The concept of ecocities and solarCity Linz, Austria, as example for urban ecological development

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Fig. 1: The ecocity solarCity Linz, model photo of the first settlement area with integrated green spaces (TREBERSPURG & STADT LINZ 2008)

Zusammenfassung

Das Konzept der Ökostadt wird momentan auf verschiedenen Ebenen getestet und neu entwickelt. Es wird ganz oder teilweise in vielen in der Planung oder im Bau befindlichen Ökostädten weltweit umgesetzt. Diese Städte oder Stadtteile können Beispiele für eine neue nachhaltige Stadtgestaltung werden.

Eine Ökostadt ist eine ökologisch gesunde Stadt. Eine Ökostadt ist eine Stadt, die Umweltbelastungen verringert, Lebensbedingungen verbessert und die Verwirklichung einer nachhaltigen Entwicklung unterstützt, indem eine umfassende Planung sowie ein effizientes Flächen- und Ressourcenmanagement das städtische System nachhaltig verbessern und Umweltverbesserungsmaßnahmen umsetzt (GORDON 1990).

Die Entwicklung neuer Siedlungen ermöglicht, stets den neuesten Stand der Technik, Architektur, Planung und Design zu integrieren. Ehrgeizige moderne Planungen werden immer versuchen, ökologische Kriterien in der Planungen zu berücksichtigen. Solche neuen Städte oder Stadtteile werden "ökologische Städte" oder "Ökostädte" genannt. Am Beispiel der Öko-Stadt solarCity Linz wird untersucht, welche ökologischen Kriterien bezüglich Bau und Design beachtet wurden. Zudem wird eine Bewertung auf Basis allgemeiner ökologischen Kriterien durchgeführt, um die tatsächliche ökologische Zielerreichung der Ökostadt zu evaluieren.

Schlüsselwörter: Ökostadt, nachhaltige Stadtgestaltung, nachhaltige Stadtentwicklung, solarCity Linz

Abstract

The ecocity concept is actually in proofed and developed new on different scales. It is implemented completely or partially in many ecocities worldwide which are in planning and in built. They can be examples for a new sustainable urban design.

An ecocity is an ecologically healthy city. An ecocity is a city that decreases environmental 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 (GORDON 1990).

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”. 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 estimating the ecological content of the ecocity.

Keywords: ecocity, sustainable urban design, sustainable urban development, solarCity Linz

1. The ecocity concept

1.1 What is an ecocity?

An ecocity is an ecologically healthy human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems and living organisms. It is an entity that includes its inhabitants and their ecological impacts. An ecocity is a subsystem of the ecosystems of which it is part – of its watershed, and bioregion (ECOCITYBUILDERS 2011).

An ecocity is a city that decreases environmental 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 (GORDON 1990, 15ff.).

An ecocity must enable people to live in balance with nature and achieve sustainable development. People oriented ecocity development requires the comprehensive understanding of complex interactions between environmental, economic, political and sociocultural factors based on ecological principles (RAVETZ 2000, 3ff.; ECOCITYBUILDERS 2011).

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 (BARTON 2000, 10ff.).

The ecocity concept also starts on the neighbourhood-scale, the city-district level (Ecodistrict). Ecodistricts allow learning about district-scale sustainability best practices in finance, governance and policy, district energy and water utilities, net-zero buildings, smart grid, networked transportation, urban ecosystem services, zero waste, and human behaviour.

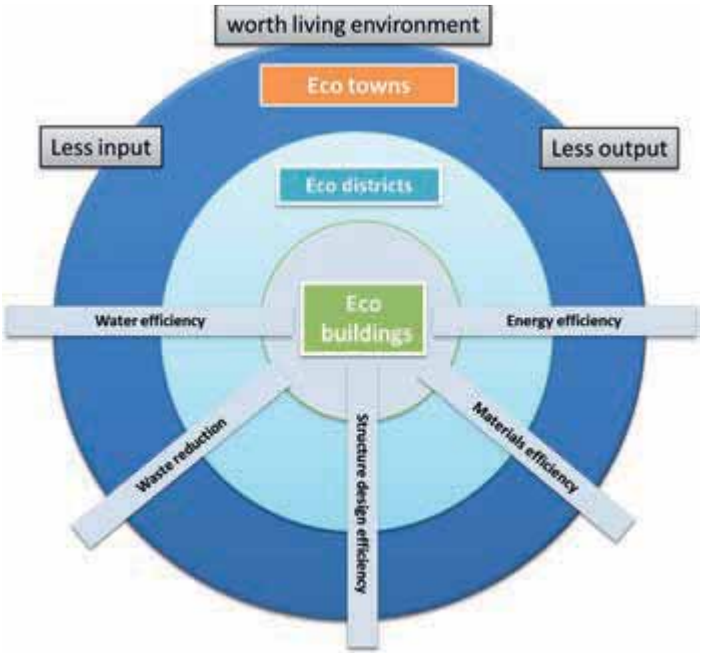

Fig. 2: Scales of the ecocity concept (BREUSTE, unpublished)

1.2 What does ecocity development require?

Ecocities can be characterized by some essential elements:

• Ecological security – clean air, and safe, reliable water supplies, food, healthy housing and workplaces, municipal services and protection against disasters for all people.

• Ecological sanitation – efficient, cost-effective eco-engineering for treating and recycling human excreta, grey water, and all wastes.

• Ecological industrial metabolism – resource conservation and environmental protection through industrial transition, emphasizing materials re-use, life-cycle production, renewable energy, efficient transportation, and meeting human needs.

• Ecological-landscape integrity – arrange built structures, open spaces such as parks and plazas, connectors such as streets and bridges, and natural features such as waterways and ridgelines, to maximize accessibility of the city for all citizens while conserving energy and resources and alleviating such problems as automobile accidents, air pollution, hydrological deterioration, heat island effects and global warming.

• Ecological awareness – help people understand their place in nature, cultural identity, responsibility for the environment, and help them change their consumption behaviour and enhance their ability to contribute to maintaining high quality urban ecosystems (GORDON 1990, 38ff., BREUSTE & RIEPEL 2008).

1.3 What actions for ecocities are needed?

To target on an ecocity a set of actions can be inluded:

• Provide safe shelter, water, sanitation, security of tenure and food security for all citizens.

• Minimize the loss of rural land by all effective measures, including regional urban and peri-urban ecological planning.

• Identify ecologically sensitive areas and identify areas where nature, agriculture and the built environment should be restored.

• Design cities for energy conservation, renewable energy uses and the reduction, re-use and recycling of materials.

• Build cities for safe pedestrian and non-motorized transport use with efficient public transportation.

• Provide strong economic incentives to businesses for ecocity building and rebuilding.

• Provide adequate, accessible education and training programs to increase community participation and awareness of ecocity design and management.

• Create a government agency at each level – city, regional and national – to craft and execute policy to build the ecocity. The agency could coordinate and monitor functions such as transportation, energy; water and land use in holistic planning and management, and facilitate projects and plans.

• Encourage and initiate international, intercity and community-to-community cooperation to share experiences, lessons and resources in ecocity development and promote ecocity practice in developing and developed countries (TJALLINGII 1995, 10ff.; RAVETZ 2000, 263ff.; BREUSTE & RIEPEL 2008).

Selected Eco-City Projects in China

Projekt:	Foreign Partner	Status
Beijing Mentougou Eco-City	Finnland	Signing of Sino-Finland Ecological Valley in May 2010. currently in the planning phase
Beijing Changxing International Eco-City	England (Arup)	Planning phase
Tangshan Caofeidian International Eco-City	Schweden (Sweco)	Start of the construction in September 2008; Start in March 2010 with 10 big projects (Total investment: 11,6 Billion RMB)
Shanghai Chongming Dongtan Eco-City	England (Arup)	MoU-Signing in January 2008; Start in the second part of the year 2008; currently not in progress
Suzhou Western Eco-City	-	Construction began in February 2010
Langfang Wanzhuang Eco-City	-	Construction began in Jun 2008
Wuxi National Low-Carbon Eco City Demonstration Zone, Wuxi Sino Swedish Low-Carbon Eco-city	Schweden (Tengbom)	Construction began in July 2010
Tianjin Sino-Singapone International Eco-City	Singapur (Keppel)	Construction began in 2008. Until the end 2009: realised investment 8,0 Billion . RMB, The total planned investment by the end of 2010: 17,0 Billion RMB
Zhangjiagang Sino-Danmark Ecological Science & Technology Park	Dänemark	Planning phase
Hubei Xianning Eco-City	Deutschland (Siemens)	Signing the „Strategic Partnership Fremework Agreement" in October 2009; currently in the planning phase

Tab. 1: Selected ecocity projects in China (2011)

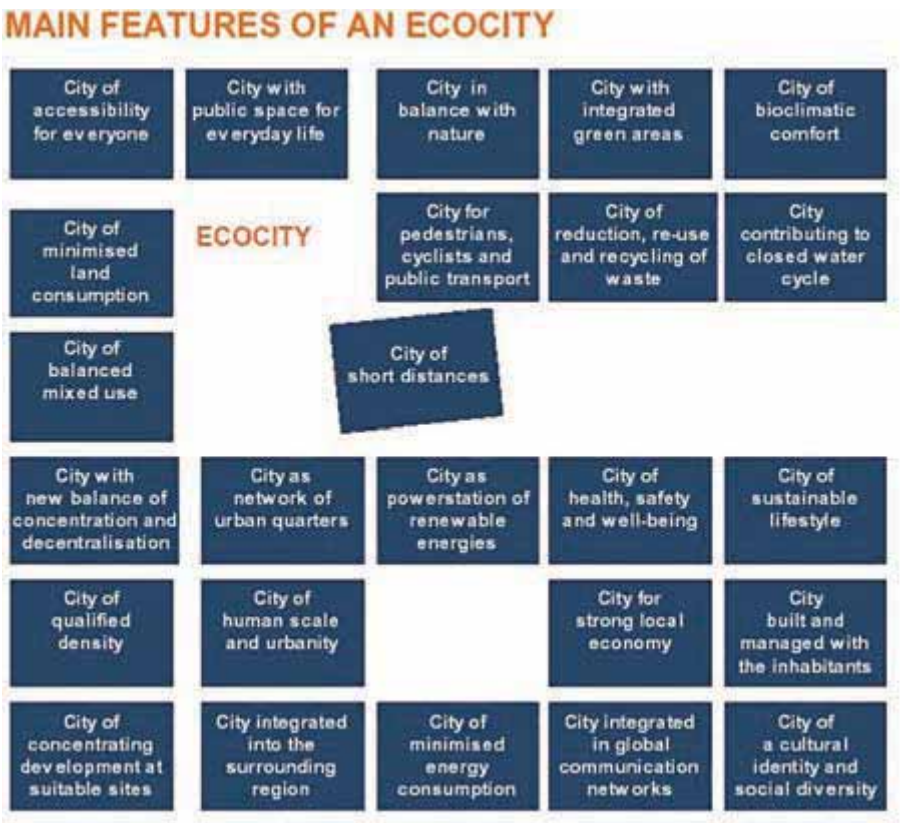

Fig. 3: Main features of an ecocity (ARKITEKTUR 2005, quotet by BREUSTE & RIEPEL 2008)

Actually several ecocities are in planning or in built. Only 170 Chinese cities aim to become sustainable or ecocities. 40 ecocities are in China actually in planning or in process (see tab. 1).

2. The ecocity solarCity Linz, Austria

2.1 The planning

The project initiative for an ecocity in the scale of an ecodistrict began in 1990, when Linz, the capital of Upper Austria, 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 fossil 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 selected development area in the south of Linz next to the village Pichling is characterised by small lakes and by the Traun-Danube floodplains, one of the largest, continuous, natural biotope landscapes in Upper Austria (MAGISTRAT LINZ 2004). This required careful planning, to provide a sensitive integration of a future housing estate into the existing landscape surroundings.

The master plan for the Linz-Pichling residential district (ecocity solarCity) was finished 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. 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.

The EU General Directorate XII for Research and Development subsidised the planning work with a contribution of EURO 600,000 (EIBLMAYR 2004, 44). 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.

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 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.

The construction was finished in 2005 in its first part on 35 ha ground with 2,942 residents live in 1,293 apartments. Each of the 12 housing associations involved in this project have finished their buildings by 2006 (BREUSTE & RIEPEL 2007).

2.2 The actual status and key principles of sustainable framework

The leading architect TREBERSPURG wrote 2008

"The solarcity is a model for a sustainable future. To be more precise, it is a complex, conscientiously planned, constructed, used an inhabited urban model which at all levels and in all aspects represents the latest state of development" (TREBERSPURG & STADT LINZ 2008, 9f.).

This had been proved by BREUSTE & RIEPEL 2007. Beside the several very positive results this statement could only be partly confirmed (see 2.3).

The name solarCity 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 and

• new approaches in general for a lasting development of residential areas (MAGISTRAT LINZ 2004).

The city of Linz set up criteria for preserving the basic ideas of the solarCity. Low-energy construction (with an energy factor not exceeding the maximum of 40 kW/m²a) 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/m²a, others do not even exceed 21 kWh/m²a (WAECHTER-BÖHM 2004, 33).

A tramway line of about 2.3 km connects the city center of Linz since September 2004 with the solarCity. However, the distant to Linz and who to bridge it is the weakest point of the ecocity.

Most part of the "Traun-Donau wetlands" is legally protected. This unique nature reserve remains protected and at the same time it is meant to constitute a nature experience for the solarCity's residents. Wooden footbridges for walks are installed in the alluvial forests. Info-checkpoints make the offer complete. The connection of nature protection and urban development is a very important and actual challenge for urban development. SolarCity is an example for a project in which this was not only included in the design of the city and its surroundings, but in which, beyond that, nature protection and recreation were excellently integrated so that both complement each other.

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. It 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 (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 photovoltaic, 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).

Fig. 4: SolarCity residential estate (Photo J. Breuste)

The designers and planners of the ecoCity list up the following in aspects of ecological development they have included for solarCity:

- Energy efficiency and sustainable energy usage,
- Recreational infrastructure and pedestrian routes,
- Open spaces and landscape as planning focus,
- Nature protection and people's contact with nature,
- Innovative building concepts,
- Management of resources,
- Social stability (ownership and rental, age groups etc.),
- Urban district management,
- Mobility management,
- Optimization and adaptation of both constructional and social standards to changing conditions,
- Sustainability - Monitoring – focusing particularly on urban development, architecture, energy management, climate protection, material management and user satisfaction and
- Adaptability of the concept to other places

2.3 Ecological evaluation of the project

It goes without saying that not all guidelines can be met in this ecocity project. Preconditions and circumstances differ enormously between evaluation subjects and project areas. However, it is striking that most criteria and guidelines that had been 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, not fulfilled or even not target at all. But the ecocity 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).

The grade 5 (insufficient) corresponds with the former category 1 (not implemented): 1 = excellent, 2 = good, 3 = satisfactory, 4 = sufficient, 5 = insufficient. The used (BREUSTE & RIEPEL 2007) 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.

To achieve a final grading of the ecocity project solarCity Linz, the five hierarchical categories are going to be transformed into grades from 1 to 5 (VAN DER VEN 1980, 34). 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". A comparison and assessment is more effective with the evaluation of the assessment categories and the single criteria instead of summarizing them to single number.

The ecocity solarCity was evaluated by BREUSTE & RIEPEL 2007 on its ecological criteria. This analysis is based on the evaluation of all available relevant documents, observations, inquiries and conversations with the stakeholders. It is as possible objective and proves all relevant ecological criteria.

The following criteria had been included, following KENNEDY 1984a, b and KENNEDY & KENNEDY 1998: siting and land use, open space, soil, material, indoor environmental quality, energy, traffic, waters and waste.

Assessed criteria	Assessment results
Open Space	
Use existing vegetation and landforms to moderate climate conditions and provide protection for native habitats	3
Plant native or well-adapted species	3
Use greenbelts and protected wetlands to create a continuous web of native habitats	4
Restore the native landscape	4
Open space for recreation and child's play	5
Roof gardens can be established on the flat roofs of buildings using potted trees, shrubs and plants	2
Energy	
Energy-Conscious Urban Planning	5
Energy Conservation	4
Use renewable energy sources	5
Passive Heating and Cooling	5
Insulation	3
Alternate Sources of Energy	4
Daylighting	4
Energy Efficient Equipment and Appliances	1
Traffic	
Settlements should be located around or close to public transport nodes and frequently used routes	3

Settlements should be planned around a network of pedestrian routes which encourage walking and cycling	4
Limit on-site parking	3
Use porous alternatives to traditional paving for roads and walkways and reduce street width	3
Carpooling strategies should be encouraged in addition to mass-transit use	1
Use existing vehicular transportation networks to minimize the need for new Infrastructure	2
Minimize noise disturbance	1
Water	
Use permeable surfaces	3
Collect and use harvested water	4
Collect and use rainwater	4
Design an appropriate harvesting and storage system	5
Reduce overall water use	4
Utilize greywater for nonpotable purposes	4
Use constructed wetlands	4
Treat brownwater from toilet-flushing with on-site systems	4
Use reclaimed water for purposes such as toilet-flushing	3
Waste	
Minimize use of resources - Reuse Existing Buildings	1
Minimize waste generated from construction, renovation and demolition of buildings	3
Minimize waste generated during building occupancy	4
Material	
Design for future reuse and adaptability	3
Use durable products and materials	3
Choose low-maintenance building materials	3
Buy locally produced building materials	4
Use salvaged building materials when possible	1
Minimize packaging waste	5
Indoor Environmental Quality	
Design for human comfort	5
Improve indoor air quality	4
Siting and Land Use	
Renovate older buildings	1
Create community	4
Encourage in-fill and mixed-use development	4
Minimize automobile dependence	4
Value site resources	5
Existing planted vegetation that has to remain on site needs to be protected during construction	4
Situate buildings to benefit from existing vegetation	1
Building smaller is better	3
Design for durability	3
Soil	
Minimize pavement area	1
Emphasize preservation of mature vegetated soils	1
Minimize earthwork and clearing	1
Minimize use of landscape irrigation, herbicides, pesticides, and fertilizers	1
Consider use of permeable paving materials	1
Build pedestrian surfaces with loose aggregate, wooden decks, or well-spaced paving stones	2

Tab. 2: Structuring of evaluation criteria and assessment for solarCity (BREUSTE & RIEPEL 2007)

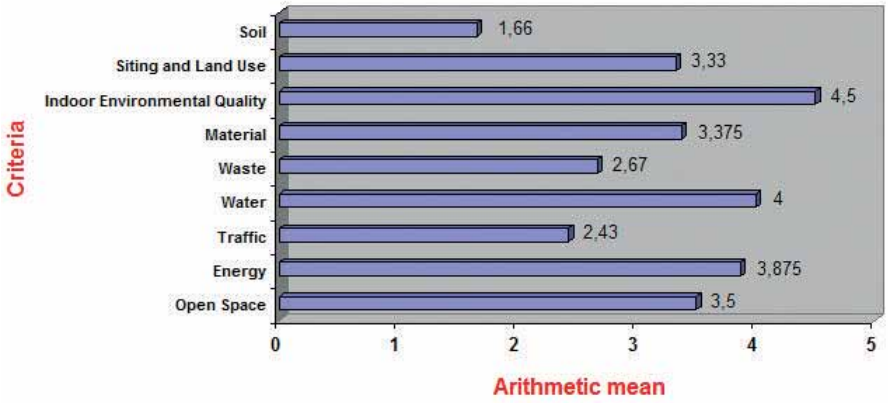

Figure 5: Validation of the single criteria (BREUSTE & RIEPEL 2007)

3. Summary

The location, gross density and form of an ecocity should 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 study solarCity the development as well as the current methods for the ecological settlement planning had been mentioned. Solarcity Linz is a good example for an ecocity. The standardisation of ecological criteria, which were already implemented in smaller ecological settelment projects, are often 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.

The existing ecological standards according to a list of criteria had been implemented to the solarCity example. 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. Most important is not the technical measure, like the supplies 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 develop the concept of ecocity further (BREUSTE & RIEPEL 2007, 2008).

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