usually reflected by clouds back onto the land. As you move into the centre of Australia, the light becomes more orange-red – it is being affected by the desert dust.

PEOPLE
How we manage the sun in our buildings will also determine the degree of comfort we achieve inside them. How have people's demands in terms of indoor comfort changed over the last few decades?
When I was a boy, we had no air conditioning, and we just had a single bar heater in the home. I can remember some hot nights, when I slept with a sheet or less and had to open all the windows in the room to get cross-ventilation. Nonetheless, I can't ever remember being acutely uncomfortable.

What happened with the advent of air conditioning is that people got lazy. People stopped wearing jumpers inside. People took the verandas off their houses or built them in for more room. Air conditioners also changed our tolerance to weather. In countries where rooms are predominantly air-conditioned, people's tolerance is just a few degrees of temperature variation. Out in the landscape in Australia, our tolerance by necessity is up to 35 degrees.

How do you deal with these changing requirements in your own work?
Once people have become used to this kind of thermal intolerance, the comfort inside a home becomes critical. We avoid air conditioning in the houses, but sometimes clients insist and we manage to restrict it to particular rooms – bedrooms, say, so they don't have to sleep in the heat of the night. We have only ever designed three air-conditioned homes, the third of which is under construction at the moment. Of the other two houses, one client has used it just three times in five years, and I don't think the other one has ever used it.

One reason for this is that if you balance the indoor climate by purely passive means, for example using thermal mass, the temperature fluctuations are reduced. Furthermore, your body is far more sympathetic to natural temperature variations than to unnatural temperatures. When you go out into the sun from an air-conditioned room, it takes at least half an hour for your body to adapt. Whereas if you're in a passively-cooled environment and you walk outside into the heat, you notice it, but it is not disruptive and you adapt much faster.

I often discuss the comfort levels in our buildings with clients. I am confident that we can manage 90-95% of the comfort passively simply because of the knowledge we have gathered over time on ventilation, thermal mass, heat storage, the management of moisture in the air, and cooling. For example, I am currently building a house for my family, on a site with one of the most magnificent views in Sydney. The living is at ground level, below the view line. People are mystified but I know that if we put the bulk of living area up at the view line, that is also where the heat is, and the tough coastal weather. And we won't enjoy living there, we'll always feel we have to shut the windows and isolate ourselves. Whereas at ground level, we'll live incredibly comfortably, even in summer, and we will journey upstairs to the view whenever we want to.

"Air conditioners also changed our tolerance to weather. In countries where rooms are predominantly air-conditioned, people's tolerance is just a few degrees of temperature variation. Out in the landscape in Australia, our tolerance by necessity is up to 35 degrees."

The upper floor of the house will essentially consist of a series of solid panels around a partly glazed and ventilated box. We can open and shut the solid panels according to the time of year, so that in winter, the ones to the low sun in the north will be open. In summer, they'll be shut and we will open the ones to the south instead, where there is no direct sun. The whole building will be modulated and changed based on the weather patterns.

BUILDING ENVELOPES
A striking feature of your buildings is their horizontal permeability. You often work with large expanses of glazing and large, openable sections in facades. What is your motivation to do so?
There are two essential reasons why our buildings tend to be more open than the traditional European ones. Firstly, we can afford it climatically. And secondly, we aim to create connections. If you can connect people with place, their world expands. It's not restricted to the house any more, but becomes far bigger – it becomes an understanding of the natural environment. You will find that people adapt very quickly to connection with nature. Not

Previous spread **On a coastal plot on the outskirts of Tokyo, Peter Stutchbury designed Wall House for a Japanese designer in 2007–2009. The building shows two distinct faces towards its environment: towards the street it is closed off with unplastered grey masonry walls; whereas towards the gardens, the house opens up with ceiling-high glass doors that can be shaded with filigree wooden panels.**

Left page and next spread **Beach House (2006) is located in Newport Beach on the very northern edge of Sydney. Its spatial concept can be described as 'living on the beach and sleeping in the sky'. The bedrooms on the upper floor can be protected from the wind and weather by means of robust, sliding metal louvres. The living rooms at ground floor, in contrast, can be largely opened up towards the coast.**

to connection with an urban street full of cars or people – but if the manner of the openings in your buildings connects you with the change of nature and enables you to watch the sky or to watch a plant grow, you are in effect educated by nature. The Japanese are exponents of this art. I designed a house in Japan and, at one point I asked my client, "Why did you get me to come to Japan to do your house?" He said, "Because you will connect me with nature." And when I asked another – South African – client a similar question, she replied, "Because it will educate my children."

These kinds of statements might appear poetic. On the other hand, when people are connected with nature, this will create a respect that leads to a certain attitude to sustainability and energy use, and to a responsibility that goes far beyond economics. When I arrive home the other night, bush fires were ablaze locally, their smell was in the house. If I had an air-conditioned house, external life would be absent. I was very aware that these bush fires were less than 20 kilometres away. Last night at about three in the morning, I heard a possum jump from a tree to our roof and I intuitively identified that the possums, so quiet over winter, are again active. When your house has a life, when it is a living organism – and the Aboriginal people talk about buildings and rocks and caves as living things – then you develop an attachment to the cycles of nature. We don't design buildings in isolation, we design them as connections. That way, they have an expansive understanding of what contributes to place and composes life.

How do you try to achieve this openness and connection with nature in urban settings?
Although it might not seem so at first glance, many of our buildings are actually located in urban settings. Many of them are close to a town centre. In this environment, we connect houses to their exterior environment, even beyond the boundaries of the site itself. The Japanese traditionally practiced connectivity. In their more famous temples, particularly Entsuji, on the outskirts of Kyoto, they 'borrowed' the landscape beyond to connect to the greater place. Entsuji is on a small hill, and right in front of it there is an urban development. When you walk up to the boundary of the temple precinct and look over the wall, you'll see a suburb of buildings, but if you go back to the temple and sit on the veranda, the mountain that is about five kilometres away comes into your view line, seemingly becomes a part of the garden. Very clever – and in many ways a paradigm of what we try to do in our buildings.

In general, what external factors and what design principles are most important to you when designing a new house?
We are not focused on style in our work. Rather we concentrate on the place where buildings are located. You will notice that all our buildings are different; they derive their difference from the site. Every site has a very particular set of qualities and therefore the buildings should respond to those qualities. It would be unworkable to grow desert plants in the rain forest. Likewise, every client has a very particular quality to which the building must respond and ultimately house. Our clients are both the benefactors and beneficiaries of our work – we are forever grateful for their insight and generosity. Regularly, the most remarkable outcomes can be traced to the clients' contribution.

OUTLOOK

How did your approach to architecture evolve over time, and what role did user feedback play in this evolution?
The wonderful thing about architecture is that you never reach the final verse. You travel through cycles, wonderful cycles. You are educated by your last building and equally by the life it promotes.

Our buildings evolve through patience, and through a growing understanding. You have to be patient with your thinking. This whole issue of computer education frustrates me because a wise education usually comes from the stewardship of an elder. An older person will pass on knowledge in a very educated and sympathetic way, traditionally through story telling. A computer doesn't pass on knowledge in the same way. You'd be hard pressed to assemble the same sort of knowledge from a computer as from an elder, and to assemble it with the same passion of interpretation. I often say, "Hug an elder, then go and hug a computer! And understand the difference."

"... when people are connected with nature, this will create a respect that leads to a certain attitude to sustainability and energy use, and to a responsibility that goes far beyond economics."

The last question I have is related. You've been teaching at various universities and architecture schools. What main messages do you try to convey to your students?
The main message I would like to convey to students is design responsibility. We're like the conductors of a big orchestra. We are led to assume the money people control destiny, but in fact architects are building for the future. Their buildings represent the culture of our globalised world. I therefore believe it is essential for architecture students to develop a respect for people, for place and for culture. And the second thing I try to convey to students is the lifting of spirit through beauty. What makes us as architects and designers different from a builder or an engineer or a project manager? My sense is it's our understanding and perception of beauty. A building is not a work of architecture unless it's beautiful, and unless it contains some form of serenity. It is essential that qualities that take you beyond the mundane are found in architecture. I am always challenging my students to find qualities that lift the soul and engage one's perception of beauty.

TOMORROW'S BUILDINGS TODAY

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"I always say that our first impression when we moved into the house, was an excellent air environment. One of the nicest aspects about this house was the incredible amount of daylight, which we get into this house. Rarely, do we turn on lights in the house during the day."

David Smith, Smith Residence

01 Torzhkovskaya Street, St. Petersburg
02 Soltag, Copenhagen
03 Àtika, Bilbao
04 VELUXlab, Milan
05 VELUX House, COP15, Copenhagen
06 Home for Life, Århus
07 Green Lighthouse, Copenhagen
08 Sunlight house, Vienna
09 LichtAktiv Haus, Hamburg
10 Maison Air et Lumiere, Paris
11 CarbonLight Homes, Kettering
12 Osram Culture Center, Copenhagen
13 Guldberg School, Copenhagen
14 Solar Prism, Albertslund
15 Russian Active House, Moscow
16 Solhuset, Hørsholm
17 ISOBO aktiv, Stavanger
18 Future Active House, Trondheim
19 Smith Residence, St. Louis
20 De Poorters, Montfoort
21 Great Gulf Active House, Toronto


"The Future Active House project is very much in line with our purpose: to encourage initiatives with high ambitions and creative solutions."
Gry Kongsli, Senior Advisor at Husbanken, about Future Active House
"It's especially great to wake up and see the world waking up with you. Not only is the sun rising, but people are starting to move around, dogs are barking and running in the distance and the shadows are disappearing."
Asja Dunaevskaya, Russian Active House
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"We can sit and relax outside as early as March because the wood absorbs the heat of the sun and releases it again."
Dorfstetter family
Sunlighthouse blog
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HEALTHY AND CLIMATE-FRIENDLY BUILDING SOLUTIONS CAN GO HAND IN HAND.

This is demonstrated by more than 20 demonstration buildings and Active Houses that the VELUX Group has built, together with architects and planners, housing companies and research institutions during the last decade. The following article summarises the most important findings from the design and operation of these buildings.

Society is in need of energy-efficient buildings that provide a healthy indoor climate for people living, working or playing inside them, while having minimal impact on the environment. A transition is needed – and already underway – in which the VELUX Group is taking an active part. We do so by engaging with stakeholders in the building industry, initiating experiments and offering high-quality roof windows that enable people to live healthy and comfortable lives while maintaining a good energy balance in the building. Since 2005, the VELUX Group has been driving and co-creating a wide range of experiments with sustainable living at the focal point; we have

- made discoveries through full-scale building experiments, establishing in-depth knowledge and research about sustainable living in buildings
- engaged in dialogue with stakeholders in the building industry, initiating experiments and sharing knowledge
- influenced the agenda of sustainable buildings via collaboration and argumentation.

The experiments in sustainable construction and the promotion of architecture that enhances our quality of indoor life started with the climate renovation 01 **TORZHKOVSKAYA STREET** in St Petersburg, Russia in 2000. We continued in 2005 with 02 **SOLTAG**, designed by Rubow Architects, a demonstration house funded under the EU 6th Framework Programme. This research project was undertaken in collaboration with research institutes, housing associations and manufacturers with the aim of demonstrating energy efficiency in the building sector.

This project formed a starting point for the VELUX Group in a series of demonstration buildings in which we initiated a broad collaboration with architects, engineers, builders, researchers, manufacturers and other relevant stakeholders in realising a large number of buildings to demonstrate that energy efficiency must go hand in hand with a healthy indoor climate.

03 The third project was **ÁTIKA**, erected in Bilbao in 2006. The building was specifically designed for Mediterranean climate by ACXT architects from Bilbao. It focused on creating a healthy, low-energy environment with good summer comfort and optimal daylight conditions all year round. Today the building has found its permanent location at Politecnico Milano, where, under its new name 04 **VELUXLAB**, it is monitored to evaluate its energy consumption and its thermal behaviour.

As a continuation of the Soltag project, the pavilion 05 **VELUX HOUSE** was developed in collaboration with Rubow Architects to demonstrate a carbon-neutral modular housing unit to be built at an attractive price. The house was the exit pavilion of the COP 15 climate conference in Copenhagen in 2009, and today functions as VIP and visitors' pavilion in La Rochelle, France.

The pavilion projects showed that a key to the understanding of any demonstration project is that an effort is made to evaluate the buildings. This includes monitoring their performance in use – in terms of energy and indoor environment – but also, importantly, how the living conditions are perceived by the building occupants.

Based on this, the VELUX Group launched the Model Home 2020 project, with the intention of determining whether the predicted energy regulations for 2020 can already be met with today's products, knowledge and processes. The vision was tested from 2009 to 2011 by building six full-scale experimental demonstration buildings, all climate-neutral and with high liveability. The houses are inhabited by test families and are being closely monitored in use.

The first two experiments are located in Denmark. 06 **HOME FOR LIFE** is a single-family house in Aarhus designed by AART architects, whereas 07 **GREEN LIGHTHOUSE**, an office and teaching facility for the University of Copenhagen, was designed as Denmark's first carbon-neutral building, by CCO Architects. The public-private partnership behind the project consists of the University of Copenhagen, City of Copenhagen, the Danish Building and Property Agency, and the VELUX Group. The house has been visited by some 15,000 people, including the Mayor of New York, the President of Russia, the Prime Minister of South Korea and high-ranking Chinese ministers.

08 The **SUNLIGHTHOUSE** in Vienna, Austria was designed by Juri Troy, and its energy concept developed by Peter Holzer from the Danube University in Krems.

09 **LICHTAKTIV HAUS** in Hamburg, Germany, is the result of a student competition at Technical University Darmstadt, and has been built in collaboration with Ostermann

10 Architekten. **MAISON AIR ET LUMIERE** in Paris was

11 designed by Nomade Architects and Cardonnel Ingeniuers, and the two semi-detached **CARBONLIGHT HOMES** in Kettering, UK were conceived by HTA architects and engineers. Each building involved a number of local and regional partners – architects, engineers, builders, suppliers and researchers – and all reflect and respond to three main principles – efficient energy design, a high degree of liveability and minimum climate impact. They all also respond naturally to the different climatic, cultural and architectural conditions of the countries and regions in which they are built.

In parallel with the Model Home 2020 Project, the VELUX Group has been a strategic partner in a number
12 of other demonstration projects. **OSRAM CULTURE CENTRE**, designed by T-Plus Arkitekter, is a climate renovation developed in a public-private partnership with
13 the Municipality of Copenhagen, as was **GULDBERG SCHOOL** (architects: NOVA 5), and the climate renova-
14 tion **SOLAR PRISM** (Rubow Architects) in Albertslund. All three projects were completed as demonstration showcases for the COP 15 Climate Summit.

15 **RUSSIAN ACTIVE HOUSE** was built in collaboration with the building company Zagorodny and Polygon Lab
16 Architects in Moscow. The Kindergarten **SOLHUSET** – the first climate-neutral building of this type in Denmark – was designed by CCO architects and Ramboll engineers and built by the municipality of Hørsholm.

17 In Norway, **ISOBO AKTIV** was realised in collaboration with SF AS Arkitektur, Arkitektkontoret IHT AS, and building company Jadar House in Stavanger. For
18 **FUTURE ACTIVE HOUSE** in Trondheim, the VELUX Group collaborated with architects Brendeland & Kristoffersen and construction company Tore Ligård. Cross-
19 ing the Atlantic, the **SMITH RESIDENCE** in St Louis, USA, was built in collaboration between Jeff Day and
20 Associates together with Hibb's Homes. **DE POORTERS VAN MONTFOORT** is a climate renovation of ten social housing units in which the VELUX Group collaborated with architects BouwhulpGroep and the Stichting GroenWest. The latest project, opened in October
21 2013, is the **GREAT GULF ACTIVE HOUSE**, designed by superkül architects.

One of our main objectives with the demonstration buildings was to share the knowledge gained in the design, construction and evaluation of the buildings with a wide range of stakeholders. Furthermore, we aim to intensify the dialogue with legislative bodies, housing companies, and organizations specialising in green building certification across Europe about the sustainability standards of the future. So in 2010, the VELUX Group co-founded the Active House Alliance together with a number other manufacturers, planners and investors, and assisted in the development of the Active House Principles. These are both a planning aid and a catalogue of criteria for energy-efficient, healthy and ecologically sustainable buildings.

All permanent projects – realised since 2009 – have been built and evaluated based on these principles, which comprise comfort, energy and environment. Focusing on a healthy and comfortable indoor environment, low energy consumption and environmental concerns, the Active House Principles ensure that the design process is never a question of either-or but always a quest to find solutions that combine benefits for people and the planet alike in the design of new and renovation of existing buildings.

Looking ahead, we see an imperative to scale up these well-tested solutions for the many, and above all to take up the challenge of the existing housing stock. 90% of the building stock that will exist in 2050 is already there, so the question arises of how to renovate these buildings to be healthy, sustainable and affordable. With our next demonstration project, we aim to test this – in a
22 house in the garden city **BON AIR**, in the city of Anderlecht near Brussels. The climate renovation is based on the Active House principles and on a competition-winning design by ONO Architects. It is expected to be complete and ready for occupation by the test family in 2015.

More information on our demonstration buildings can be found at: www.velux.com/sustainable_living/demonstration_buildings


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VELUX House


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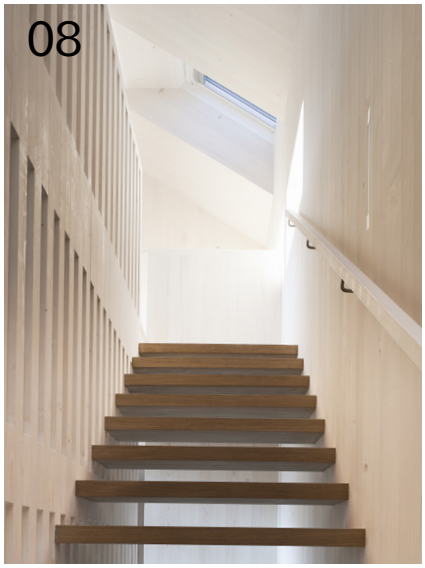

PHOTOS BY: ADAM MØRK (14 IMAGES), TORBEN ESKEROD (1 6 IMAGES), VELUX (3 IMAGES)

FINDINGS AND LESSONS LEARNED SO FAR

A main target for the VELUX Group has been to monitor the buildings after completion – and to see how the interaction between the buildings and their residents was. Consequently, a detailed monitoring programme has been set up for each building and the performance on energy and indoor climate was evaluated on a monthly basis by teams of scientific experts. On these pages, we share the most important learnings so far:

ENERGY

Legislative targets – **2020 is possible today!**

The ambitions for the Model Home 2020 experiments were high, generally targeting energy neutrality with some national variations. These ambitions were discussed with the teams of consultants, who took on the task of designing houses that could achieve these ambitions.

As a result, the four first Model Home 2020 houses have demonstrated that the energy targets of 2020 can be achieved with the knowledge, technology and building components that were available when the houses were planned in 2008–2010.

In some cases the energy performance has been communicated by the engineers based on national compliance tools – which can be misleading, as compliance tools are not necessarily made to predict the actual energy consumption of the completed buildings. Based on these experiences, it is evident that it would create more value for a customer if the calculated energy consumption is communicated as a range of values – because the actual performance depends on the actual use of the building. For the same reason, calculations should be made a tool that is meant for predicting actual use of energy.

COMFORT

Thermal comfort – **use dynamic external solar shading**

In none of the projects was there any summertime overheating, despite the large areas of glazing and high daylight levels (average daylight factor/DF above 5%). These are unusually positive results for new low-energy buildings, as these have been experienced to have a large risk of overheating. External solar shading and openable windows for natural ventilation have been used extensively in all buildings to prevent overheating.

09

"Occupants have gained greater knowledge about energy consumption and production resulting in a change in behaviour towards increased energy-consciousness."

LichtAktiv Haus finding

Energy consumption **– user-dependant, subject to variations**

The monitoring programme has revealed a variety of deviations from the predicted consumptions, mainly with regards to heating systems and building automation systems. It has become evident that evaluating the performance of new buildings after their completion is still not common. In particular, it has often been difficult to achieve the predicted target coefficient of performance (COP) of the heat pump and connected systems.

10

"The ventilation concept is also really great at sucking the dust out of the house and renewing the air inside the rooms. Since we moved in, we have never had to dust the TV set or the furniture for example, and there is still no dust on it.

There is also an undeniable advantage regarding allergies. Before moving in, Rayan often had sore eyes because of the dust, and my eyes were irritated in the morning when there was too much of it. All of this has considerably decreased since we moved in."

Pastour family, Maison Air et Lumiere Blog

08

"A big plus is the nocturnal cooling behaviour of the house. When it is cool in the evening, the house can very quickly cool down to a comfortable temperature. The cool forest air from the basement rises through the open-plan staircase as in a chimney, and out again through the roof windows. So even after nights when it is over 20 degrees outside, it is very pleasant in the morning, and the residents are pleasantly refreshed."

Ludwig Dorfstetter, Sunlighthouse Blog

Air quality – **natural ventilation can be an efficient airing principle**

Most projects are naturally ventilated during summer and use mechanical ventilation with heat recovery during winter, so no energy is used for fans or for heating during summer. In the investigated houses, opening windows and use of solar shading is sufficient to maintain an acceptable thermal environment, and opening windows and natural ventilation is sufficient to maintain a good indoor air quality (IAQ). It is seen that the best IAQ (and lowest CO2 concentration) is found in summer whereas winter IAQ is acceptable.

09

"No artificial light in the day! It's great that the evening light is so long, thus we come out from breakfast until long after dinner without artificial light, a great feeling. That was unthinkable in the old apartment."

LichtAktiv Haus findings

09

"Occupants want direct sunlight to enter the house consistently in the morning, the afternoon and evening throughout the year – and at noon in the autumn and spring."

LichtAktiv Haus findings

Daylighting **– minimises the need for electric lighting**

Generous daylight levels have been a key parameter for all projects, and occupant diaries from the Model Homes state that electric light is almost only switched on when it is dark (before sunrise and after sunset). The monitoring, which also showed that the use of light is highly affected by the interior daylight level.and that electric light is switched on only when it is dark outside.

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"I think many house buyers are worried about the air quality. I think it is very important to show that qualities like air and light are compatible with energy-efficient buildings."

Prof. A. G. Hestnes on Future Active House

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"It has been interesting to experience that the house reacts – in some cases it even feels like the house acts as a direct function of human needs. The solar shading, for instance, closes just as we start to feel the need to rub our eyes and the skylight window curtains closes just before the sun breaks through the clouds. If one did not know better one might think that the house was connected with one's nerve system."

Home for Life, Family Kristensen

ENVIRONMENT

Carbon-neutrality

Carbon neutrality depends on a variety of factors, including the energy sources used and how efficiently this energy is used. All the buildings use solar-driven heat pumps for heating, supported by solar thermal panels. The monitoring results showed little deviation between the predicted and actual energy outputs of the PV and solar thermal systems. However, they also showed that solar arrays and hot-water storage tanks need to be carefully sized, and the operation of the building systems needs to be closely supervised to make sure that a maximum amount of the solar energy can actually be used in the building. In some cases, changes were implemented during the operational phase to further increase the renewable energy use. One such example is LichtAktiv Haus, where a geothermal probe was drilled after the first year of operation in order to store excess heat from the solar thermal array during summer and use it to heat the house in winter.was drilled after the first year of operation in order to store excess heat from the solar thermal array during summer and use it to heat the house in winter.

The residents and their patterns of life have a significant influence on the performance of the buildings. The families who have lived – or live in – the Model Homes, have willingly participated in keeping diaries and answering questionnaires on how they perceive the houses and the living conditions inside them. This material is currently being used as the foundation of a PhD project that will be published in 2014.

HOUSING WELL-BEING

The most profound scientific investigation of the housing well-being of the residents has been undertaken in a research project by the Humboldt University, Berlin*. The scientific work focuses on housing well-being as a three-component model. The model distinguishes between cognitive, affective and conative reactions that can manifest themselves verbally and non-verbally and that can be measured. Originally developed for the monitoring of LichtAktiv Haus in Hamburg, the model is now being used to evaluate the next demonstration projects.

The LichtAktiv Haus quite clearly offers a high level of living comfort and, apart from a few minor criticisms, its occupants are very satisfied with their new home (affective dimension). As one would expect, alongside the architecture and the generous amount of space, it is primarily the abundance of daylight that is considered to be responsible for the positive effects. However, the evaluation also showed that not everything that is considered to be technically expedient can be reconciled with the everyday reality of the occupants (e.g. the automatic operation of windows and other building systems at night). This problem is familiar from sociological technology studies. Nevertheless, we can conclude that the technical infrastructure results in increased living comfort, as it optimises the indoor climate and automates certain processes.

The LichtAktiv Haus also fulfils its expectations with regard to sustainability. It would appear that the new living environment has made the occupants more aware of energy-saving considerations and consequently they have modified their energy-consumption behaviour (conative dimension). It may be because of this sustainability in particular that the family identifies very strongly with the Model Home Project and the LAH and is very proud to represent future-oriented housing.

09

"Friends, neighbours, acquaintances and parents like to come when they see the weather is good. Then they call – and our telephone now rings much more frequently."

Irina Oldendorf, LichtAktiv Haus

* Fedkenheuer, Scheller, Wegener (2013): Housing well-being as a multi-component view of attitude. Interim report on the psycho-social monitoring of the VELUX LichtAktivHaus during 2012, Berlin

09

"On really hot days we have at least two or three sliding doors open so that it is very airy in here... you feel as if the room merges with the garden to a certain extent, so that it is more like a veranda. A really nice effect actually."

Irina Oldendorf, LichtAktiv Haus Interview

20

"It would be fair to say that comfort was very bad before the remodelling. That has changed now, we are amazed by the extra space in the attic. Thanks to this extension, we now have four bedrooms. That is great for a family with four children."

Edwin Hamelink, De Poorters van Montfoort

11

"For me the biggest and most obvious difference to our flat is the amount of light in our new home. We really don't use the lights anywhere near as much as we used to in the flat. It makes such a difference to everyday life, even in the family bathroom – even with only the light tunnels we still don't need to put the lights on if it's daylight outside. It gives me a huge sense of well-being and I definitely feel happier."

Laura Glazebrook, CarbonLight Homes blog

PROCESSING, PLANNING AND COMMISSIONING

Many of the projects were developed in a stage/gate model as a process, steering and decision model. This has proved to be a valuable tool when working with development projects across cultures, borders and interdisciplinary boundaries with experts and laymen. Covering eleven of the projects mentioned, an external survey was made; asking representatives from investors, architects, engineers, contractors and advisors about the design and construction processes. As an overall conclusion, all stakeholders learned from the projects; they also provided very useful and reflective input for optimising future projects: and finally, they would like to participate in a new project.

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"The Future Active House project is very much in line with our purpose: to encourage initiatives with high ambitions and creative solutions."

Gry Kongsli, Senior Advisor at Husbanken

COMMISSIONING & QUALITY

Construction quality **– experienced craftsmen are needed, and prefabrication is a good idea**

Airtightness of the buildings is very important for their actual energy performance. In this respect, a number of national differences appeared. While good design is important for the airtightness, it is even more important that care is taken with every detail in the construction phase; and this depends to a large extent on the experience of the craftsmen. It has been noticeable that in those countries that had the longest tradition of low-energy buildings, the houses achieved the target airtightness with the first blower door test. Furthermore, the houses based on prefab construction achieved the airtightness goals almost instantly.

11

" The CarbonLight Homes' high average daylight factor, intelligent use of natural ventilation and dynamic building envelopes make them a truly unique residential development that provides an indoor environment that will actively promote occupant health. Space, light and air are key ingredients in a recipe that we believe will appeal to home buyers and that we believe could be replicated more widely – bringing the good life to the volume market."

Ben Derbyshire, Managing Director of HTA Architects

Commissioning – **co-contractors should be involved at least one year ahead**

When it comes to controls and technologies, the projects showed that climate controls and comfort parameters are interlocked and that there is a high degree of complexity. The building sector has not had a tradition of sharing knowledge on how technologies work in practice. Furthermore, there is a lack of consensus on communication protocols, hierarchies and functionalities with systems that include several interfaces and products.

06

"The summer months have given us more insight into the house's reactions. We've found that the roof windows have been busy ventilating the house to keep the temperature down."

"The light in the house is impressive (...) and there's no need for electric lights during the daytime."

"It's great that there's so much light in the house. The nature of the light changes with the weather."

Diary extracts of the Kristensen family from their first year in Home for Life

09

"Bright, open, spacious, comfortable and of course energy efficient. And we are very satisfied! There is always fresh air, thanks to the automatic window ventilation, many hours of daylight because large windows have been put in every room, as well as open and spacious rooms in the house, which produces enough energy to cover our needs."

Oldendorf Family, LichtAktiv Haus blog

11

"The beauty of having so many windows that automatically open to regulate the inside temperature means our house has felt really comfortable during the summer heat wave. It's not once felt too hot inside."

Nik Glazebrook, CarbonLight Homes Blog

OUTLOOK

We are proud and happy to present the key results and findings, and look forward to elaborating further and deeper. There is no doubt that more work needs to be done in terms of systematic monitoring and evaluation particularly in residential buildings. We are sure that all those involved – building owners, designers and particularly residents – can benefit from this.

In the years to come, we therefore aim to intensify the knowledge exchange with other stakeholders from the building industry – and we invite all those interested to take a closer look at the Active House Principles and the activities of the Active House Alliance. More information on this can be found at www.activehouse.info.

07

"Analysis of the responses found that most employees expressed an interest in working in a sustainable building and enjoyed the results. In general, the building is perceived as beautiful and full of daylight. Many respondents talked about the quality of the indoor environment, mentioning in particular the freshness of the air even during long meetings."

Green Lighthouse users in the book Green Buildings Pay

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