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SOLARCITY LINZ/AUSTRIA – A EUROPEAN EXAMPLE FOR URBAN ECOLOGICAL SETTLEMENTS AND ITS ECOLOGICAL EVALUATION

Summary: The demand for more ecological development of cities and towns is urgent. Most of the actual cities have environmental and resource related problems. Best practice examples can help to distribute urban ecological knowledge and set standards. The example of SolarCity Linz/Austria allows to define ecological indicators at a practical example and to evaluate the fulfilment degree of these indicators. It can be shown that even a highly accepted example of an ecocity has still a number of not fulfilled ecological demands. But it shows also that via ecological indicators a comparability of different ecocity-examples is possible.

Key words: ecocity, ecological indicators, urban development, urban ecology

1. INTRODUCTION

The development of new settlements always allows the integration of the state of the art in architecture, planning and design. Ambitious modern planning will always try to use ecological planning criteria. Such new cities or districts are often called “Ecological Cities” or “Ecocities”. But often it is not clear which criteria had been included and in what way, the label eco-city doesn’t fulfil its meaning. On the example of the eco-city SolarCity Linz it will be showed which ecological principles had been used in building and design and an evaluation of the general ecological criteria and its implementation allows clearly to estimate the ecological content of the eco-city.

2. THE PROJECT ECOCITY LINZ

Linz is one f the biggest cities in Austria, located at the Danube river, the capital of the federal state Upper Austria, shaped by industry and typical central European urban development.

The project initiative began in 1990, when Linz City introduced a policy of low-energy social housing. At that time 12,000 people were looking for homes in the Linz area. Simultaneously awareness was increasing that high consumption of fossile energy was a significant contributor to the greenhouse effect. Both facts provided decisive arguments for an ecological and sustainable housing scheme. It was decided to construct a major development on low energy lines with a minimised consumption of fossil fuels. So the idea for building a "solarCity" was born. Many planning issues were raised by this objective. One was the supply of energy to houses, another was the design of the settlement in a manner that minimised transport requirements.

The Pichling area, to the south side of Linz, seemed to be the only possible development area. This region is characterised by an existing housing estate of private houses, small lakes and by the Traun-Danube marshes, on of the largest, continuous, natural biotope landscapes in Upper Austria (Magistrat Linz Mai 2004).

All this required careful planning, to provide a sensitive integration of a future housing estate into the existing surroundings. A tight planning brief was therefore required that would permit the development of a residential area in harmony with its setting. In November 1991 Linz City agreed on the housing programme – Pichling.

The renowned Austrian urban planner, Prof. Roland Rainer, was commissioned to prepare a comprehensive regional urban development plan, the master plan for the Linz-Pichling residential district in 1992. This master plan makes provision for between 5,000 and 6,000 homes together with the entire infrastructure servicing the area. This concentrates development in nodes along a tram route that links in to a local railway station and the city centre.

In 1993, the Linz City Council took the proposal further by commissioning a study to demonstrate how the homes in Pichling could serve as an example of low energy living. The following year the City of Linz, together with four of the most important non-profit-making housing associations in Linz, agreed to finance the planning and development of 630 low energy homes in Pichling. Eight non-profit-making building organisations joined the development in 1995. Therefore current plans propose 1,317 on a site of around 32 hectares forming one of the nodes proposed in the Master Plan. Subsidies will be provided by the Province of Upper Austria. Construction started in 2001 and is expected to be completed soon (Magistrat Linz May 2004). This was a highly prestigious project. The City of Linz commissioned world-class architects Norman Foster,

and Richard Rogers from England and Thomas Herzog from Germany to plan the first 630 homes.

These architects set up a working party with the famous German energy technology planner Norbert Kaiser under the name of the READ group -- Renewable Energies in Architecture and Design – whose aim is to promote the breakthrough of low-energy construction methods at the international level. The EU General Directorate XII for Research and Development subsidised the planning work with a contribution of EURO 600,000 (Eiblmayr 2004: 44).

The City of Linz held an architectural competition in 1996 for the design of more homes. The winner of this competition, the Viennese architect Martin Treberspurg, a solar architecture specialist with experience in public residential construction, is now preparing the plans for the second stage. The planned school, kindergarten and community commercial centre are models of resource-saving solar architecture, with special provision for bio-climatic design to reduce expensive air conditioning.

Fig. 1. Site plan of the solarCity Linz (Magistrat Linz 2004)

The project has been led by an interdisciplinary group working according to "systemic" principles working with a project advisory board drawn from the public sector, business and the community. Considerable effort has been allocated to developing a project identity and project marketing. Awards from the European Union and the 100 Best Practices Programme have been prominently publicised as part of the development of a marketable image.

By 1995, an additional 8 building contractors were participating in this project, therefore 1,300 flats could be built on an area of ca. 34 hectares.

The name implies an extensive utilization of solar energy according to the European Solar Charta in architecture and town planning, installed in 1996. The term "solar" is to be understood in a wider sense and includes functions as follows:

- designing residential areas and individual buildings according to the principles of solar architecture
- utilization of active and passive solar energy
- direct use of the sun to increase welfare of people inside as well as outside of buildings
- general utilization of renewable energies
- emphasizing the aspects nature and leisure
- social integration, social warmth, social energy
- new approaches in general for a lasting development of residential areas

(Magistrat Linz 2004)

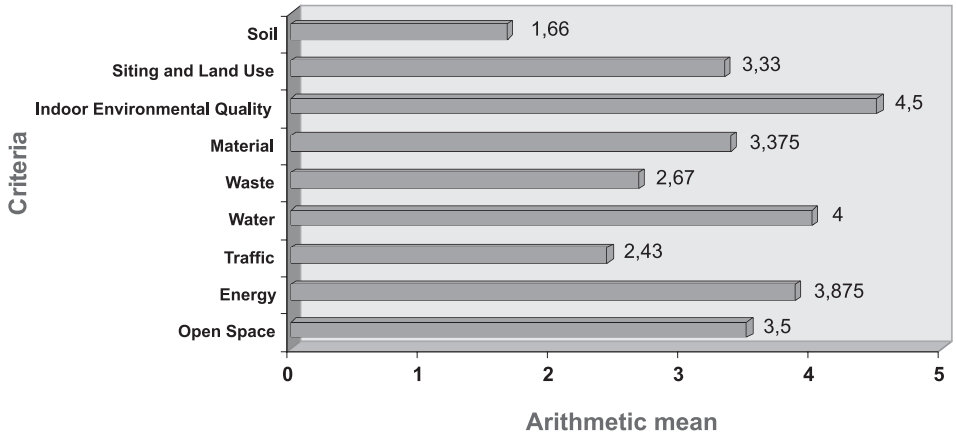

Fig. 2. Validation of single criteria

3. ECOLOGICAL EVALUATION OF THE SOLARCITY LINZ PROJECT

The assessment scale consists of five categories with a different hierarchy (Zöfel 1988: 267ff): 1 = not implemented, 2 = partly implemented, 3 = implemented, 4 = well implemented, 5 = very well implemented.

This analysis is based on the evaluation of all available relevant documents, observations, inquiries and conversations with the stakholders. It is as possible objectiv and proves all relevant ecological criteria.

Tab. 1. Evaluation of criteria: Open Space

Criteria	1	2	3	4	5	Measures in the solarCity Linz
1. Open Space						
Use existing vegetation and landforms to moderate climate conditions and provide protection for native habitats			**XX**			Roof gardens, Traun-Danube Riverside, park landscape
Plant native or well-adapted species			**XX**			Revitalisation of the Aumühlbach, Plantings in the park landscape
Use greenbelts and protected wetlands to create a continuous web of native habitats				**XX**		Traun-Danube Riverside; Aumühlbach
Restore the native landscape				**XX**		Revitalisation of the Aumühlbach
Open space for recreation and child's play					**XX**	Playgrounds for children; Local recreation in the Traun-Danube Riverside; Park landscape and Weikerlsee for recreation (sports, bathing)
Roof gardens can be established on the flat roofs of buildings using potted trees, shrubs and plants		**XX**				Only a small part of the buildings have roof gardens

Tab. 2. Evaluation of criteria: Energy

Criteria	1	2	3	4	5	Measures in the solarCity Linz
2. Energy						
Energy-Conscious Urban Planning					**XX**	Orientation of the buildings; Atria; Mixed use development; Settlement is planned around public transportation, walkways and bicycle paths
Energy Conservation				**XX**		No use of fossil fuels; Use of local produced goods to minmize amounts of energy in construction
Use renewable energy sources					**XX**	Electric energy generation (Photovoltaics); Energy-saving street lighting

Passive Heating and Cooling					**XX**	Compact construction method to reduce heat-energy demand; Heating rooms through passive solar energy; Rest through distant heating
Insulation			**XX**			Highly heat-insulating facades
Alternate Sources of Energy				**XX**		Solar collectors to heat water; Use of biomass-energy for heating and electricity
Daylighting				**XX**		Daylighting; Sunlight to the outside surface to enhance comfort and growth of plants
Energy Efficient Equipment and Appliances	**XX**					

Tab. 3. Evaluation of criteria: Traffic

Criteria	1	2	3	4	5	Measures in the solarCity Linz
3. Traffic						
Settlements should be located around or close to public transport nodes and frequently used routes			**XX**			The estate is connected to the city centre by means of trams, fast buses and the Ebelsberg bypass
Settlements should be planned around a network of pedestrian routes which encourage walking and cycling				**XX**		Maximum priority is given to pedestrian and cycle traffic
Limit on-site parking			**XX**			Individual motorised traffic is parked in collective underground car parks
Use porous alternatives to traditional paving for roads and walkways and reduce street width			**XX**			Parking spaces are mainly covered by porous surfaces
Carpooling strategies should be encouraged in addition to mass-transit use	**XX**					
Use existing vehicular transportation networks to minimize the need for new Infrastructure		**XX**				Existing networks were extended
Minimize noise disturbance	**XX**					

Tab. 4. Evaluation of criteria: Water

Criteria	1	2	3	4	5	Measures in the solarCity Linz
4. Water						
Use permeable surfaces			**XX**			Parking spaces are mainly covered by porous surfaces

Collect and use harvested" water				**XX**		Roof greening; Retention ponds
Collect and use rainwater					**XX**	Rainwater cultivation concept; Trench and swale retention system
Design an appropriate harvesting and storage system					**XX**	
Reduce overall water use				**XX**		Water-saving fittings in most buildings
Utilize greywater for nonpotable purposes				**XX**		Greywater will be cleaned in planted sand bed filters and conducted into the nearest creek
Use constructed wetlands				**XX**		Traun-Danube riverside is a natural wetland used as the northern preflooder; Also the creek Aumühlbach is integrated in the system
Treat brownwater from toilet-flushing with on-site systems				**XX**		Rotting containers were the brown- and greywater will be filtrated; Two different pipings for brown- and greywater
Use reclaimed water for purposes such as toilet-flushing			**XX**			Drained off water is filtrated in a rotting-container and is used as a fertilizer; Compost toilets for example in the school

Tab. 5. Evaluation of criteria: Waste, Material. Indoor Environmental Quality

Criteria	1	2	3	4	5	Measures in the solarCity Linz
5. Waste						
Minimize use of resources - Reuse Existing Buildings	**XX**					The solarCity a newly developed district in the south of Linz
Minimize waste generated from construction, renovation and demolition of buildings			**XX**			Waste generated from construction is collected in separate bins
Minimize waste generated during building occupancy				**XX**		White and mixed paper, aluminium cans, plastic, glass and organic food waste is seperated; Space for recyclables is provided
6. Material						
Design for future reuse and adaptability			**XX**			Better part of materials is renewable and recyclable
Use durable products and materials			**XX**			Mainly durable materials ("natural" resources) to save energy
Choose low-maintenance building materials			**XX**			Low maintenance; Reusable; Easily renewable materials
Avoid materials that will off-gas pollutants					**XX**	Building materials used minimise the harm to the environment and the noxious effects on the persons living in the buildings

Choose building materials with low embodied energy			**XX**			Careful handling of energy during construction (wood, lightweight concrete etc.)
Buy locally produced building materials				**XX**		Local resources are used; Encouragement of the local economy; Reduction of the routes of transport
Use salvaged building materials when possible	**XX**					
Minimize packaging waste					**XX**	Reduction and ecologically sound recycling from waste
7. Indoor Environmental Quality						
Design for human comfort					**XX**	Social proximity through site and voice contact; A lighting and illumination concept for the spatial edges and facade surfaces, so-called „rear cover"; Light shining from the homes
Improve indoor air quality				**XX**		Natural ventilation; Reduction from pollutant emissions

Tab. 6. Evaluation of criteria: Siting and Land use

Criteria	1	2	3	4	5	Measures in the solarCity Linz
8. Siting and Land Use						
Renovate older buildings	**XX**					solarCity Linz was constructed on a greenfield
Create community				**XX**		Compact construction to promote community; Encouraging social proximity
Encourage in-fill and mixed-use development				**XX**		Settlement is located around a central open market square; Mix of residential, commercial, office and retail space
Minimize automobile dependence				**XX**		People don't need to travel for shopping and services district of short distances; Tram route to the city centre
Value site resources					**XX**	Orientation of the buildings to take advantage of solar energy; Protection of the riverside forest; Enlargement of the existing "Weikerlsee" for recreation; Integration of the creek Aumühlbach as a natural feature within the settlement
Existing planted vegetation that has to remain on site needs to be protected during construction				**XX**		Maintenance of a variety of natural landscapes and habitats; Protection of the riverside forest

Situate buildings to benefit from existing vegetation	**XX**					
Building smaller is better			**XX**			Building height limitations to allow solar access for all buildings; Compact construction
Design for durability			**XX**			Mainly durable products were used during construction

Tab. 7. Evaluation of criteria: Soil

Criteria	1	2	3	4	5	Measures in the solarCity Linz
9. Soil						
Minimize pavement area	**XX**					
Emphasize preservation of mature vegetated soils	**XX**					No information
Minimize earthwork and clearing	**XX**					No information
Minimize use of landscape irrigation, herbicides, pesticides, and fertilizers	**XX**					No information
Consider use of permeable paving materials			**XX**			Mainly use of permeable materials to cover footpaths and bicycle lanes, e.g. Terrain around the lake "Weikerlsee"; Majority of parking spaces covered by porous surfaces
Build pedestrian surfaces with loose aggregate, wooden decks, or well-spaced paving stones			**XX**			Pedestrian surfaces are mainly covered by permeable materials (Natural stone, waterbound materials)

4. ACTUAL SITUATION OF SOLARCITY LINZ

15 years after the project idea, 2,942 residents will be living in 1,293 apartments in the solarCity of Linz, the new district of Pichling, comprising an area of 36 hectares. Each of the 12 housing associations involved in this project have finished their buildings by 2006.

In its real estate sale contract, the city of Linz set up criteria for preserving the basic ideas of the solarCity, which were binding on all associations. Low--energy construction (with an energy factor not exceeding the maximum of 40 kW/m¸a) was compulsory, as well as the use of solar panels for creating hot water. Furthermore, the city of Linz invested approx. EUR 73 million into the exemplary and complete infrastructure.

Due to its costs, solar electricity generation was only applied in individual projects of the solar city's infrastructural buildings. Solar hot water production, on the other hand, took place ubiquitously and reached an average of 47–48%

of WW demand. The buildings normally run at a level much lower than recommended. Some require a thermal heat value of only 28 kWh/m¸a, others do not even exceed 21 kWh/m²a (Waechter-Böhm 2004: 33).

The new district "solarCity" is a perfect example of future-oriented town planning. For the first time an entire district was constructed in the economical low-energy construction method, according to ecological criteria. This goes for residences as well as the whole urban and private infrastructure. The highly controversial project has developed into an ideal example for eco-friendly town planning. The solarCity's residents profit from low overhead expenses of their apartments and from a high living standard through south-oriented buildings, a clear glass architecture, solar hot water production and floor heating. A versatile infrastructure can be used on foot. In June 2004, they started the second step of the expansion of the tramway of about 2.3 km, the line has created a direct tramway connection to the city center of Linz since September 2004. However, it has not yet been decided whether the tramway line will be extended to the station of Pichling. Discussions on the future route are presently held. In the beginning, the intention was to create a fast and attractive connection to the city center of Linz by linking the tramway to a high-speed railway line.

Most part of the "Traun-Donau wetlands" is legally protected. This unique nature reserve will remain protected and at the same time it is meant to constitute a nature experience for the solarCity's residents. Wooden footbridges for walks will be installed in the alluvial forests. Info-checkpoints make the offer complete.

The solarCity Pichling is not only regarded a positive example for a well--organized town planning project because of its architecture, but it also sets a benchmark by simultaneously completing the overall project and the infrastructure necessary for the residents.

The solarCity is the perfect example for a "smooth" town expansion in the open countryside, too. That is because way back in the beginning of the project ecological aspects and social demands were connected with each other. By connecting the solarCity to the already existing downtown of "Alt-Pichling", it was avoided to create an isolated satellite city. It was rather a goal to make Pichling's residents profit from the town expansion (Waechter-Böhm 2004: 33).

Yet one must not forget that a project in this dimension involves a high degree of complexity. The development of the project turned out to be a learning process for all participants. New technologies, knowledge transfer and setting up an extensive communication network were new and unfamiliar to them. When building the solar City, the emphasis clearly lay on the energy supply concept. Besides thermal solar panels and photovoltaics, also wind and biomass were taken into account in the energy concept.

All in all, the "solarCity project" was awarded several prizes. In 1998, for instance, the United Nations granted them the "Best Practice" award in the course

of a competition for the enhancement of the environment. In 1999, the solarCity received the "Environmental Award 2001" from the "Earth Society Foundation", an NGO group (non-governmental organization) located in New York. In 2000, the project stood among the top five "innovative building concepts" in the competition "Haus der Zukunft" ("House of the Future"), and in 2001 it also found itself on the same position in the second international conference "business and municipality – new partnerships" in Bremen (Magistrat Linz 2004).

It goes without saying that not all guidelines set up in this thesis can be met in an ecological housing development project. That is because preconditions and circumstances differ enormously from project to project. However, it is striking that most criteria and guidelines that I detected were regarded in the development concept and during the construction of the solarCity. Moreover, the guidelines are just there to give some clues for an ecological housing development project. Still, the more criteria and guidelines a project fulfils, the more ecological a residential area gets, in a sustainable sense. A large number of criteria were met in this project, the emphasis lying definitely on the energy concept and open space planning. Other criteria, such as soil, were neglected or not fulfilled at all. But the urban expansion project "solarCity", with its lasting effects and organization, is undoubtedly a positive step towards a sustainability-oriented future, as far as guidelines in ecological settlement projects are concerned.

On the basis of the results an arithmetic mean could be calculated. With this, an overall evaluation of the single criteria, implemented in the solarCity Linz project, can be deduced. The arithmetic mean is that point in the scale which is at a time below and above of the half of the values (Zöfel 1988: 43).

To achieve a final grading of the ecological urban expansion project solarCity Linz, the five hierachical categories are going to be transformed into grades from 1 to 5 (Van der Ven 1980: 34). The grade 5 (insufficient) corresponds with the former category 1 (not implemented): 1 = excellent, 2 = good, 3 = satisfactory, 4 = sufficient, 5 = insufficient

The arithmetic mean from all criteria was calculated to achieve this final grading and resulted in the value 3,24. This value stands for the cumulative grade "satisfactory".

5. CONCLUSION

Much of the historical urban development proceeded in an unregulated way. At the end of the 19th century, as a response to the manifest problems of industrialisation and the uncontrolled urban sprawl (housing shortage, urbanisation), several architects, mainly in Europe and North-America, began to develop plans to reform urbanistic ideas. These overall models for future cities had in common

an intensive treatment of urban growth. The conservation of open spaces for the growing cities was very important in these models.

The aim of the Garden City Model and other futuristic urban structure models is to have a strong connection to nature. A major requirement is that nature in the open space between the city centres will be conserved and not overused. In the meantime this assumption was proved to be wrong. The intensity of the urban emissions as well as the power of the land prices were underestimated. In all the models the ecological resources (surface areas, air and water) are supposed to be infinite. The focus was mainly concentrated on the economic and social needs. Theoretically, all the models were not fully developed because efficiency of the open space was not related to the emissions of the developed area. At the start of the 21st century, the cities are supposed to enable people to live in harmony with nature and achieve sustainable development. Therefore the term ecological city was developed in recent years.

An ecocity is an ecologically healthy city. An ecocity is a city that decreases environmental burden/stress, improves living conditions and helps in achieving sustainable development through a comprehensive urban improvement system involving planning and management of land and its resources and implementation of environmental improvement measures.

People oriented, ecocity development requires the comprehensive understanding of complex interactions between environmental, economic, political and socio-cultural factors based on ecological principles. The post-war pattern of Western urban development is not only ecologically unconscionable but economically inefficient and socially inequitable. In contrast, sustainable development implies that the use of energy and materials is in balance with such 'natural capital' processes as photosynthesis and waste assimilation.

Cities, towns and villages of the new century should be ecologically designed to enhance the health and quality of life of their inhabitants and maintain the ecosystems on which they depend.

Ecocity development integrates administration, ecologically efficient industry, people's needs and aspirations, harmonious culture, and landscapes where nature, agriculture and the built environment are functionally integrated.

The ideal urban form for a particular locale will depend to some extent on the nature of the energy supply options: for example, higher densities make most efficient use of district heating and public transport networks, while lower densities may make solar energy more viable. The location, gross density and form of new development should therefore be determined in conjunction with programs for energy supply and conservation technologies. Lots of studies demonstrate that the pattern of growth is more important than the amount of growth in determining the level and efficiency of resource use and traffic congestion.

On the basis of the case studies we have mentioned the development as well as the current methods for the ecological settlement planning. The standardisation

of ecological criteria, which were already implemented in smaller ecological settlement projects, was not sufficiently applied yet in bigger projects, for instance in the solarCity Linz.

One of the reasons for this is that there is not enough experience with such huge projects. The general conditions for the various projects are too different and the willingness to change planning to a more ecological attitude has not happened yet.

It is predominantly the duty of public authorities and private planning entities, which are responsible for projects like the solarCity Linz, to consider the ecological standards in town and settlement planning in order to not keep on destroying nature.

In this thesis we have outlined the existing ecological standards according to a list of criteria. This list does not define the technical instruments for ecological settlement planning but set the holistic standards with simultaneous consideration of ecological aspects. Considering this list of criteria it would be possible, before starting an ecological settlement project, to develop scenarios, which, depending on different existing general conditions could show various ecological approaches and thus could lead to the ideal solution. The most important thing is not the technical measure, like the supply of energy through for example wind power or biogas, but that renewable energy is used at all.

Developing such scenarios a collaboration of various scientific areas would be useful in order to understand the interrelation of the "ecosystem earth" and thus deducing responsible acting.

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