Criteria and Indicators for Environmentally Sustainable Construction and Housing - An ongoing research project in Germany -

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INTRODUCTION

By consuming energy, materials, and land, construction and housing is responsible for a considerable proportion of environmental burdens in a densely polulated, industrialized country like Germany. Therefore, this field of action has key importance for sustainable development.
The German national sustainability strategy adopted in spring 2002 highlights the prime trends in economy and society, and traces on this basis the necessary course towards sustainability. Furthermore, it designs a vision for sustainable development and presents a set of goals and indicators for the country. In a second part, the programme of action, it sets out as far as possible the necessary concrete and practical steps.
Among the environment-related aims mentioned in this sustainability strategy, the need to reduce resource consumption and land use is emphasized besides climate protection:

- By 2020, energy and raw material intensity is to be reduced by around half in relation to the levels of 1990 and, respectively, 1994. Through this, resource use will be reduced in absolute terms, too.
- The climate protection policy of Germany aims to reduce the emissions of the principal greenhouse gas CO_2 by 25% by 2005 in relation to 1990. A drastic reduction in present greenhouse gas emissions is required in a long run.
- Land use for settlement areas is to be reduced from the present rate of 130 hectares per day to a maximum of 30 hectares per day by 2020.

THE GERMAN ENVIRONMENT INDEX (DUX)

To be able to identify whether the environmental situation is developing in a direction corresponding to these aims, it is necessary to have indicators serving – in a manner comparable to the inflation rate or gross national product in the economic realm – as a yardstick for the condition of the environment in Germany.

To meet this need, an 'Environment Barometer' (Umweltbarometer) has been created which makes the development of the environment measurable by a few indicators. These indicators cover main issues of environmental protection and are connected to policy targets.

The six indicators of the Environment Barometer stand for the issue areas of climate, air, land use, water and resources (energy and raw materials). The German Environment Index (Deutscher Umweltindex, DUX) delivers a further aggregation of the information provided by the Environment Barometer, summarizing the results as a single number – an 'environment index'. The DUX connects indicator values with goals (distance-to-target concept). The Environment Barometer and the DUX are updated at regular intervals, and are complemented by information concerning the individual indicators (www.umweltbundesamt.de/dux/).

Sustainable development has to be achieved in real fields of action. Whether a system makes progress on the path to sustainability can - from the environmental viewpoint - only be judged if the development of the profile of environmental demands generated by that system is rendered comparable with the corresponding sustainability goals by means of environmental indicators.

Tab. 1: German Environment Index (DUX)

Subject	State February 2002	Maximum points
Climate	604	1000
Air	682	1000
Soil	-100	1000
Water	295	1000
Energy	239	1000
Raw Materials	82	1000
DUX	1802	6000

SCENARIOS FOR SUSTAINABLE CONSTRUCTION AND HOUSING

The profile of the environmental demands made by production and consumption arises from the analysis of the material and energy flows triggered by this system. In a research project focussing on sustainable construction and housing in Germany, national scenarios have been calculated for the development of construction and housing activities[1].

Using the methodology of 'needs-focused material flow analysis' (bedürfnisfeldbezogene Stoffstromanalyse) and the BASiS[2] material flow model, and involving key protagonists such as the housing industry, the academic community and public administrations, the project succeeded in identifying possibilities for setting development trajectories on track to achieve the essential environmental aims.

For this, various possible activities were identified to save resources in the area of construction and housing. In a specific'sustainability' scenario, the assumption was examined that the full potential of all available possibilities is exploited simultaneously.

The results of the computed scenarios demonstrated clearly that, for the area of construction and housing, it is indeed feasible to achieve the environmental aims of the national sustainability strategy, if efforts are successful to:

- upgrade the building and housing stock through refurbishment, modernization and joining of apartments,
- renew cities and towns vigorously,

- promote dense urban configurations and building designs,
- use available brownfield sites wherever possible,
- establish low-energy ("passive") house construction standard in the mass market,
- advance the thermal retrofitting of existing buildings forcefully,
- increase the share in space heat supply of biomass, cogeneration, and solar energy,
- use more recycled materials for concrete aggregates,
- use more renewable materials (wood), and
- realize cost savings through simpler constructions, using the savings thus achieved to improve energy standards, among other things.

The scenarios made clear which course is necessary from the environmental viewpoint for the 'construction and housing' action area. The requisite concrete and practical steps concern protagonists at various action levels, from the legislature through to building clients/developers, and planners.

The general sustainability indicators for the national level are not immediately applicable to the decisions of these protagonists: They must rather be reached on their own activity levels with specific and criteria and indicators that can guide their actions.
The 'information pyramid' (Fig. 1) provides a clear picture of these connections.

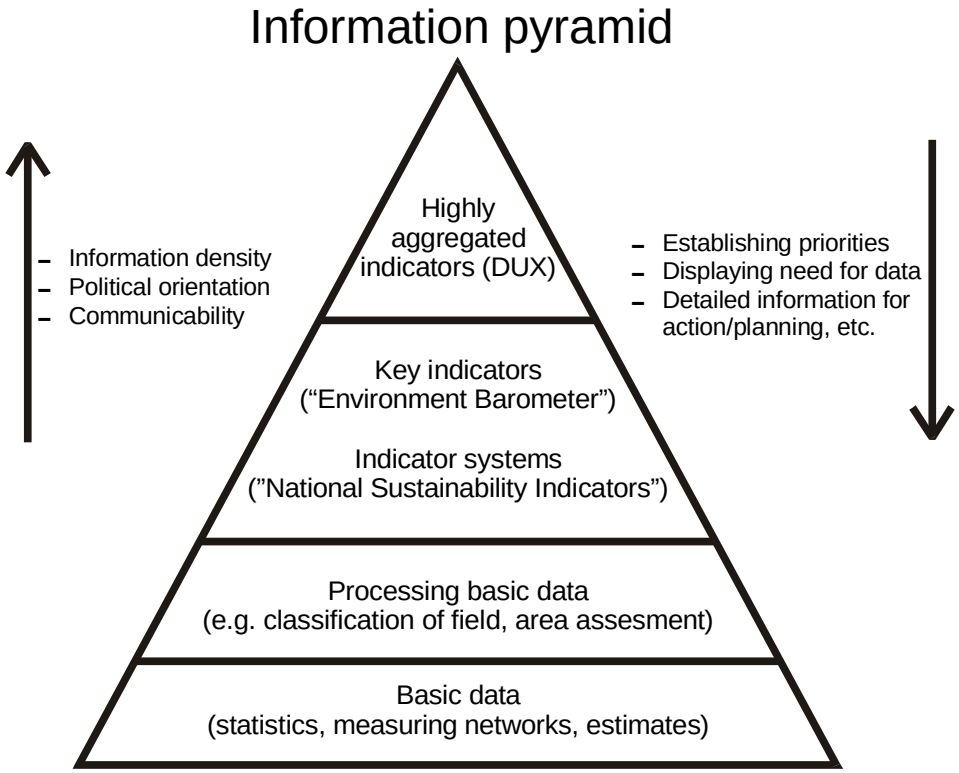

Fig. 1: The integration of data and indicators in the information pyramid of the DUX.

DEVELOPMENT OF ACTION–ACTOR-FOCUSED CRITERIA AND INDICATORS
A new project on 'criteria and indicators for environmentally sustainable construction and housing' is therefore seeking to close the gap described above, namely the absence of criteria and indicators which are capable of specifically guiding actions.

To adequately meet the requirements posed by the action- and actor-focused approach, it is essential to select criteria and indicators on the basis of both the variety of protagonists and the variety of guiding principles and aims which prevail in this complex and extensive area of action and needs.
To ensure sustainability, it is essential to harmonize economic and social requirements – which have one-sidedly dominated the housing and construction sector until now – with the concerns of environmental conservation. On the one hand the action possibilities have to be investigated at which this is possible and on the other hand the obstacles which stand contrary to this have to be removed. A comparison of the different social, economic and environmental guiding principles and aims in terms of agreement, neutrality or conflict reveals that the topic of land use for settlement areas is especially controversial[3].

Using a qualified selection of criteria and indicators, an important contribution can be made to a more rational discussion of conflict status and the possible approaches to resolving the various conflicts of goals. The operationalizability of the approaches and the representation of environmental impacts is to be guaranteed in the new project by means of indicators and EDP supported tools.
After some discussions it became clear that the indicators would need to impact upon existing decision-making operations of the various protagonists which shape the housing and construction area. This presented the challenge to identify the web of protagonists in its breadth and interlinkages, and to explore essential decision-making operations.
The following two sections present these aspects of the project: the structure of the selected indicator model and the actor network analysis.

STRUCTURE OF THE INDICATOR MODEL

The search for well-targeted indicators is at the centre of interest of the indicator concept demonstrating the environmental impact of the activities of construction and housing protagonists. This means that indicators should directly address protagonists and their possibilities of intervention. However, beyond this a universal coherence of indicators is also aimed at in order to be able to aggregate environmental impacts across the different levels.
Giving consideration to these requirements and the three dimensions (social, ecological, economic) of sustainable development, a multi-column and multi-layered indicator catalogue has been designed, which can be supplemented with further indicators when required.
The model contains two basic types of indicators: 1. actor indicators, 2. universal indicators (Fig. 2).
The actor indicators are tailored to different key protagonists of the various activity levels. Activity levels which need to be taken into account include: object (single building), neighbourhood, municipality, region, state.
The actor indicators will be suited for immediate assimilation into existing decision-making and operational processes and will make it possible to address target groups directly. Building and construction industry enterprises will be confronted with different indicators than housing associations or municipal planning departments.
The universal indicators will, in contrast, allow for permeability and aggregation along main environmental issues and across different activity levels. Wherever feasible, the actor indicators shall be chosen such that their translation into the universal indicators is possible. For example, per-capita carbon dioxide emissions is a suitable universal indicator.

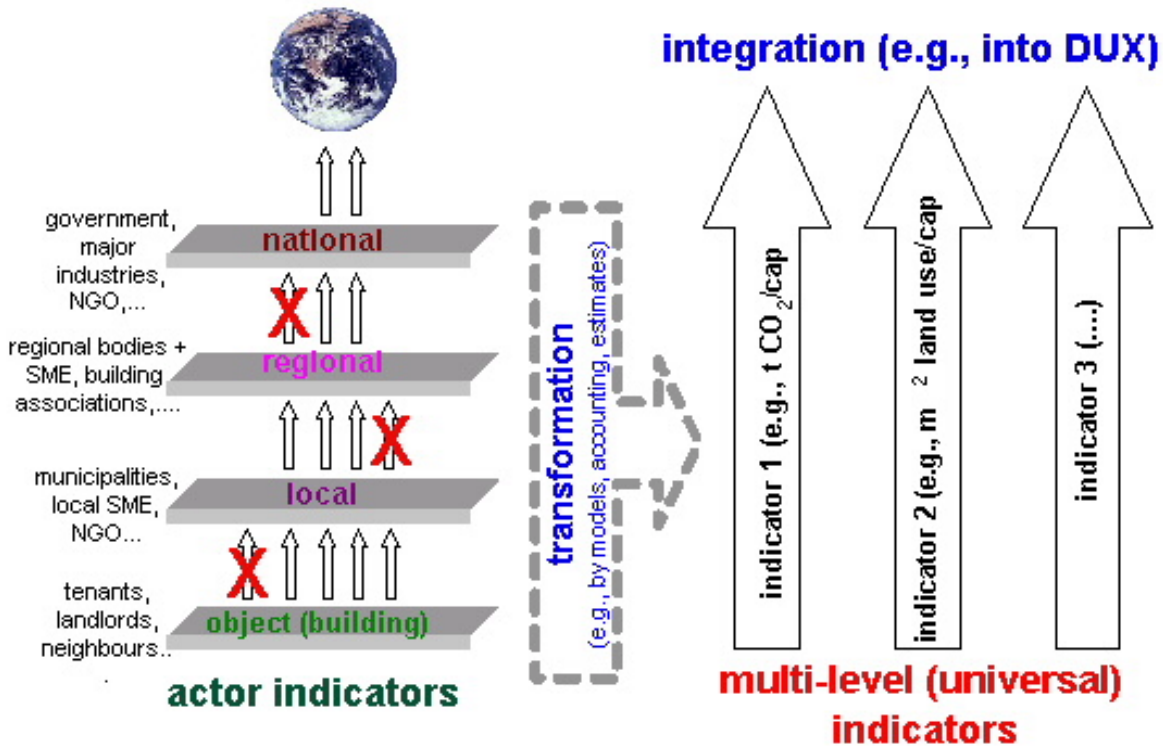

Fig. 2: The connection between actor indicators and universal indicators

This implies that indicators need to be sought for the different actor groups which can be converted into CO_2 emission equivalents or allow estimated values. The number of universal indicators is to be kept within bounds, not exceeding 3 to 5.
An analysis of available local, regional and national sustainability indicators found that environmentally oriented universal indicators are to be sought among the following: land use for settlements, solid wastes, CO_2 emissions, non-renewable primary energy consumption, drinking water consumption, share of renewable energy sources, waste recycling ratios.

ACTOR NETWORK ANALYSIS

For the housing sector, the construction industry, housing associations, clients/developers, crafts enterprises and architects as well as planners have been identified as essential protagonists. Examination of the life cycle of buildings demonstrates that not only is the actor network in fact much wider, but also a number of protagonists who have considerable capacity to exert influence must be given greater consideration. These include, e.g., credit institutions, insurance companies, and water and energy supply companies.

With regard to the influence of actor groups on energy and material flows, a distinction can be drawn between the demand side – investors, owners, users – and the supply side – building material manufacturers, building firms, utility suppliers, service providers. The demand side is concerned primarily with issues of sufficiency, the supply side with issues of efficiency.
As it can be assumed that the actor groups on the supply side already seek to maximize efficiency as a part of their business management considerations, the project focuses especially upon the demand side. Proceeding from the demand side, the project examines, step by step, those actors which influence this side through their supporting, advising, planning (et cetera) activities.

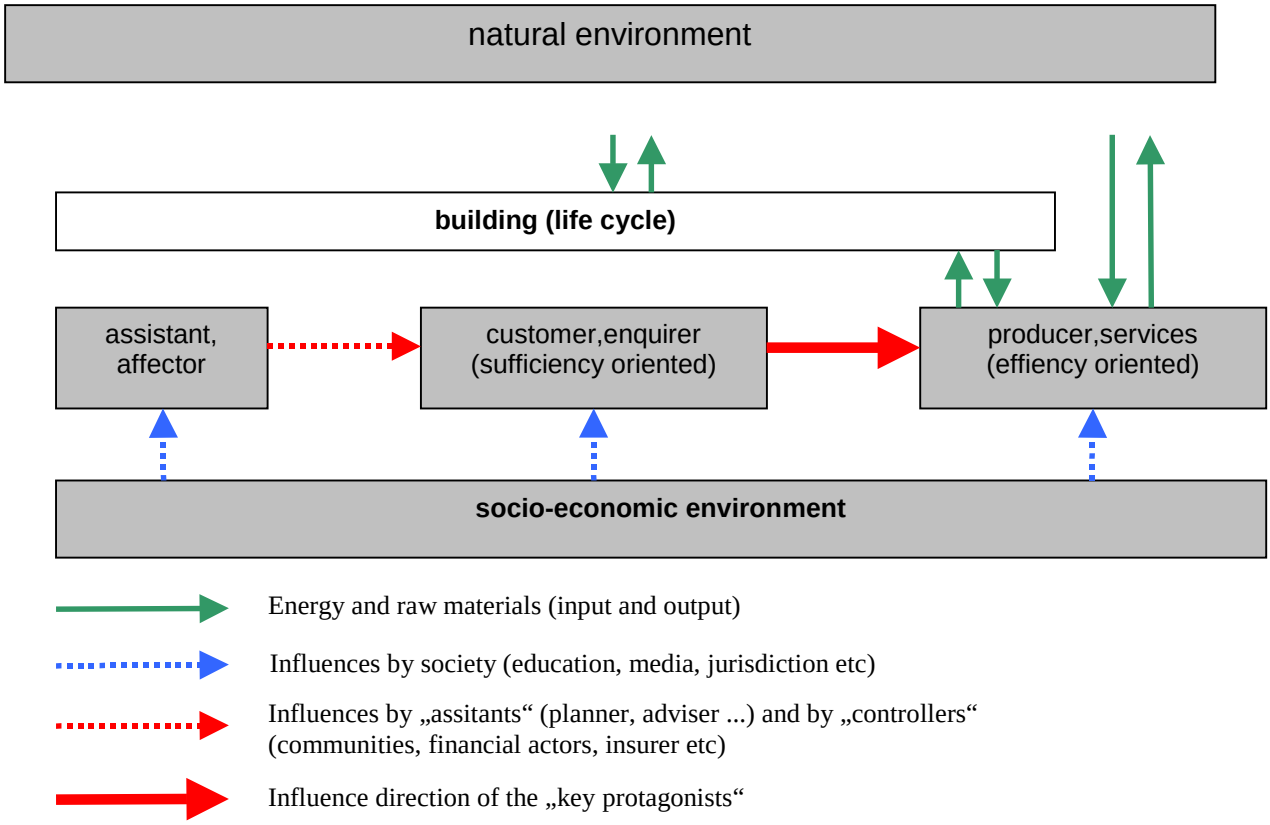

Fig. 3: Simplified network of examined actor groups

The owners of apartments and houses play a key role in influencing one-off (at the construction stage) and ongoing (in the building operation phase) energy and material flows. This group, however, is highly heterogeneous. Specific owner sub-groups pursue specific strategies with regard to their time horizon when formulating aims and considerations, their profit expectations, their tax status and treatment as well as their personal or institutional attitude concerning environmental and health issues.
These strategies have partly changed within recent years and will continue to change. Analysis of these strategies delivers the basis for linking them to indicators and tools for identifying and influencing environmentally relevant effects – work which will be done in the next steps of the project.

Notes

[1] „Stoffflussbezogene Bausteine für ein nationales Konzept der nachhaltigen Entwicklung – Verknüpfung des Bereichs Bauen und Wohnen mit dem komplementären Bereich öffentliche Infrastruktur“ (material flow related modules for a national concept of sustainable development – combination of the area of construction and housing with the complementary area of public infrastructure), research project on behalf of the German Federal Environmental Agency (UBA) carried out by Öko-Institut, and Institut für ökologische Raumentwicklung (IÖR) Dresden

[2] BASiS = **B**edarfsorientiertes Analysewerkzeug für **S**toffströme **i**n **S**zenarien (needs-oriented analysis tool for material flows in scenarios)

[3] Chmella-Emrich, E., Greiff, R., Steinmüller, B., Werner, P. u. Wullkopf, U. (1999): Beitrag der Wohnungspolitik für eine nachhaltige Entwicklung (contribution of housing policy to sustainable development). Hearing of experts on behalf of the German Ministry of Transport, Construction and Housing and the Federal Agency for Building and Spatial Planning, Institut Wohnen und Umwelt, Darmstadt (summary in English)