energy
innovation
austria

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Current developments and examples of sustainable energy technologies

Active Buildings

Building and renovating with innovative technologies

LifeCycle Tower LCT ONE, Source: Cree GmbH © Daniel Flax

In Europe raising and lowering temperatures in buildings accounts for 49 % of total energy consumption. The energy efficiency of buildings is a key element in the European Union's energy and climate package. In conjunction with making greater use of renewable sources of energy, measures to minimize resource consumption in constructing and to maximize energy productivity in running buildings play an essential part in achieving the EU's energy policy goals. In Austria numerous smart design ideas and technologies for buildings aimed at pushing sustainability in the energy-intensive building sector are being researched and tested.

Energy efficiency 2020 – New technologies for intelligent Buildings of Tomorrow

Today more than 50 % of the world's population lives in cities with more than a million inhabitants, and the proportion is increasing. The building sector is among the most energy-intensive fields worldwide: buildings account for 40 % of total energy and resource consumption, are responsible for 60 % of transport worldwide and produce 40 % of total waste and CO_2 emissions.

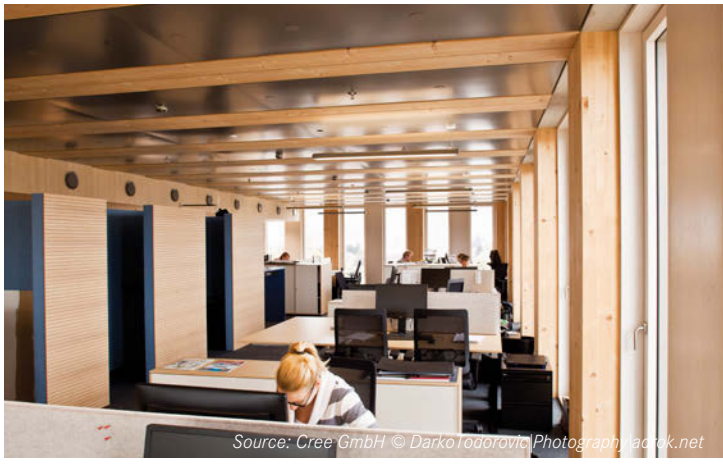
An EU directive adopted in 2010 on the energy performance of buildings prescribes nearly zero-energy buildings as the standard across the EU. The new directive stipulates that from 2020 onward only nearly zero-energy buildings may be erected, with very high overall energy efficiency and needing very little energy for heating, hot water, ventilation and cooling. In the case of new administration buildings the rules apply even earlier, from 2019 onward. Minimum standards for calculating overall energy efficiency are to apply throughout the EU. These buildings' extremely low energy consumption is to be covered by renewable sources of energy, if possible from the region in question. In future the same requirements will also apply to major renovations (involving more than 25 % of the building envelope).

Austria plays a leading role in the field of sustainable building. For many years now, with support from the Ministry of Transport, Innovation and Technology (BMVIT) and the Climate and Energy Fund, and as part of focussed research programmes (e.g. Building of Tomorrow, New Energy 2020), innovative building designs and technologies have been developed and tested in practical demonstration projects. Several technologies and products have already reached the industrial production stage and been marketed internationally.

These days current strategies are aimed at creating the technological foundations for energy surplus buildings which generate more energy over a full year than they consume. For this to work and for these strategies to catch on, implementation must be cost-effective. Prefabricating components and building elements on an industrial scale plays an important part here.

Sustainable construction designs are especially relevant in an urban environment: work on strategies for the city of tomorrow, a "Smart City", has been in progress in Austria for years. In cities of the future new technologies in the fields of energy, transport, building and environment should be coupled together. ◘


Source: Cree GmbH © Norman A. Müller


Source: Cree GmbH © DarkoTodorovic|Photography|dark.net


Source: Cree GmbH © Norman A. Müller

LifeCycle Tower LCT ONE
Timber-hybrid multistorey building, a prototype for sustainable construction

The eight-storey LifeCycle Tower LCT ONE, built by Cree GmbH in Dornbirn and opened in November 2012, is the first building worldwide to feature the unique modular construction system "LifeCycle Tower". In the course of research over several years a team of experts (architecture, timber construction, structural engineering, structural analysis, etc.) developed a commercially viable design for timber-hybrid buildings of up to 30 storeys. The result is an intelligent modular construction system which can be used for a wide variety of residential, office and industry buildings and permits construction in minimal time. The design guarantees minimal resource and energy consumption, a CO_2 balance sheet improved by 90 %, and also cost-effective performance over the building's entire life cycle.

Photos: Cree GmbH © DarkoTodorovic|Photography|adrok.net

Timber – Building material in urban construction

Timber is a naturally renewable raw material available in many places, combining lightness with strength and excellent properties with respect to thermal insulation, soundproofing and curbing vibration, and provides real comfort for residents. Timber is 100 % recyclable, which cuts life-cycle costs and delivers tremendous cost advantages. Where timber is used in urban environments considerable carbon sinks develop, which can reduce pressure on the environment in a sustainable fashion. The LCT System relies on an optimized combination of timber with other construction materials in order to achieve efficient resource use together with the best functionality and meet tight fire safety standards at the same time.

System building

The system components for the LifeCycle Tower (floor, column, façade) are prefabricated industrially and can be used as modules. Right from the start they contain key components for building services. On the construction site all that has to be done is to assemble the modules. This ensures very short construction periods, low noise and dust emissions, while cost overruns are avoided and the highest quality of implementation is achieved.

„We are convinced that multi-storey timber construction is the solution for sustainable, resource-conserving building, particularly in an urban environment. The Cree System is capable of implementation worldwide, using regional resources, and provides (inter alia) Austrian companies with openings in researching and developing innovative building technologies. As this construction system spreads, it encourages economic growth of an intelligent, sustainable and inclusive nature."

Hubert Rhomberg
CEO Rhomberg Holding, Cree GmbH

Despite mass production the system permits many different design variations. As no supporting walls are necessary inside, the size of individual rooms can be determined freely. The architecture of the façade is also a matter of free choice. An energy-smart approach to building services design (energy surplus, passive-house or low-energy standard are available) ensures low energy consumption, which can be covered by various renewable sources of energy.

LCT ONE – Prototype for high-rise buildings

The LCT ONE prototype demonstrates how well the system functions in real-life conditions. An eight-storey office building with 2,500 m^{2} of gross office space to passive-house standard was erected on a plot of land measuring 24 by 13 m. It is Austria's tallest wooden building. The high-rise building consists of a rigid staircase core which the office floors are attached to. The timber-concrete composite rib floor is the real key to building high, making it possible to separate individual storeys with non-flammable layers.

Unlike timber buildings in the past, the load-bearing elements of the LCT ONE are not concealed. The open, exposed timber structure puts the benefits of timber as a construction material for interiors on display; at the same time it plays an important part in the fire safety strategy. The building services are integrated in the open panels between the beams in the hybrid floors, as are the smoke detectors and fire extinguishers. It took only eight workdays to assemble the prefabricated timber construction including the almost finished façade elements. ◘

Heating Energy Demand	kWh/m²a
before	100,56
after	14,30

Energy surplus renovation Kapfenberg
Renovation designs for prefabricated façades

Source: Nussmüller Architekten ZT GmbH

A building with a really well-insulated building envelope, providing more energy over twelve months than its occupants need for heating, hot water and electricity, is known as an Energy Surplus House. The "Energy Surplus" strategy can work only if the thermal design of the building envelope and the energy supply system are fine-tuned and matched to each other.

AEE INTEC and its project partners develop prefabricated façade elements with integrated active solar panels; they have huge potential particularly for renovating buildings erected between 1950 and 1980. This pioneering method, currently unique, is regarded as a beacon project in Austria. The new solutions make it possible to renovate large buildings to the highest energy standard and simultaneously provide considerable advantages to its residents, both during the construction phase ("inhabited building site") and also during subsequent operation (comfort combined with cost reductions).

As part of renovating a building in Kapfenberg/Steiermark the newly developed components and technologies will be shown. The architectural concept involves making the energy-producing and distributing components visible, and makes effective visual use of solar thermal collectors and Photovoltaic modules as part of the façade and on the roof.

Active und passive façade elements

Because post-war buildings usually have regular façade patterns, a vertical layout of modules was chosen. That way large elements can be installed over the whole height of the building between building service ducts and other fittings. The thickness of the prefabricated façade modules is a function of structural requirements and the overall heat transfer coefficient (U value). The targets for freedom from leaks are achieved by separate layers (oriented strand boards) of the module. The basic module can incorporate active façade elements such as photovoltaic modules, solar collectors or solar "combs". The large façade units are prefabricated at the timber framing stage. The new triple-glazed windows plus blinds are also fitted to the elements before shipping. In future renovation is possible within a very short time and with little disruption to the occupants.

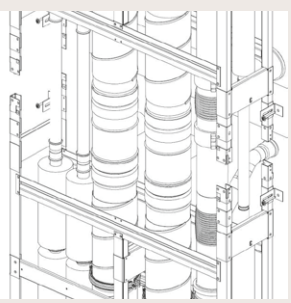
Optimized energy strategy

Solar thermal collectors on the south side of the building (solar array about 140 m^{2a}) provide the heat needed for heating and hot water. The unevenly available solar energy and waste heat are fed into a 7 m^3 layered-storage tank in the plant room. Any additional heat needed is provided by the district heat facility in Kapfenberg. It is planned to install photovoltaic modules on stilts on the roof with a total panel area of 850 m^2; this will enable the building to achieve an energy surplus. ◘

TECHNOLOGY

Spaced-off service modules

All the ingoing and outgoing cables/pipes needed are routed outside the building, located in prefabricated ducts in the adjacent building services modules on the outside. Inspection doors and openings provide access to the cables/pipes, which makes repair and maintenance work straightforward.



Source: AEE INTEC

Karl Höfler, AEE INTEC, on trends and potential in the field of sustainable building

Which technologies and design ideas for buildings do you regard as particularly crucial for the future?

In the near future sustainably renovating the existing stock of buildings thermally to high standards and employing resource-conserving energy, preferably solar, will be specially important. Building services must be converted to intelligent, affordable systems. I see great opportunities in promoting shared heating systems for groups of buildings with differing usage patterns, so as to be able to swap energy around and put it to work wherever it is currently needed.

What prospects do you see for spreading the new approaches in urban areas?

In my view the main potential is in suburbs and county towns, where no energy grids are on hand as yet. That is where strategies involving interlinked groups of buildings sharing intelligent energy systems can gain acceptance.

How important is prefabricating building components and building service modules industrially?

Extremely important, since renovation processes must go even quicker and be even less affected by weather and even more affordable. Prefabrication in a factory means tighter quality control and thus higher quality. Accessibility and separability will be the key aspects in future. Building services ought to be located in parts of the building where they can easily be retrofitted and maintained at any time.

What current trends are discernible in research and development in the building sector?

The current trend is away from the individual building towards groups of interlinked buildings and towards Smart Cities and Regions. But there is still a great need for improvement in the field of building services and components.

What opportunities result from Austrian agents' getting involved in international research activities and networks?

Swapping experience at the international level, e.g. as part of IEA research collaboration, is really important for the firms concerned to develop further. The spread of knowledge enhances Austria's capabilities – and the opportunities for new Austrian technologies and products in foreign markets are also augmented.

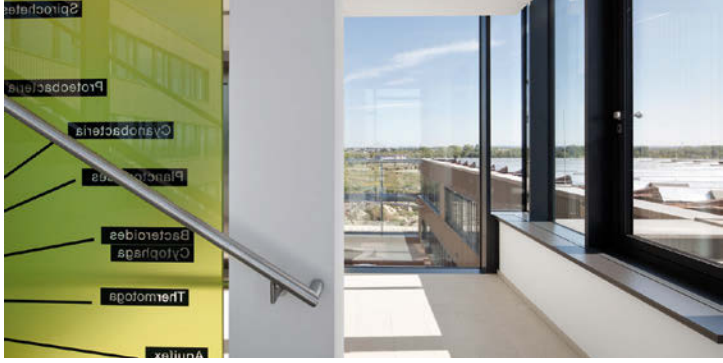
Weber energy surplus house
Renovating a historic farmstead

With buildings of historic value but in poor condition structurally and energy-wise, thermal renovation is a real challenge both at the planning and at the execution stage. In contrast to renovating postwar buildings, there is a conflict here between aesthetic considerations (preserving a culturally valuable fabric) and the structural measures required from the engineering point of view. In the project "Weber energy surplus house" a traditional farmstead dating from 1852 was converted into a energy surplus building on the basis of a comprehensive approach (by the architects Ronacher ZT GmbH), while the building's architectural and historical value was preserved intact.

The energy strategy involved reducing the building's energy consumption while exploiting the sun's energy by means of photovoltaic elements integrated in the façade and thermal solar panels. To improve the century-old stone walls' thermal properties an entirely new cellulose insulation was fitted inside them. All three storeys of the building's south face were opened and fitted with generous timber/glass modules, resulting in a huge passive energy gain. As regards using solar energy, the cornerstone is an outbuilding of a shape and size matched to an exact number and modular of photovoltaic elements and thermal collector panels.

Photos: © Hans Ringhofer

The energy budget is based on the building being occupied by twelve persons on average (seminar room and holiday apartments). A 28 m^2 collector array delivers thermal energy from the sun. The photovoltaic equipment, totalling 72 modules, comprises panels integrated in the façade (9.54 kW_p), plus balconies (3 kW_p) and parts of the stone wall round the garden (4 kW_p), adding up to a yield of approx. 16.5 kW_p from the PV facility. With a further yield of approx. 11.5 kW from solar panels, as against a forecast consumption level of approx. 23.6 kW, the energy budget is definitely in the black. ◘



Source: Vienna Business Agency © Kurt Kuball

aspern IQ
Technology centre to energy surplus standard

aspern – Vienna's Urban Lakeside is one of the largest and most innovative urban development projects in Europe. The new urban district will provide top-grade infrastructure, real quality of life and work, and excellent transport links. The launch project here is the aspern IQ technology centre, an office building developed by the Vienna Business Agency for forward-thinking firms.

Building the aspern IQ centre involved implementing state-of-the-art constructional options so as to satisfy the toughest demands as regards sustainability and user convenience. The technology centre has been built for energy efficiency and virtually no pollution; it meets passive-house standards. Eco-efficient concrete, which involves emitting 80 % less CO_2 than ordinary concrete at the production stage, was employed, and other materials harmful to the climate were not used.

Energy surplus standard

The physics of buildings, simulation of buildings' thermal behaviour, daylight simulation and the ecology of buildings all played a part in the planning process, and the centre's primary energy demand was thus reduced to 51 kWh/m²a. As an energy surplus building it generates more energy than it consumes over a twelve-month period. This is achieved by means of integrated photovoltaic elements and small windpower facilities.

The PV panels integrated in the façade, plus additional PV panels fitted on the flat roof, have a total area of 1,300 m² and generate up to 140 kW_p of electricity. The aspern IQ centre thus benefits from one of the largest solar power facilities in the business property field anywhere in Austria.

Innovative façade design

The modern façade with its excellent thermal insulation and all-round sunshielding has several functions: it serves to generate electricity, to provide shade and to support climbing plants. In conjunction with the airtight building envelope, triple glazing and thermal insulation 26 cm thick, this achieves passive-house standard. The automatic control system for the sunblinds ensures

that the right amount of daylight is admitted, while preventing too much heat from penetrating. The indoor temperature stays fairly constant, so little energy is needed to heat or cool the building. The reeds growing on the façade bind dust, store moisture and help to improve the climate indoors.

State-of-the-art approach to building services

A smart control system regulates all building services, continually switching to whichever facilities would currently be the most efficient. The building is ventilated in line with data provided by a CO_2 sensor measuring air quality indoors. In winter waste heat from the servers in the building is used to support the heating system; to cope with demand peaks heat is also brought in from the district heating grid.

In summer the building is cooled with ground water flowing through pipes let into its concrete core. In spring and autumn a free cooling heat exchanger on the roof is automatically coupled in, to take advantage of its greater efficiency.

aspern IQ is certified as a passive building in line with the klima:aktiv building standard; the Austrian Society for Sustainable Building (ÖGNB) awarded it 944 out of a possible 1,000 points. Offices, laboratories and production areas for technology-oriented firms are available in the building, which has a total floor area of 6,600 m^2 . ◘

TECHNOLOGY

ENERGYbase solar façade

In developing the aspern IQ project the Vienna Business Agency was able to build on experience gained with the ENERGYbase office building, which had been completed in 2008. In line with the principle “form follows function”, the ground plan and exterior of this pioneering building take full account of the sun as a source of energy.

The south façade has been specially angled to make the best use of insolation (passive and active): in winter, when the sun is low, its heat is captured and fed indirectly to the rooms on the north side of the building via customized ducting. A sunscreen made of perforated lamellae is located just behind the angled façade; waste air from the entire storey is vented at ceiling level. As a result heated air is drawn upwards behind the façade to the vents, instead of spreading out into the space indoors. On sunny winter days this air passes through a heat exchanger in which fresh air from outside is preheated.

The geometry of the façade is such that the windows are in shadow in summer, when 100 % of the radiant insolation is exploited by the photovoltaic modules mounted “above the fold”; in this case only indirect radiation (daylight) gets into the building. The active PV components and solar collectors are arranged specifically to maximize energy yields from the sun: the 400 m^2 of PV panels generate 37,000 kWh of electricity each year. In comparison with panels set vertically on the façade, the PV modules inclined at 31.5° achieve much higher energy yields, particularly in the summer months.

Source: Vienna Business Agency

At the top of the façade 285 m^2 of thermal collectors are integrated in the building envelope; they are used for solar cooling (desiccating and cooling fresh air) in summer and coupled into the heating system in winter.

IEA research collaboration
More energy efficiency in buildings and communities

As a component supplier we have been getting new and pioneering techniques of conserving resources to market for more than 20 years. For us, collaborating with scientists and researchers from the initial idea to a commercial launch means scientific support and dialogue with the network. Conversely, as a commercial partner we provide practical experience from which research collaboration benefits, since the scientists thus get a (vitally necessary) feel for hands-on business and engineering considerations.

Volker B. Taschil
CEO gap-solution GmbH

The International Energy Agency (IEA) directs its R&D activities towards developing and disseminating efficient technologies for generating and using energy. Austrian experts from the areas of research, politics and industry make active use of the relevant network to share knowledge and make their mark internationally. R&D and market-related activities are carried out at project level (in tasks/annexes). In the field of energy-efficient building Austria is currently one of 25 countries taking part in the IEA program "Energy Conservation in Buildings and Community Systems" (ECBCS), inter alia. As part of this program projects directed towards energy-saving technologies, implementing these in practice and disseminating them. The results provide the basis for formulating international and national directives and standards for energy. In the project "Prefabricated Systems for Low Energy Renovation of Residential Buildings" (Annex 50, already completed) comprehensive approaches to renovating typical multi-storey accomodation were developed. One of the companies taking part was the component manufacturer gap-solution GmbH, whose prefabricated solar façade system has already been successfully incorporated in various pioneering renovation projects (HdZ demonstration projects at Makartstraße in Linz and at Dieselweg in Graz).

Austria's involvement in the ECBCS program (projects in progress):

- Annex 51: Energy-efficient communities
- Annex 52: Towards net zero energy solar buildings
- Annex 53: Total energy use in buildings: Analysis & evaluation methods
- Annex 55: Reliability of energy efficient building renovation – Probability assessment of performance & cost
- Annex 56: Cost-effective energy & CO_2 emissions optimization in building renovation

energy innovation austria presents current Austrian developments and results from research work in the field of forward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Transport, Innovation and Technology and the Climate & Energy Fund. **www.nachhaltigwirtschaften.at** **www.klimafonds.gv.at**

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