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long term
trends and options in the austrian building sector

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Long Term Trends and Options in the Austrian Building Sector

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Overview

This paper is a contribution to the discussion of 'Long term R&D in the Building Sector' within the IEA Expert group 'R&D priority setting and evaluation' . Its purpose is to illustrate and discuss long term trends and options compatible with a sustainable energy system.

The article begins with an introduction, a short presentation of the Austrian energy system, and a breakdown of energy consumption in the building sector, focussing on residential buildings.
Chapter two describes the most important driving forces behind present and future trends in residential building, current R&D-activities and R&D programmes in the building sector in Austria. An attempt is also made to assess the consequences of these factors for innovation in the building sector.
In chapter three a possible vision for the energy system in relation to the building sector in 2050 is drawn up, taking into consideration all driving factors discussed above. On this basis, chapter four describes the most important technological options available for further steps towards sustainability in the building sector.

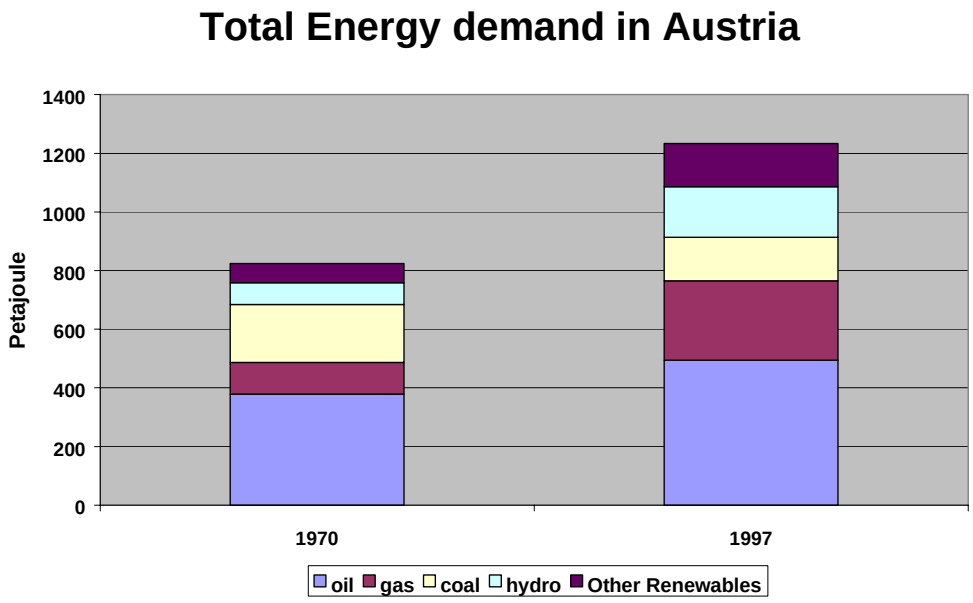
Introduction

The population of Austria in 2000 was approximately 8.1 million inhabitants, with 3.2 million households. The total area is about 83,000 km^2, of which a relatively high proportion is alpine, meaning that only 40% of the total area is permanently inhabited. 42% of the country's area is wooded.
Austria’s GDP is around 200 billion EURO, or 24,500 EURO per inhabitant, and has increased by more than 110% since 1970. Energy consumption, in comparison, has risen by around 45%.

Even though oil and gas are the main sources of energy in Austria, hydropower and other renewables are also important energy sources with a share of 12% and 14% respectively. The sector 'other renewables' primarily comprises biomass, and grew from 9% to 12% between 1970 and 1997. While consumption of coal has seen an absolute decline, oil consumption has seen an absolute increase. Gas and hydro power have seen the greatest absolute and relative rates of increase in recent decades.

Because of Austria's geographical location, the heating and hot water sector is the most important area of energy consumption, representing 40% of energy end use, although trends show that this is declining. The second largest sector of energy consumption, this time showing a strong increase, is transport.

Most standard scenarios show a further increase in CO2-emissions, especially in the transport sector. However, the building sector is seen as the most important sector in meeting the Kyoto target and for a long term reduction of greenhouse gas emissions.



Every year around 50,000 new homes are completed, of which around 60% are in multi-family houses, and 40 % in single and double family houses (data from 1999). Currently there are about 3.6 million dwellings in Austria, and although the population is growing only very slowly, an continuos increase in dwellings is expected in the next decades due to the trend to smaller families. The energy-related renovation rate for existing buildings is between 1 and 2 % per year.

The average floor area per dwelling is 83 m^2. This is expected to increase in the decades to come, even though the number of inhabitants per dwelling will decrease. The share of 'manufactured' buildings is still increasing, and this type of building is expected to become standard. Even though the number of new buildings is expected to decline, in 2050 almost 50% of all buildings will have been built after 2000. A high percentage of existing buildings will have been renovated by 2050.

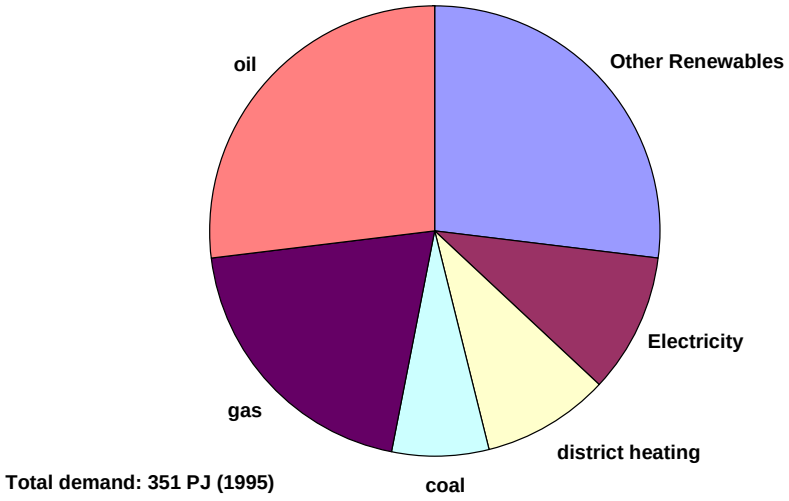
Building codes which ensure low energy consumption and subsidies for energy efficient construction are also an essential instruments in controlling building developments in Austria. Every year subsidies of around 2.5 billion EURO are awarded, 75% of which amount supports the new buildings sector, while 25% are granted for renovation projects. As some evaluations have shown, subsidies are a

very effective instrument in influencing the design of new buildings. In Salzburg a new scheme for subsidies has led to a 40% increase in terms of energy efficiency within two years and to an increase of active solar components from 9% in 1994 to 57% in 2000. The share of biomass heating systems has increased from 10% of all new buildings in 1994 to 42% in 2000. (Source: E.V.A., website)

There is a general trend towards reducing the total amount of subsidies for this sector, accompanied by an important shift of subsidies towards the energy-related refitting of buildings and towards ecological criteria as a precondition for new buildings. According to a proposed government strategy for the reduction of greenhouse gas emissions form Austria, 290 Mio. EURO should be shifted from general construction to energy related subsidies.

There is a good balance between the energy sources used in heating and hot water generation, where the high proportion of 'other renewables', especially biomass, is of particular note. A strong increase in 'modern biomass' systems, such as wood chips and wood pellets, and the high proportion of solar collectors are also significant. Apart from Greece, Austria has the highest density of solar collectors for domestic hot water generation. Around 200,000 m2 of new solar collectors are installed each year. This has also led to an important thermal solar industry in Austria. Europe's largest producer of thermal solar collectors is sited in Austria.

Energy demand for heating and hot water



The total energy demand for heating and hot water is about 350 PJ per year. Cooling systems are not widely used in Austria, but are more and more common in new buildings, especially in the commercial sector. Around a quarter (27%) of energy is coming from oil, 20% from gas, 27% of total energy for heating and hot water is biomass and 9% are produced in district heating system. 10% of energy demand is

supplied by the electric system, the share of coal is still 7% of total energy demand for heating and hot water.

Residential building is a central focus topic for R&D activities in Austria. Building on the programme 'Solar low energy houses' (1994 - 1998), 1999 saw the start of a five year 'Building of Tomorrow' programme, set up within the framework of the Austrian Programme on Technologies for Sustainable Development. The aim of the 'Building of Tomorrow' programme is to initiate the development of innovative residential, office and commercial buildings which have a high market potential, considerably reduce energy and material input, increasingly use renewable energy sources (especially solar) and renewable and ecologically sound materials, and which take into account social aspects and cost efficiency.
The programme began in 2000 with a phase of development and realisation of new buildings. Up until now about 70 projects have been financed. About 10 multi-family houses will be built in Austria within the next 3 years. The upcoming topic of the programme is the 'refitting of existing buildings', and will begin in September 2001[1].

[1] The program is managed by the Author of this paper and Manuela Schein. For further information see www.hausderzukunft.at or contact Dr. Herbert Greisberger, Austrian Society for Environment and Technology (ÖGUT, Türkenstraße 9/21, 1090 Vienna, +43/1/ 315 63 93-13; office@hausderzukunft.at

Main drivers in the building sector

As we move towards 2050, fundamental changes will take place in the building sector. Most of them are a consequence of socio-economic factors, new technologies and materials and changes in life-style. The following trends are seen to be highly relevant for future building markets:

Demographic aspects

Between 2000 und 2050 Austria's population will rise only negligibly, from 8.1 million to 8.2 million. Because the **size** of households is decreasing, however, a steady increase in the **number** of households and dwellings is to be expected by 2020. The percentage of the population aged over sixty will increase between now and 2050 from 20% to over 33%. This development will not just be relevant for the comfort standards of dwellings, it also means that there will be a significant increase in the group of residents not bound by the proximity of the workplace.

Inheritance and wealth accumulation

The wealth and income of generations to come will (for some) increase substantially, due above all to the inheritance of assets.
The effects of this on building are important inasmuch as they mean that more money is available for the fulfilment of people's living requirements. This will fuel the present trend towards single or double family buildings. The inheritance process will also lead to a clear and increasing differentiation in the population with regard to wealth and income. Cost reduction in residential building will continue to be extremely important, especially for socially disadvantaged population groups (e.g. immigrants from central and eastern Europe).

New energy markets

Because of the extensive liberalisation of grid connected energy markets, (electricity, gas and district heating) there will be a turn away from the “traditional approach” (energy supply to every household at same prices) towards market oriented behaviour. New niche markets will appear, especially in the single family house sector, which will facilitate the development of new technologies right up to energy self-sufficient buildings. Highly efficient technologies for joint heat and power generation will be available and of particular importance in the commercial area. On the other hand, the implementation of energy saving technologies and renewable energy sources in grid connected buildings will be made more difficult, due to a change in cost structures. Passive houses and low energy buildings are, to a high degree, equipped with electric heating systems. Future trends towards electric heating systems and a growing number of electric devices will lead to an increase in electricity demand. Electric heating systems lead to high peaks in electricity demand during the winter.

The changes in the energy market will also spawn new companies that offer total energy services (electricity, energy saving and heat). At the moment it is difficult to guess their consequences for the building sector, but they will lead to a reduction of energy costs in urban areas and an increase in prices for rural areas.
The shrinking demand for heating will reduce the number of new district heating systems apart from small micro-net systems. In areas with existing district heating (especially Vienna), the number of households connected to district heating will increase.

Increased need for comfort and flexibility

Last but not least, because of the growth in income, the demands for more living space per inhabitant, better facilities and fixtures and a generally higher quality of dwelling (e.g. with cooling system) will increase even further. Connected to this will be an increase in electricity comsumption per inhabitant. Changes in working patterns and lifestyles will mean that a clear increase in the flexibility of the population is to be expected in the next few decades. This will affect not only the adaptability of buildings themselves, but also the average amount of time a resident stays in one dwelling. Attachment to one particular dwelling will decrease, and as demands change, the housing sector will have to move towards providing new services and flexibility.

Use of information technology

Modern information and communication technologies will penetrate all areas of life in the decades to come. This will allow higher flexibility to all in respect to their work place and allow longer distances between “work place” and home, new energy management, measuring and control technologies will be developed and new services will be created that are based on modern information and communication technologies. Information technologies are also changing processes in the construction industry.
This will lead to an increase in electricity consumption in society and buildings.

Sustainability as an important political topic

On a political level, we can expect more and more attention to be paid to the principles of sustainability. We can also expect increasing land shortages and political measures to reduce energy use and material flows in the building sector. The traffic and transport system will stay the critical area in respect to energy and the daily life of the population. The need for mobility will increase even further with the increase of buildings in suburban areas.
Increasing environmental concern will lead to tax shifts from labour to energy, natural resources (eg land use) and material as well as strong ecological criteria in subsidy schemes.

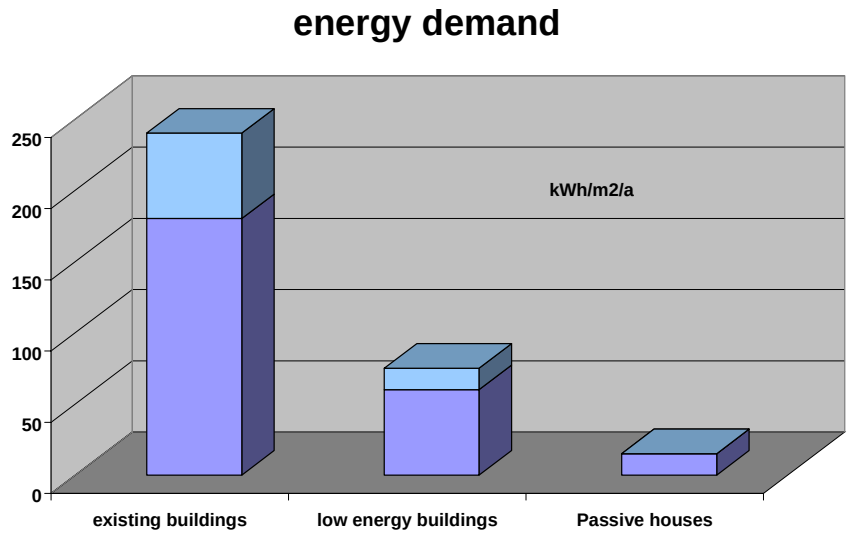
Results of ongoing R&D

The majority of R&D aims at incremental improvements in existing components (e.g. insulation systems, windows, heating systems, solar collectors). As the industry is very fragmented, R&D is mostly carried out by small companies which focus on short term R&D.
Along with other factors, existing regulations (the building sector is highly regulated in Austria) and social behaviour are important barriers to innovation. Therefore the Austrian Ministry for Transport, Innovation and Technology has started various supportive measures to increase private R&D expenditure, improve co-operative R&D between universities and industry and assure market diffusion of new technologies.

Some important innovations have been brought about through the development of passive houses and solar energy buildings, which provide a basis for middle and long term options for activities in the building sector.

- Passive houses

The principal aim of the 'passive house' concept is to reduce the total energy demand in buildings through the high standards of the building shell. It focuses on the reduction of energy for room heating, but also includes lighting, energy efficient appliances and hot water. The passive house standard is defined by a total final energy demand for heating of 15 kWh/m2/year.



This allows the designers to use the air ventilation system as the only heating system. During the last few years more than 10 multi-family passive houses have been built. Even though most of them have to be seen as demonstration buildings (with financial support from various sources), passive houses are in principle well equipped to penetrate the market and reach a market share in the mid term of up to 20% of new buildings. The projects have shown that the energy demand is reduced by a factor of 4-5 compared to low energy buildings and by a factor of 10 compared

to existing buildings. Ongoing R&D is concentrating on additional ecological aspects and renovation.

- Solar low energy buildings

The concept of 'solar low energy buildings' is geared towards an extensive reduction in energy demand coupled with the intensive use of solar heat energy and other renewable energy sources. In recent years several projects have been carrried out, ranging from buildings whose heat demand is largely covered by solar energy, to totally 'energy self-sufficient' solar buildings. Particular attention is paid to the system which combines solar energy and biomass, allowing heat and hot water to be generated without any greenhouse gas emissions.

Solar energy for the production of solar collectors, Austria

Low energy building with solar collectors and biomass system, Austria

Both developments have led to a clear reduction in the greenhouse gas emissions connected with heating and hot water generation.

Vision for the energy system 2050 with relation to buildings

The building sector in 2050 is characterised by a high degree of fragmentation, both with regard to social dwelling styles and lifestyles and the energy consumption connected with them. The spectrum ranges from the energy self-sufficient 'Ecology House', produced exclusively from renewable raw materials, via the energy producing house to the low cost house, designed for a lifespan of less than 50 years, and the 'Comfort House' , which, thanks to its many features (electrical devices, heated swimming pool, cooling system...) consumes a lot of energy.
A building's energy consumption depends, among other things, on its location, as the majority of all buildings have been renovated by 2050. The thermal quality of a building is decided to a large extent by the expectation of the future (variable) costs of the energy source. By 2050 this has led to a relatively low reduction of energy consumption in inner city areas supplied by a district heating system (energy sources: waste and industrial CHP). Another reason for this development is the higher renovation costs for historically valuable buildings. A low energy house standard of 40–50 kWh/m2/year has been attained in the residential sector in average. The demand for hot water per dwelling is sinking due to smaller family sizes. New high comfort buildings have appeared, especially in suburban regions. On the outskirts of cities new low cost settlements have been constructed which are inhabited by socially disadvantaged groups. These dwellings are built to passive house standards.

Essential characteristics of buildings in 2050 in terms of energy are: increased electrification, extensive use of solar facades, existence of stand alone buildings and altogether higher energy efficiency (combined heat and power production as standard). The building sector and the electricity systems are integrated, to a large extent. Households, businesses and industry act as producers as well as consumers of electricity. The role of the household as electricity producer is supported in particular by the temporal correspondence of electricity production as a by-product of heat production and the demand for electricity for heating systems.

Long term options

Currently ongoing R&D in the building sector is characterised by a steady flow of incremental innovations that lead to higher standards in terms of energy demand per m^2, lower cost, a higher degree of pre-manufacturing and increased comfort for the user of buildings. New materials and innovations from other technological areas (eg. IT.), are regularly integrated into the building industry. As a result the present innovation process does not lead to technological breakthroughs, that are needed to meet the Kyoto target.

The highest potential for technological breakthrough lies in the integrated development of new building concepts, as this will allow the co-ordinated improvement of all components and their integration into a whole system. Based on the vision described above, there are three main types of buildings that fit into a sustainable energy system:

- Energy producing buildings
- Green buildings
- Solar 'stand alone' buildings

All of these concepts are paragons, or ideal examples, and represent a conceptual direction which would allow fundamental changes in the building sector in respect to GHG or energy. What all the options have in common is that they take account of demands for greater comfort, greater flexibility in construction and the use of modern information and communication technologies.

Energy producing buildings

The development and market penetration of energy producing buildings demands the further development of highly efficient technologies which convert gas or renewable energies, especially biomass, into electricity and heat, especially fuel cells, new management and storage systems. These buildings are designed for the commercial sector and multi-family houses on low and medium solar energy sites in semi-urban areas. They are connected to the electricity grid, and partly also to the district heating system. The energy system in energy producing buildings is managed centrally by the energy company responsible for electricity and heat. Electricity is fed into the grid, heat is stored and used for hot water generation or heating. These buildings are normally not equipped with active solar components, but standard passive solar components and innovative insulation technologies are used.

Green buildings

Green buildings are designed for an “ecologist” niche market. Based principally on passive house technologies, their energy demand for heating is below 15 kWh/m2/year so that they do not need a conventional heating system. Hot water is produced by standard solar collectors or a heat pump.

Special focus has been placed on the reduction of energy input for materials and the use of renewable resources. Wood and recycled materials are used for construction, and straw, cork etc. for insulation. New super efficient insulation systems and modern vacuum insulation systems with considerably reduced demand for material have been developed.

As they can hardly compete with traditional concepts because of higher costs, they are mainly owned and built for environmentally conscious people with a high income. Their principal market is in the single or double family sector. Even though they are normally connected to the electricity grid, they are sited in rural or suburban areas.

Solar 'stand alone' buildings

The third option for future buildings is solar buildings on stand alone sites. As the cost for electricity lines is high in alpine areas, highly energy efficient equipment, PV and other solar based technologies are economical. Solar inflow is very high in alpine sites, so thermal solar collectors are used for heating and hot water, and PV for the production of electricity.
New concepts in thermal solar collectors focus on facade collectors which fulfill three main functions. They produce hot water in both low or high temperatures, their design is of high esthetical quality, and they are part of the insulation system. As PV elements are the only source of electricity, high efficiency standards for all electric equipment (and a limited number of electrical devices) are a precondition to the concept. Solar buildings for stand alone sites are typically designed for alpine areas and mostly used for commercial buildings (especially guest houses during summer). In the private sector they are also equipped with solar cooling devices.

The options described are ideal examples in that they are based on a uniform concept which, however, thanks to related technological developments, can be applied in all buildings.