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Guidelines for Sustainable Sports Facility Construction

Criteria for the Construction of Sustainable Sports Halls
Summary

Natalie Essig, Sara Lindner, Simone Magdolen, Loni Siegmund

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– Criteria for the Construction of Sustainable Sports Halls

A Summary

Online publication of the Federal Institute of Sport Science

Imprint

Publisher

Bundesinstitut für Sportwissenschaft
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53117 Bonn (Germany)

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Year of publication

2021 (German version: 2017)

Place of publication

Bonn

Essig, Natalie; Lindner, Sara; Magdolen, Simone, Siegmund, Loni
Guidelines for Sustainable Sports Facility Construction
– Criteria for the Construction of Sustainable Sports Halls
Summary
ISBN 978-3-96523-053-8

Layout

Elke Hillenbach

Cover photo

Sonnwendviertel Educational Campus:
Photo © pierer.net
Architecture: PPAG architects
Specialist planning: RAUMKUNST ZT GmbH

Bibliographic information of the German National Library

Table of contents

1 Summary

Sports halls, one of the most important resources for club, popular, competitive and school sports, are facing a variety of challenges. They are not only under a huge pressure to renovate and modernise, but must also meet new requirements for ecological and energy-efficient construction methods. The complexity of planning sports hall buildings has therefore increased significantly in recent years. State-of-the-art planning and construction quality is required to ensure sustainable construction of sports halls. However, sustainability in construction is not only a requirement of our time – sports halls must also implement a wide range of ecological standards and environmental regulations. Moreover, this increasingly involves more than just meeting standards and legislation: sustainability principles and the consideration of ecological, social and economic factors open up new opportunities for the further development of the sports infrastructure in Germany. They promote necessary 'life cycle considerations' and open up new perspectives for environmentally friendly, demand-oriented, functional, health-promoting and economical sports facilities. In a nutshell: Sustainability leads to higher quality in the construction of sports facilities.

This publication "Sustainable Sports Facility Construction – Criteria for the Construction of Sustainable Sports Halls: A Summary" outlines the principles, guidelines and advantages of sustainable sports hall construction, offers guidance and clarifies relevant planning principles. It builds on the more detailed guide with the same title, commissioned by the German Federal Institute of Sport Science and published by Natalie Essig, Sara Lindner, Simone Magdolen and Loni Siegmund at the end of 2015.

Importance of sustainability for sports facility construction

Chapter 2 introduces the topic, defines sports hall as a 'special-purpose property', thus distinguishing it from other types of sports facilities. It also links the construction of sports halls to socio-political and construction-related debates on sustainability, presents relevant planning instruments and develops specific criteria as well as a catalogue of indicators. Functional sport requirements must not be neglected – after all, sports halls are a 'special-purpose property' with a complex and dynamic requirement profile. This introductory chapter 'unveils' the innovative achievement of the authors, by establishing a link between the sustainability model and the sports facility sector, including the derivation of specific facility-specific criteria for sports halls.

Planning principles and processes

What planning principles, technical regulations, guidelines, directives and standards must be observed? You will find a comprehensive and systematic answer to this question in chapter 3. The importance of the quality of planning and construction processes has been neglected in on-site practice for too long – but is highly relevant. It is therefore only logical that a separate section has been devoted to this aspect: Increased process quality = increased construction and usage quality and more economic efficiency.

Healthy sports halls for all

Sports facilities are always spaces for social integration and therefore invariably have a social dimension (chapter 5), although it is only in recent years that the issue of accessibility has been given the importance it deserves (section 5.1). Sport promotes the physical and mental health of individuals and society in a very special way. Sports halls should therefore "keep us healthy", not endanger our health. Relevant aspects were therefore analysed, from indoor air quality to water quality and safety aspects (chapter 6).

Ecological challenges – and the answers

Chapters 7 and 8 deal with ecological and resource aspects respectively. Relevant legal requirements, modern building envelopes, efficient drinking water and wastewater concepts or the use of renewable energies are just a few of the keywords here. Since the end of 2016, Germany has pursued an ambitious climate protection policy that aims to achieve climate neutrality (!) in almost all its buildings. This goal is as ambitious as it is necessary in terms of climate policy, but is still largely unknown to many sports hall owners and operators. It is thanks to Prof. Dr. Natalie Essig and others to have scientifically anchored the aspect of ecological sustainability in the discussion about sports facilities in this guideline.

No more "cheap building": Life cycle assessments

Whereas conventional planning and construction processes only took into account the production costs – and thus the orientation towards the current or coming financial year – sustainable sports facility construction requires a life cycle analysis. This promotes economic efficiency and quality in equal measure, but requires a move away from the consideration of cost minimisation in the annual budget, which remains a challenge, especially in municipal policy. The present summary, like the detailed guidelines, takes up this key aspect of sustainability, provides a non-didactic commentary (chapter 9) and combines it with an outlook in the last and 10th chapters.

Materials

A checklist (chapter 11) and a list of sources (chapter 12) round off the summary and at the same time create a bridge for a more in-depth examination of the topic of sustainable sports facility construction.

(Andreas Klages, Deputy Head of Sport Development, German Olympic Sports Confederation)

2 Fundamentals

2.1 Definitions, figures and economic importance of sports facility construction

Within the context of current sports facility development planning, the term 'sports facilities' is defined as a collective term, based on the "Guidelines for sports facility development planning" ("Leitfaden für die Sportstättenentwicklungsplanung") of the Federal Institute of Sport Science (Bundesinstitut für Sportwissenschaft, 2000). In this context, the term 'sports centre' stands for sports facilities and sports amenities, defined as follows:

- Sports facilities:
  facilities specially designed for sports, such as gymnasiums, sports fields, tennis courts, swimming pools or ice rinks
- Sports amenities:
  facilities or areas used for sport but created for other purposes, such as parks with lawns for ball games or field and forest paths for cross-country skiing and jogging

Both sports facilities and sports amenities can be divided into covered and uncovered venues. These in turn can be divided into facilities subject to regulations (e.g. triple gymnasiums and tennis courts) and those which are not (e.g. exercise rooms and amateur football fields) (Wetterich et al., 2009).

The typology of 'sports hall', which is the main focus of this summary, refers here to sports facilities as well as to 'covered and regulated sports facilities'.

Fig. 2.1: Definition of 'sports hall'

Number of sports facilities

There are very few statistics available on the exact number of sports facilities. Apart from the "Sportstättenstatistik der Länder" ("Statistics on sports facilities of the federal states") from the Berlin Senate Department for Education, Youth and Sport, 2002, (Senatsverwaltung für Bildung, Jugend und Sport, 2002), which was carried out in the year 2000, and the study "Die wirtschaftliche Bedeutung des Sportstättenbaus" ("The economic significance of sports facility construction") of the Federal Ministry of Economics and Technology (BMWi) of 2012, only a few studies have dealt comprehensively with the statistical quantity recording of sports facilities in recent years.

The statistics on sports facilities of the federal states recorded a total of 123,954 sports facilities in the survey year 2000. The share of sports halls was 27.9 percent, i.e. 35,409 buildings. This survey did not include private sports facilities and special sports facilities such as equestrian or water sports facilities (Berlin Senate Department for Education, Youth and Sport, 2002). Twelve years later, a methodologically broader survey was therefore conducted as part of the BMWi study of 2012. In this context, 136,754 sports facilities were surveyed, with 35,438 sports halls included therein, whereby the latter hardly differ from the results of the sports facility statistics of 2000 (Berlin Senate Department for Education, Youth and Sport, 2002).

	Total sports facilities	Uncovered facilities	Sports halls	Large sports halls	Pools	Tennis facilities	Ice rinks	Shooting ranges
Sports facility statistics (2000)	123,954	60,161	35,409	408	6,719	14,192	186	8,814
BMWi (2012)	136,754	66,462	35,438	78	7,499	13,040	120	15,000

Tab. 2.1: Number of sports halls surveyed in 2000 and 2012 (Federal Ministry of Economics and Technology, 2012; Berlin Senate Administration for Education, Youth and Sport, 2002)

With regard to the type of operator, the statistics on sports facilities of the federal states ("Sportstättenstatistik der Länder") show that, as a rule, municipalities are the owners and operators of sports facilities. In 2000, for example, around 61 percent (about 78,000 sports facilities) were operated by municipalities. Due to changes in the sports segment, clubs and associations in particular have started to play a greater role in the operation of sports facilities and now manage 32 percent of all sports facilities (41,000). However, the operator situation varies greatly from one type of facility to another: When it comes to sports halls in particular, municipalities dominate with 85 percent (30,000 halls), while clubs account for only nine percent (3,000 halls) (Berlin Senate Department for Education, Youth and Sport, 2002).

Sports facility statistics of the federal states (2000) [Sportstättenstatistik der Länder (2000)]
The sports facility statistics of the federal states presented an initial overview of the equipment and condition of the sports infrastructure in all federal states in 2000. The information on the number of sports facilities refers to sports halls and fields, outdoor and indoor swimming pools, ice rinks, as well as tennis and shooting ranges. This survey did not take into account private sports facilities and special sports facilities such as horse riding or water sports facilities.
The survey of sports facilities was conducted at the level of the federal states according to facility types, operator forms, year of construction, requirements for renovation and equipment.
A total of around 35,409 public sports halls were recorded in Germany.
The result of the study was that only about 20 percent of the 123,954 sports facilities have been completely renovated or newly built since 1991. In the survey year 2000, more than 50 percent of the existing sports facilities have not been modernised in the last 20 years, which means that there is a high need for renovation.

Tab. 2.2: Sports facility statistics of the federal states (2000)

Golden Plan

As early as 1961, the German Olympic Society (Deutsche Olympische Gesellschaft – DOG) developed the so-called "Golden Plan" that set out a planning and financing strategy for the sports facility infrastructure of German municipalities for the next 15 years (German Olympic Sports Confederation, 1985). Its main objective was to counteract the lack of sports facilities in the Federal Republic of Germany and to implement the goal of "Sports for All". On this planning basis, the number of mostly municipal core sports facilities, such as sports halls and sports fields, was doubled in the following 30 years and the number of municipal indoor swimming pools quintupled (Rütten et al., 2010). Around 17 billion Deutsche Marks (approx. EUR 8.7 billion) were invested in the improvement of the sports facility infrastructure until 1975 – a total of 11 billion Deutsche Marks more than originally estimated. More than half of the total expenditure (approx. 63 percent) was accounted for by cities and municipalities (Federal Ministry of Economics and Technology, 2012).

"Golden Plan"
The "Goldener Plan" ("Golden Plan") was a programme of the German Olympic Society (DOG), which in 1960 presented proposals for the planning and financing of sports facilities for the period 1961-1975 (15-year plan) and became widely accepted as the basis for sports facility planning. The programme set down guidelines for the creation of recreational, play and sports facilities in the municipalities; in 1960, it established that a total area of 127 million m² was required for children's playgrounds, sports fields, sports halls, indoor and outdoor swimming pools, which was met in the following years by the federal, state and local authorities through appropriate planning and construction measures (Deutsche Olympische Gesellschaft, 1962). The first "Memorandum on the Golden Plan for Health, Play and Recreation" ("Memorandum zum Goldenen Plan für Gesundheit, Spiel und Erholung") contained detailed information on the state of health of the population at the time, the lack of sports facilities and the necessary measures (Mevert, 2009). This was followed in 1967 by the Second Memorandum ("Zweite Memorandum"), which both gave an account of the successful first half of the "Golden Plan" period and contained proposals for the second half of the period (Mevert, 2009). In 1984, the German Sports Confederation (DSB) published further guidelines for sports facilities in its "3rd Memorandum on the Golden Plan" ("3. Memorandum zum Goldenen Plan") (Deutscher Sportbund, 1986). In 1992, the "Goldene Plan Ost" ("Golden Plan East"), a similar 15-year programme designed for the new federal states) was adopted by the DSB (Deutscher Sportbund, 1992).

Tab. 2.3: "Golden Plan"

On the basis of a second and third memorandum on the Golden Plan, another 20 billion Deutsche Marks or so was invested in the construction of sports facilities between 1976 and 1993 (Deutscher Sportbund, 1992). The memoranda updated the development goals, requirements and financial expenditure in line with the times. At the time, the planning of sports facilities was based on reference values, meaning that urban planning guidelines and population figures (m² of sports area per inhabitant) were used to determine the need for publicly financed sports facilities(Rütten et al., 2010).

After reunification, the "Golden Plan East" was adopted by the German Sports Federation (DSB) in 1992. The 15-year programme for the new federal states promoted new buildings and the conversion of sports facilities as well as the initial equipping with sports equipment – also based on reference values (Deutscher Sportbund, 1992).

Today – 50 years after the introduction of the Golden Plan – Germany must deal with its aftermath (Deutsche Presse-Agentur GmbH, 2013). Although basic sports services are now extensively available, the latest statistics from the year 2000 show that around 40 percent of sports facilities in the old and 70 percent in the new federal states are in urgent need of renovation, leading to an enormous bottleneck in the development of sports facilities (Berlin Senate Department for Education, Youth and Sport, 2002).

Economic significance of sports facility construction

Nowadays, both leisure and professional sports have major importance for the economy. As early as 1993, the sports sector acquired the same economic significance as agriculture (in terms of GDP) and the chemical industry (in terms of jobs). However, sport is a cross-sectional activity, i.e. it is not only covered by a single economic sector, but covers a large number of sectors (Federal Ministry of Economics and Technology, 2012).

Local authorities are the most important owners of sports facilities and bear the main responsibility for the construction and maintenance of sports facilities.

However, the municipalities often lack the money for the necessary renovations. The fact that the federal government and the federal states support remediation work with subsidies has a positive effect. For example, the federal government funded the renovation of sports facilities with 71 million euros as part of the Golden Plan East. The Economic Stimulus Package II (2009/2010) also made approx. 1.7 billion euros available to municipalities for the modernisation and renovation of sports facilities (Federal Ministry of Economics and Technology, 2012).

However, the need for refurbishment is usually so high that subsidies only cover a small proportion of the costs. In 2005, on the basis of the sports facility statistics of the federal states, Jägemann determined a renovation requirement for all core sports facilities amounting to around 42 billion euros (Jägemann, 2005). In 2008, the German Institute of Urban Affairs (Deutsche Institut für Urbanistik – Difu) also estimated that municipalities would need investments of up 35.3 billion euros in the sports sector until 2020 (Reichenbach et al., 2008).

For many municipalities, however, the construction costs of sports facilities are nowhere near as burdensome as the operating costs. For example, the study on the current economic significance of sports facility construction in Germany, published by the Federal Ministry of Economics and Technology in 2012, shows that operating and maintenance costs, at 9.7 billion euros, accounted for the largest share (approx. 43 percent) of the total volume of sports facility construction in 2008.

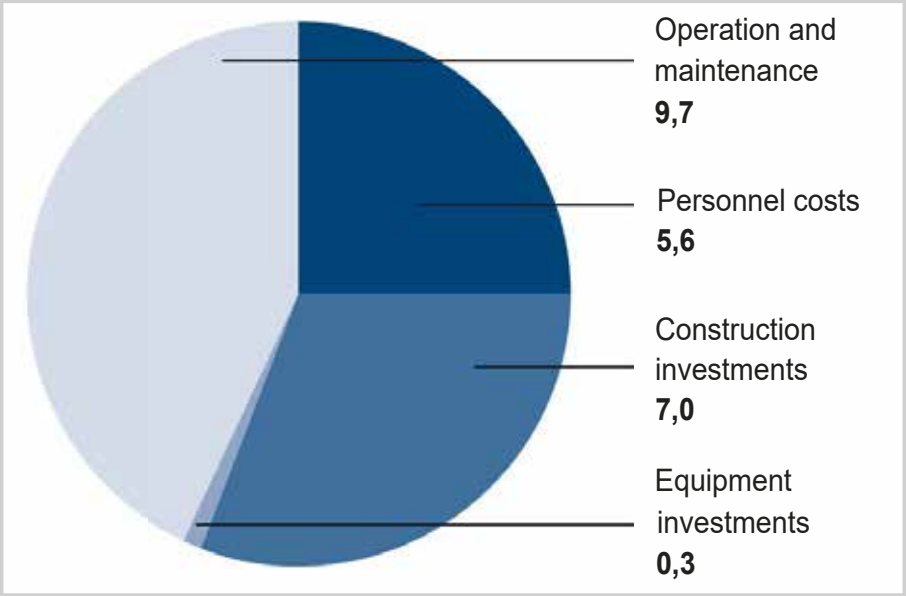

Fig. 2.2: Economic significance of sports facilities for 2008 in billion Euro (Federal Ministry of Economics and Technology, 2012)

If we look at the total expenditure on sports facilities by category, core facilities in particular, such as sports halls and swimming pools, account for by far the largest share of all expenditures, at 13.3 billion euros. Here, sports halls (single, double, triple halls, including gymnasiums and ancillary rooms) are the most cost-intensive sports facilities with 5,176 million euros, followed by swimming pools and sports fields (Federal Ministry of Economics and Technology, 2012).

Future development of sports facility construction

What does the future development of sports facility construction and especially of sports halls look like? On the one hand, there is an enormous need to renovate existing sports facilities, and on the other hand, facilities built according to reference values are facing demand profiles that have changed since the 1970s. For this reason, the Conference of Sports Ministers of the Federal States held in 1999 decided that the population-based reference values of the Golden Plan were no longer suitable as parameters for determining the demand for sports facilities and instead recommended the application of the “Guidelines for Sports Development Planning" of the Federal Institute of Sport Science (BISp)

(Sportministerkonferenz, 2013). In order to ensure sustainable sports facility concepts in the future, all planning must therefore be preceded by sports facility development planning (Ott, 2012; 2014). The new version of DIN 18032-01 "Sports halls – Halls and rooms for sports and multi-purpose use – Part 1: Principles for planning" from 2014 in the area of covered facilities extended possibilities for the conception of a sustainable sports facility mix (DIN 18032-01: 2014).

The guideline builds on the ten theses for the further development of sports facilities ("Zehn Thesen zur Weiterentwicklung von Sportanlagen") defined by the project advisory board of the research project "Grundlagen zur Weiterentwicklung von Sportanlagen" ("Fundamentals for the Further Development of Sports Facilities") of the Federal Institute of Sport Science (BISp) on the basis of the research results (Wetterich et al., 2009). These describe in brief the basic positions and scenarios for further sports facility development (Project Advisory Board of the research project "Grundlagen zur Weiterentwicklung von Sportanlagen" ("Fundamentals for the development of sports facilities"), 2009).

Ten Theses on the Further Development of Sports Facilities
▪ **Thesis 1:** The range of sports facilities will change, while the number of facilities will remain largely unchanged.
▪ **Thesis 2:** Rule-compliant sports facilities remain important – but will be supplemented by more open-rule facilities.
▪ **Thesis 3:** Sports facilities are necessary, ranging from simple to sophisticated construction with sports-functional equipment, as well as varying degrees of quality of stay for sport participants, such as children, people with disabilities or elderly people.
▪ **Thesis 4:** Access restrictions will continue to exist – nevertheless, sports enthusiasts and active sport participants are expected to open up access to sports facilities.
▪ **Thesis 5**: The need for decentralised sports facilities close to residential areas in the neighbourhood/urban district is increasing. In cities and regions with a sharp decline in population, it cannot be ruled out that large sports facilities can only be maintained at decentralised locations.
▪ **Thesis 6:** Cost-effective solutions and life cycle considerations will play an increasing role in sports facility construction.
▪ **Thesis 7:** The importance of ecological aspects in the planning, construction and operation of sports facilities will increase, especially with the aim of reducing resource consumption and operating costs.
▪ **Thesis 8:** New planning procedures and methods must be increasingly put to use.
▪ **Thesis 9:** New forms of cooperation and partnership will emerge for sports facilities.
▪ **Thesis 10:** The further development of sports facilities requires a wider variety of designs and types of sports facilities as well as greater structural adaptability.

Tab. 2.4: "Ten theses for the development of sports facilities" (Project advisory board of the research project "Grundlagen zur Weiterentwicklung von Sportanlagen" ("Fundamentals for the development of sports facilities"), 2009)

2.2 Sustainable development of sports architecture

Since time immemorial, nature and humans have had the most diverse relationships and interactions. However, implementing environmental protection while promoting social progress and economic growth is only a product of the 20th century and is based on the guiding principle of sustainable development (Essig, 2010). Sport cannot be considered in isolation. Be it physical activity as a leisure-time pursuit or as competitive sport – sport is one of the most important elements of our society and unites millions of men, women and children worldwide in clubs, associations and private networks.

Like any action, sport has positive and negative effects on the surrounding environment. Sport and sustainable development are therefore closely linked and need to be increasingly considered together. Consequently, the implementation of sustainability is not only the task of business and politics. Organised sport in particular, with its 98 sports associations and more than 91,000 sports clubs under the umbrella of the German Olympic Sports Confederation (Deutschen Olympischen Sportbundes – DOSB), plays an important role in anchoring the issue of sustainability in our society (German Olympic Sports Confederation, 2011).

Even if the link between sport and sustainability is not always obvious at first glance, there are numerous and diverse links. The area in which sport is practised has an important role to play here, in social, economic and environmental terms.

Fig. 2.3: The three dimensions of sustainability

The following chapters are therefore dedicated to construction measures for sports halls and include the entire life cycle of sports facilities. Ecological, economic and social aspects are considered over all life cycle phases of a sports hall, starting with the planning, (re)construction, operation and subsequent use up to demolition.

Today's concept of sustainability was coined to a large extent by the World Commission on Environment and Development (WCED), the so-called Brundtland Commission. The 1987 Brundtland report “Our Common Future” describes development as sustainable if it ensures that the needs of the present generation are met without compromising the ability of future generations to meet their own needs. Nevertheless, the idea of sustainable development is not a phenomenon of our society today, but can be traced back to 18th century forestry. The various actors approach the concept of ‘sustainable development’ with different strategies, instruments, contents and definitions (Ebert, et al., 2010).

Sustainable development cannot however be achieved by implementing a single strategy alone, but must combine multiple approaches and mutual interaction. This is because only a significantly reduced consumption of energy or materials as a result of efficiency and sufficiency measures is the prerequisite for meeting the remaining demand through the use of renewable energy and material sources (consistency) (Hegger et al., 2008).

Consequently, sports facilities must be planned and operated

- better (efficiently)
- differently (consistently)
- and with less resources (self-sufficiently).

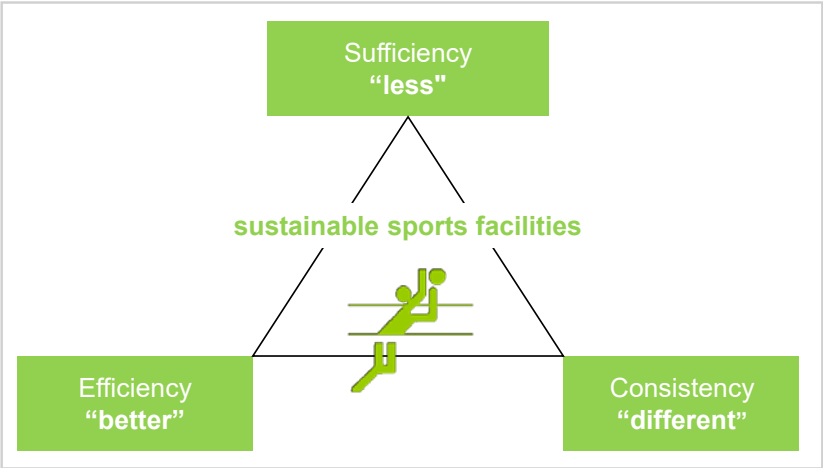

Fig. 2.4: Definition for sustainable sports facilities

In order to safeguard the quality of life of future generations, the sustainable and efficient use of the planet's resources must therefore be ensured. This requirement is also the overriding objective in the construction of sports facilities. If you look at the impact of the construction industry on the environment, its influence is enormous. The European construction sector consumes about 50 percent of the natural resources, 40 percent of the energy and 16 percent of the water. In addition, the construction industry generates around 60 percent of all waste. In addition, around 40 per cent of global greenhouse gas emissions results from building production and use (Ebert et al., 2010).

Fig. 2.5: Impact of the European construction sector (Ebert et al., 2010)

In times of climate change, carbon footprint savings and extensive soil sealing, the sustainability debate is playing an increasingly important role in architecture and urban planning as well as in sports facility construction. To this end, numerous environmental initiatives and strategies have been developed since the 1960s. Since the end of the 1980s, the implementation of ecological principles and energy-efficient concepts as well as the use of renewable energies have increasingly become the standard. Numerous environmental laws and initiatives have been introduced in the construction sector – from energy saving to waste separation and water management. Milestones of these efforts in Germany have been, above all, the development of the heat insulation and energy saving regulations, the legal regulations for the use of renewable energies and the concepts for low-energy, passive and plus-energy houses. Even though sustainable construction today offers numerous economic advantages in terms of the value development of buildings, everyday practice still lags far behind the opportunities that are available.

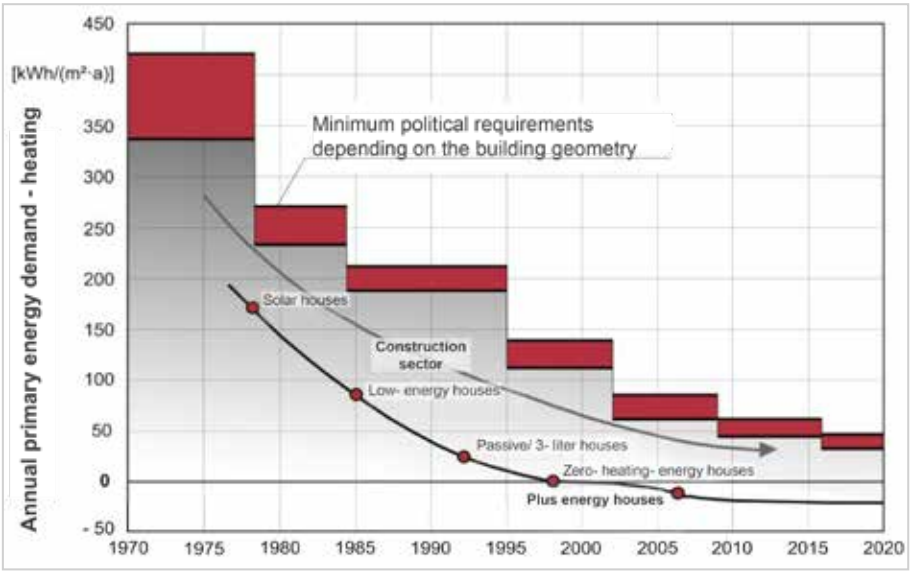

Fig. 2.6: Energy efficiency in the construction sector: Development of energy-efficient construction in Germany using the example of residential buildings (Hauser, 2013)

2.3 Instruments and methods for planning sustainable sports facilities

In recent decades, German sports associations in particular have contributed to the implementation of sustainable sports venues, developing numerous information platforms and guidelines. Alongside environmental communication services, such as

- the DOSB information service “Sport schützt Umwelt” (“Sport protects the environment”)
- the DOSB internet portal “www.klimaschutz-im-sport.de”
- and sports associations information brochures
- the “Öko-Check” (Eco Check)

plays an important pioneering role (German Olympic Sports Confederation, 2011).

Information for sustainable sports facility construction
Federal Institute of Sport Science ▪ Link: www.bisp.de
DOSB information service "Sport schützt Umwelt" ("Sport protects the environment") ▪ Link: www.dosb.de/de/sportentwicklung/sportstaetten-umwelt-und-klimaschutz/service/informations-dienst/
DOSB Internet portal ▪ Link: www.klimaschutz-im-sport.de
Eco check ▪ Information on the websites of the national sports associations
Information brochures of the sports associations ▪ Information on the websites of the national sports associations
Other ▪ Chambers of Architects of the federal states ▪ Chambers of Engineers of the federal states ▪ Chamber of Crafts ▪ etc.

Tab. 2.5: Information for sustainable sports facility construction

For many years, various state sports federations, such as the State Sports Federation of Hesse, the Bavarian State Sports Association and the State Sports Federation of Rhineland-Palatinate, have been offering the Öko-Check consulting service for sports facilities, which analyses of sports buildings and facilities with a view to energy and drinking water savings and gives recommendations for action linked to funding opportunities (German Olympic Sports Confederation, 2011).

In addition to sports-specific guidelines and information services, numerous general instruments from the construction and real estate sector are available for the implementation of sustainable sports venues. These have established themselves as planning instruments for sustainable construction over the past decades.

A summary is given below (Essig, 2010):

- **Environmental labels:** Labels for construction products and auxiliary materials, e.g. Environmental Product Declarations (EPDs)
- **Element or component catalogues:** Evaluation of building components and elements (environmental parameters, building physics parameters, etc.), e.g. control details of software programs for energy performance certificates or component catalogues
- **Tendering aids:** Ecologically-oriented service descriptions
- **Energy certification:** Description and evaluation of the energy efficiency of buildings
- **Checklists and guidelines:** Formulation of goals, principles and guiding principles for energy-efficient, ecological planning and construction
- **General building authority approvals:** Environmental, health, fire protection, hygiene, stability

- **Holistic planning and evaluation tools:** Interactive tools for decision making such as life cycle assessment or life cycle costs, e.g. LEGEP or GaBi
- **Building labels, evaluations or certificates:** Building evaluation with regard to ecological, economic and social aspects

Information on planning instruments for sustainable sports facilities

Checklists and guidelines

- Information portal on sustainable construction of the BMUB and
- Guideline "Sustainable Building" of the BMUB
  Link: www.nachhaltigesbauen.de

Building labels, evaluations and certificates

- Assessment System for Sustainable Building (BNB) of the BMUB
  Link: www.nachhaltigesbauen.de
- Sustainable Small Residential Building Rating System (BNK) of the BMUB
  Link: www.bau-irn.de
- DGNB Certificate of the German Sustainable Building Council (DGNB)
  Link: www.dgnb.de
- BREEAM DE certificate from the German Private Institute for Sustainable Real Estate (DIFNI)
  Link: www.difni.de
- LEED of the United States Green Building Council (USGBC)
  Link: www.usgbc.org
- OPEN HOUSE: European criteria catalogue for building sustainability (EU research project)
  Link: www.openhouse-fp7.eu/
- iiSBE: International Initiative for a Sustainable Built Environment
  Link: www.iisbe.org

Product and service descriptions

- Institute for Building and the Environment (IBU): Environmental Product Declarations
  Link: www.bau-umwelt.de
- Ökobau.dat: Building material and building database
  Link: www.nachhaltigesbauen.de
- DGNB Navigator: Database with product information
  Link: www.dgnb-navigator.de
- WECOBIS: Ecological building material information system
  Link: www.wecobis.de
- Baubook: Ecological building products
  Link: www.baubook.info

Tab. 2.6: Information on planning instruments for sustainable sports facilities

Internationally, a wide range of instruments for the sustainability assessment of building structures and products have been developed, which are specifically tailored to the needs of the respective nations as regards their climatic, cultural and legislative starting conditions.

Germany developed its own national seal of quality five years ago, and the certification processes seem to be increasingly integrated into day-to-day planning processes. Here, the German Sustainable Building Council (DGNB) is primarily responsible for the private construction industry and the internationalisation of the system, while the BMUB is responsible for all buildings of considerable public interest, i.e. all federal buildings. While the DGNB promotes the awarding of the DGNB certificate, the further development of the certification system and system variants, the training and further education of auditors, as well as the certification body and quality assurance mechanisms at national and international level, the BMUB regulations stipulate that from 2012 all federal construction measures must achieve at least the "BNB Silver" standard.

2.4 Criteria for sustainable sports halls

At the beginning of the 21st century, sports facility planning faces a variety of challenges. Issues such as changing sports behaviour, demographic change, developments in school policy, needs-based, multifunctional and conversion possibilities, but also aspects such as ecological and energy-efficient construction methods, the use of renewable energy sources and environmentally friendly and health-compatible building materials are increasingly demanding on sport and its players, but also open up new design possibilities.

When planning and assessing the sustainable building quality of sports halls, it is therefore important to consider ecological, economic and social factors equally. The technical characteristics, process quality and location of the building are also assessed. For the typology of sports space planning and sports facility construction, it is important to also integrate the quality 'sports function'.

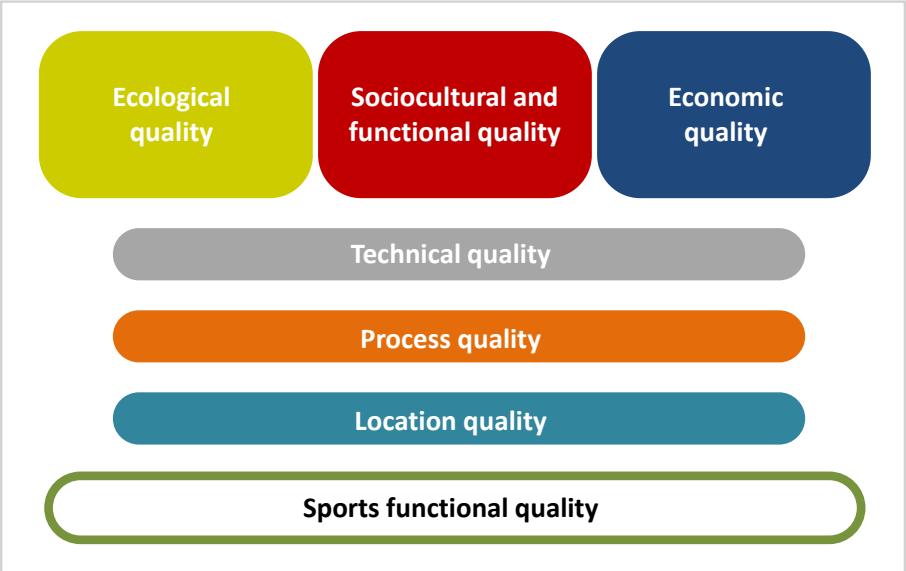

Fig. 2.7: Aspects of sustainable sports hall construction

The entire life cycle of sports facilities also plays an important role, starting with

- development planning
- on to design
- on to construction
- on to operation (including renewal and repair)
- up to demolition (end-of-life) (Essig, 2010).

Fig. 2.8: Life cycle of a sports hall (Essig, 2010)

The criteria structure of BMUB's Assessment System for Sustainable Building (BNB) was used (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2013) in the context of the research project Guidelines for Sustainable Sports Facility Construction. The existing catalogue of criteria for new office and administrative buildings was analysed with regard to the building typology "new sports hall building" and new criteria for sports hall construction were added as required.

The catalogue is provided as a checklist (see Appendix 1).

In summary, sustainable sports hall construction can be described with the following indicators:

- **Ecological quality:** Environmental impact, life cycle assessment (LCA), energy (renewable, non-renewable), materials, water, land, waste, recycling, etc.
- **Economic quality:** Economic efficiency, life cycle costs (LCC), third-party use, etc.
- **Sociocultural and functional quality**: Comfort (thermal, acoustic, visual), health, indoor air quality, users, accessibility, space efficiency, conversion capacity, safety, accessibility, user influence, cycling comfort, architecture and design, regional and cultural criteria, innovation, etc.
- **Technical properties:** Fire protection, durability, ease of cleaning, weather and environmental resistance, technical building equipment, building envelope, dismantling etc.
- **Process quality:** Planning process, preliminary planning, integral planning, tendering, construction site procedures, commissioning, operation, etc.
- **Location quality:** Micro-site, transport links, neighbourhood, building regulations, possibilities for expansion, land consumption, biodiversity, user-specific facilities, etc.
- **Sports functional quality:** Implementation of sports facility development planning, competition and training areas, multi-purpose facilities, infrastructure, development, media facilities, users (athletes, spectators) etc.

Whether as an assessment system, as a guideline or as recommendations for action, the criteria presented can be used in a variety of ways by the parties involved in the construction process, whether for competitions, for planning, operation or the end-of-life phase of a sustainable sports hall. The diverse use of these systems has led to the development of new process sequences, planning techniques and documentation requirements for the construction industry. As a result, in recent years the industry has seen the establishment of new professional groups such as auditors or environmental and sustainability consultants, who, alongside building owners, planners and project managers, can anchor these new processes in today's planning processes and also apply them to the planning and refurbishment of sports facilities (Preuss et al., 2011).

While labels and certification systems for office and residential buildings has increased enormously in recent years, the evaluation of the sustainability quality of sports facilities has not yet been able to gain a foothold. Sustainability assessments are increasingly seen as an important tool only when major events such as the Olympic Games are being held. For example, a separate evaluation ("BREEAM for Olympic Park and Venues") was developed for the London 2012 Olympic Games, based on the IOC (International Olympic Committee) requirement to carry out a sustainability assessment for all Olympic buildings during the bidding process and to implement the major buildings according to specified planning objectives. The international soccer association FIFA is also calling for the implementation of environmental standards for all stadium buildings, based on the American LEED rating label. These requirements are based on the fact that the use of sustainability assessment methods brings considerable added value to sports venues. Based on the results of the 2010 study by Essig, the following advantages of a sustainability assessment of sports halls can be cited (Essig, 2010):

- Promotion of the implementation of sustainable sports facilities by setting mandatory planning targets already in the project development phase
- Increased competitiveness and significant added value of the sports facility throughout its life cycle
- Ensuring the comparability of the building quality of sports facilities with regard to ecological, economic and social aspects
- Improving the transparency of the planning process by describing the sustainability quality of sports facilities and providing information for the operators and users of sports facilities
- Ensuring the implementation of the sustainable building quality of sports facilities and their operation through an integrated planning process (planning phase) and targeted monitoring (operation)
- Promotion of national sports facility construction quality standards by accelerating the market introduction of new energy-efficient technologies and ecological materials
- Reduction of emissions (greenhouse gases etc.), improvement of the functional and technical building quality, energy efficiency, resource savings (water, materials etc.), user comfort and the public image of sports facilities over their entire life cycle
- Improvement of comfort and user convenience and thus improved starting conditions for sport participants
- Improved building documentation for sports halls

3 Sports-functional requirements

3.1 Sports development planning and sports facility development planning

Changes in population structure, sports behaviour, the education system or public budgets are just some of the challenges that affect today's sports development planning. Consequently, the way sports facilities are used and the requirements they must satisfy are also evolving (Wetterich et al., 2009). With a view to the increased importance and beneficial effects of sport on society, new scope for action in sports facility construction has also opened up (Ad hoc “Sport Development” Committee (“Sportentwicklung”) of the German Society of Sport Science, 2010).

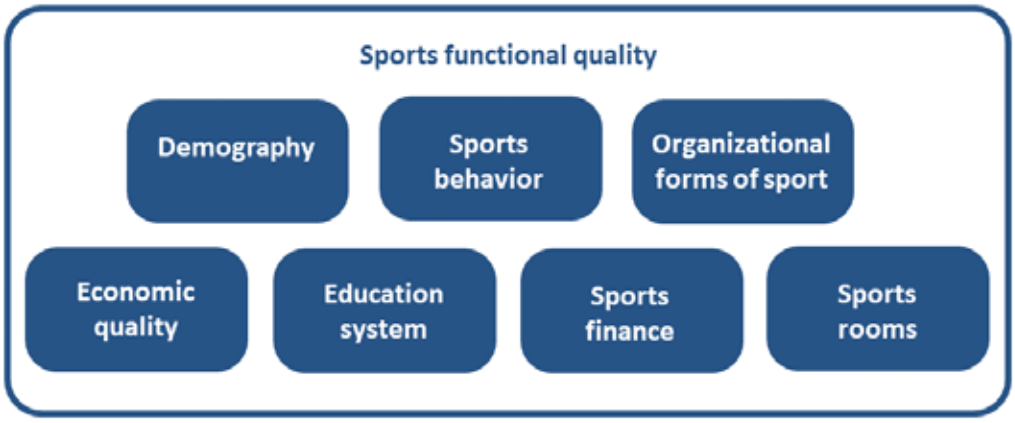

Fig. 3.1: Challenges for sport development planning

To meet these challenges, sport – and, consequently, sport spaces – face the need for action and innovation. The social and regional changes described above must already be integrated into the requirements planning for a sustainable sports hall. For this purpose, instruments such as

- sport development planning
- sports facility development planning

are available.

Both instruments, which can be used to gauge the current sport needs of a municipality or neighbourhood, cannot be considered in isolation, but must be integrated into the overall context of regional, urban and social considerations and planning. The upshot is that both sports development planning and sports facility development planning provide an important basis for the planning, construction and operation of sustainable sports halls.

In recent years, different concepts and approaches have evolved for sport development planning. To establish a uniform standard, the German Society of Sport Science (Deutsche Vereinigung für Sportwissenschaft – dvs) issued a memorandum on municipal sports development planning in 2010. This describes municipal sport development planning as a methodical, goal-oriented approach that defines the framework conditions for sport and physical activity in society and develops an overall concept from this (Ad-hoc "Sport Development" Committee of the German Society of Sport Science, 2010).

For sports facility development planning, the Federal Institute of Sport Science (BISp) presented a corresponding planning methodology in 1991 with the preliminary version of "Guidelines for Sports Facility Development Planning" ("Leitfadens zur Sportstättenentwicklungsplanung"). After the basic supply of sports facilities had been largely secured from the 1980s onwards (in the old federal states), questions about the forecast and quality of future facility requirements have come to the fore since the end of the 1980s. After a phase of practical testing, the guidelines were completed in 1999 (Federal Institute of Sport Science, 2000). In 2006, the BISp presented a further basic document on the topic with a commentary on these guidelines.

The concept has been applied, reviewed and alternative concepts have been developed by municipalities and sports science institutes as well as consulting institutions. The "Memorandum on Municipal Sports Development Planning" ("Memorandum zur kommunalen Sportentwicklungsplanung"), which was prepared by the German Society for Sport Science with the support of the German Olympic Sports Confederation and the German Association of Cities and Towns (Deutschen Städtetag) and published in 2010, summarises the development of this planning approach and its alternative variants and components (Ad-hoc "Sports Development" Committee ("Sportentwicklung") of the German Association for Sports Science, 2010).

In principle, sports facility development planning is a goal-oriented procedure to define the structural, infrastructural and spatial conditions for sport and physical exercise in an overarching concept. As a rule, the procedure includes empirical stocktaking (e.g. number and structure of sports facilities), determination of requirements and definition of goals and measures.

Definition of "sports facility development planning"
The task of sports facility development planning is to objectively and transparently present the spatial and constructional requirements for the development of sport in the municipality in a forward-looking and networked planning process. It is geared to a medium and longer-term planning period.
The goal of sports facility development planning is to determine current and forecast future facility requirements according to sports-related parameters that have been collected.

Tab. 3.1: Definition of "sports facility development planning" (Federal Institute of Sport Science, 2000; Metz, 2006; Köhl & Bach, 2006)

This planning approach allows the availability of sports facilities to be determined for a selected area, as well as the design of necessary further development and construction measures and preparation of appropriate policies. These processes give due consideration to regional sports projects and sports policy priorities. To be able to successfully continue the sports facility development planning afterwards, the guidelines recommend continuous checking and updating of the data collected (Köhl & Bach, 2006).

Information on sports and sports facility development planning
Federal Institute of Sport Science (BISp) ▪ Guidelines for sports facility development planning ▪ Commentary on the guide for sports facility development planning Link: www.bisp.de
German Association for Sports Science ▪ Memorandum on municipal sports development planning Link: www.sportwissenschaft.de
Hesse State Sports Association (lsbh) ▪ Zukunftsorientierte Sportstättenentwicklung [Future-oriented sports facility development.] Volume 16. Orientierungshilfe zur kommunalen Sportentwicklungsplanung [Orientation guide for municipal sport development planning] (Wopp, 2012)
Ministry for Family, Children, Youth, Culture and Sport of the State of North Rhine-Westphalia ▪ Programme for sports facility development planning Link: www.mfkjks.nrw.de
Ministry of Health and Social Affairs of Saxony-Anhalt ▪ Action guideline for sports facility development planning Link: www.ms.sachsen-anhalt.de
German Olympic Sports Confederation (DOSB) ▪ Materials and information on sport development planning and urban development Link: www.dosb.de/de/sportentwicklung/strategieentwicklung-grundsatzfragen
Further literature ▪ Essay “Kommunale Sportstättenentwicklungsplanung – Bilanz und Perspektiven” [“Municipal sports facility development planning - assessment and prospects”] (Hübner, 2011) ▪ Grundlagen zur Weiterentwicklung von Sportanlagen [Fundamentals for the further development of sports facilities] (Wetterich et al., 2009) ▪ “Die zukunftsfähige Sportstätte – Leitbild zur nachhaltigen Sportstättenentwicklung” [“The sustainable sports facility - model for sustainable sports facility development”] Link: www.quaspo.de

Tab. 3.2: Information on sports and sports facility development planning

3.2 Requirements for the planning of sports halls – Standards, directives, planning aids and guidelines

To be able to plan, build and operate sports halls in a functional way, the relevant standards, ordinances and technical regulations as well as the system-related requirements of competition rules and regulations must be observed. What’s more, numerous sports institutions and associations have published information brochures in recent years that deal with the planning and operation of sports facility construction. These deal with topics ranging from functionality, safety, accessible construction and energy efficiency, to lighting in sports facilities.

There is a comprehensive set of standards for sports halls, which is valid nationally and internationally. A distinction is made between national standards (DIN), European standards (EN) and international standards (ISO). Parallel to this, technical regulations such as DIN-VDE standards (Association of Electrical Engineers) or VDI guidelines(Association of German Engineers) must be observed. The most recent version applies.

The normative basis for the planning of sports halls is

› DIN 18032 “Sports halls – Halls and rooms for sports and multi-purpose use”.

In this context, the standard DIN 18032 – Part 1 plays a superordinate role as a “planning standard”. The planning principles listed in Table 3.3 must be observed here.

Design principles of sports halls according to DIN 18032-01
▪ Compliance with the requirements regarding number and size as well as type and equipment of the different user groups, school and club sports and sports for people with disabilities ▪ Consideration of the usage and safety needs of all user groups and, if necessary, the requirements as a place of assembly and work ▪ Design in the sense of sustainable development and thus consideration of economic, ecological, social, technical, process and location quality (according to the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2016) ▪ Inclusion of all phases of a building in the context of a life cycle analysis, from planning, construction, use, management to demolition, including disposal of materials ▪ Examination of the combination of several halls or rooms in buildings and the connection with other uses because of their multiple possibilities of use ▪ Orientation towards needs analyses in the sense of sports or sports facility development planning and with regard to sports needs Consideration of changes in sports behaviour, demographic changes, changed curricula in school and university sports, structural changes in club sports and general public welfare ▪ Participation of all relevant groups (users, associations) in the planning process

Tab. 3.3: Planning principles of sports halls according to DIN 18032-01 (DIN 18032-01: 2014-11)

DIN 18032-01 also covers the following topics:

- room programme for sports rooms and ancillary rooms,
- room allocation,
- lighting,
- heating,
- ventilation,
- sanitary installation,
- electrical engineering
- as well as sound insulation and room acoustics.

Parts 2 to 6 of DIN 18032 regulate the requirements for

- sports floors,
- testing the ball throwing safety,
- two-leaf dividing curtains,
- telescopic grandstands
- and structural measures for the installation and anchoring of sports equipment.

If a sports hall is also used by schools, the following standards must also be observed:

- DIN 58125 “School construction – Structural requirements for the prevention of accidents”,
- the safety rules and information sheets of the municipal accident insurance associations (GUV)
- and the GUV regulation “Construction of schools – Constructional requirements for accident prevention” (GUV-V S 1: 2001-05).

With the introduction of the German Energy Saving Ordinance (Energieeinsparverordnung – EnEV) in 2002, further requirements in the field of energy efficiency were introduced to sports hall planning, such as compliance with

- DIN V 18599 "Energy evaluation of buildings" (non-residential buildings).

In this context, the Renewable Energies Act (Erneuerbare-Energien-Gesetz – EEG) introduced in 2000 must also be taken into account:

- EEG: Act for the fundamental reform of the Renewable Energy Sources Act and on the amendment of further provisions of the Energy Industry Act (EEG: 2014-07-21).

The regulatory areas of standards and directives may overlap. However, standards and directives are not binding per se. Standards and directives only become compulsory if they are based on a statutory or legal obligation or a contractual agreement (German Institute for Standardization, 2015).

Sports halls with multi-purpose use must meet the extended requirements for places of assembly. Accordingly, the respective

- Ordinance on the Construction and Operation of Places of Public Assembly (Versammlungsstättenverordnung – VStättV)

must be considered with regard to the scope of a federal state. Due to the different provisions contained in the ordinances on places of assembly across the federal states, these guidelines refer to the Model Ordinance Governing Places of Assembly (MVStättV) (Musterversammlungsstättenverordnung, 2014). The MVStättV is a recommendation on the ordinance for "places of assembly" and was drawn up by the expert commission "Bauaufsicht" ("Construction Supervision") of the IS-ARGEBAU of the Conference of Construction Ministers in 2005 and amended by a resolution in February 2014 (IS-ARGEBAU, 2015). According to the MVSättV, a place of assembly is a building in which one room or several rooms, which are evacuated via a common escape route, can hold more than 200 visitors. Particularly in sports halls with multi-purpose use, increased requirements are made with regard to escape routes and fire protection.

Another important component is the

- state building regulations

of the respective federal state in which the sports hall is being built. Due to the different provisions contained in the building regulations of the federal states, these guidelines refer to the current Model Building Regulations (MBO) (Musterbauordnung, 2012).

According to the MBO, sports and leisure facilities are defined as publicly accessible buildings and must therefore be "accessible to disabled persons, elderly persons and persons with small children in the parts of the facilities serving the general visitor traffic and must beusable for the intended purpose without outside help." (Musterbauordnung, 2012). The requirements regarding fire protection must also be observed.

For the structural implementation of the requirements of competitive sports,

- the system-related stipulations of the competition regulations of the sports associations

must be considered.

Fig. 3.2: Technical regulations for sports halls with multi-purpose use

In addition, sports institutions and associations as well as the Federal Institute of Sport Science (BISp) have published numerous information brochures dealing with the planning and operation or sub-areas of sports facility construction. Further selected standards, technical regulations, planning aids and guidelines for sports halls are summarised in the respective chapters.

Information on standards and technical regulations for sports halls
Federal Institute of Sport Science (BISp) ▪ Guidance P1/08 Equipment for gymnasiums and games
Standards ▪ DIN 18032-01: Sports halls – Halls and rooms for sports and multi-purpose use - Part 1: Principles for planning ▪ DIN V 18032-02: Sports halls – Halls for gymnastics, games and multi-purpose use - Part 2: Sports floors; requirements, tests ▪ DIN 18032-03: Sports halls – Halls for gymnastics, games and multi-purpose use - Part 3: Testing of safety against ball throwing ▪ DIN 18032-04: Sports halls – Halls for gymnastics, games and multi-purpose use - Part 4: Two-leaf dividing curtains ▪ DIN 18032-05: Sports halls – Halls for gymnastics, games and multi-purpose use - Part 5: Telescopic grandstands ▪ DIN 18032-06: Sports halls – Halls and rooms for sports and multi-purpose use - Part 6: Structural measures for installing and anchoring sports equipment ▪ DIN EN 13200-01 to 06: Spectator facilities ▪ DIN EN 14904: Sports floors – Multi-purpose sports hall floors – Requirements

Tab. 3.4: Information on standards and technical regulations for sports halls

4 Sports halls – Sustainable planning process

Sustainable building is not an invention of our time. Issues of energy efficiency and economy, social aspects and site-specific factors have been incorporated into the planning process of buildings for decades. But the demands on building are becoming more and more extensive. This also applies to sports hall construction. The increased degree of complexity, as well as specialisation in all areas of construction, is replacing the traditional planning team and requires the early involvement of experts from various disciplines (König et al., 2009).

As a result, the individual specialist planners increasingly work independently of each other and consequently have different planning objectives for the same construction project. Due to the lack of coordination, this can often translate into additional work and thus higher construction costs. In recent years, sustainability has become an additional factor, which is usually perceived as an increased workload. However, 'sustainable building' is not a supplementary aspect, but rather organises and connects the individual disciplines and specialist planners together in an overarching framework.

The cooperation and involvement of competent partners and specialists is required from the start of the project to implement aspects such as comfort, energy efficiency, environmental friendliness and smooth operation in sports halls. Additional and increased requirements in terms of technology, safety, material efficiency and accessibility pose new challenges, while reliable cost plans for construction and operation must be maintained. In addition to the planning of a sports hall, the process must therefore be planned and controlled from the outset and the entire life cycle – from planning, construction and use to the end-of-life phase – must be taken into account in the first steps of project development. Only in the planning phase can an effective influence be exerted on the sustainability and overall economic efficiency, i.e. on the costs of construction, operation and maintenance (Ebert et al., 2010).

Sustainable planning process of a sports hall
Parties involved ▪ Client/operator (municipality, city, association etc.) ▪ Users and affected parties (clubs, sport participants and spectators) ▪ Architects/planners ▪ Energy consultants ▪ Sustainability consultants ▪ Auditors/certifiers ▪ Specialist engineers (building services, lighting design, structural engineering, building physics, fire protection etc.) ▪ Construction companies and contractors ▪ Facility manager/ caretaker ▪ Politicians ▪ Urban and regional planners ▪ Landscape architects and ecologists ▪ Financing institutions and banks
Involving stakeholders in the planning process through ▪ working groups ▪ information and discussion events, citizens' meetings ▪ publications, articles, posters ▪ surveys ▪ advisory activities by representatives ▪ co-determination through planning groups (feedback)

Tab. 4.1: Sustainable planning process for a sports hall (Ebert, Essig & Hauser, 2010)

4.1 Project preparation

The early phases of the design process have a particularly strong impact on the design, costs, entire life cycle and sustainability of sports halls.

The project preparation involves a basic evaluation and provides a basis for decisions in the planning process of a sports hall. The aim of sustainable sports hall planning is to optimise the planning results through early demand planning and a corresponding target agreement. Comparison of variants, site selection and the choice of a suitable, interdisciplinary planning team play just as important a role as the involvement of users and the public, initial cost estimates and the sustainable documentation of the planning documents.

Sustainable sports hall construction therefore begins with project development, as the course for the future sustainable quality of a building is set in the early planning phases and this is where the greatest potential for optimisation lies. In this phase, the project team has the greatest scope for action and influence for the implementation of a sustainable sports hall. This is because only at the beginning of the planning process can an effective influence be exerted on the overall economic efficiency, i.e. on the costs for the construction, operation and maintenance of the sports hall.

Information on demand planning and target agreement, integral planning and user and public participation
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 5.1.1 Project Preparation Profile 5.1.2 Integrated Design ▪ Sustainable Building Guidelines ▪ RBBau guidelines for the execution of federal construction tasks Link: www.nachhaltigesbauen.de
German Institute for Standardization ▪ DIN 18205: Planning to requirements
Laws/Regulations ▪ Regulations on Contract Awards for Services of Freelancers (Vergabeordnung für freiberufliche Leistungen, VOF)
Work phases according to the Official Fee Scale for Services by Architects and Engineers (HOAI) ▪ Link: www.hoai.de
Project stages according to the German Association of Construction Project Managers (Deutschen Verband der Projektmanager in der Bau- und Immobilienwirtschaft e. V.) and AHO (Committee of the Associations and Chambers of Engineers and Architects for Fee Regulations) ▪ Link: www.dvpev.de and www.aho.de
Further literature ▪ Nachhaltigkeitsrelevante Prozesse in der Projektsteuerung [Sustainability relevant processes in project management] (Deutscher Verband der Projektmanager in der Bau und Immobilienwirtschaft e. V., 2011)

Tab. 4.2: Information on demand planning and target agreement, integral planning as well as user and public participation

The location of a sports hall plays an important role in the project preparation. A sustainable site is defined by the following characteristics:

› Sports development and sports facility development planning:
The choice of location of a sports facility should basically be based on the results of the development planning for sports and sport facilities and be incorporated into the urban master plan (Wetterich, Eckl, & Schabert, Grundlagen zur Weiterentwicklung von Sportanlagen, 2009).

- Transport connections at the location:
  Good transport connections of a sports hall include, in addition to a high-frequency public transport services within walking distance, connection to a well-developed network of footpaths and cycle paths as well as quickly accessible parking spaces (Federal Ministry for Environment, Nature Conservation, Construction and Nuclear Safety, 2011).
- Ecology of the site:
  In general, redensification, the use of brownfield sites and the renaturation of contaminated land ("brown-field redevelopment") are preferable to new construction on greenfield sites. The biodiversity of the property must always be taken into account and care must be taken to ensure that no additional burdens are placed on neighbouring water and nature conservation areas.
- Burdens and risks at the site:
  The lower the impact and risks (outdoor air quality, outdoor noise levels, etc.) of a location on the sports hall, the less danger there is to the health of athletes and spectators (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2011).
- Characteristics of a neighbourhood and proximity to facilities relevant to its use:
  The location of a gymnasium must be planned according to its future environment. Aspects such as proximity to residential areas or educational institutions are just as important as the proximity to catering facilities, local supplies or parks (Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety, 2011).
- Possibilities for expansion:
  As early as the requirements evaluation phase, it must be checked which future uses are planned and how additional extensions to the sports facility can be implemented in the future, both in terms of design and technology.

Information for a sustainable choice of location for a sports hall
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 6.1.1 Risks at the Micro-Site Profile 6.1.2 Conditions at the Micro-Site Profile 6.1.3 Image and Character of Location and Quarter Profile 6.1.4 Public Transport Connections Profile 6.1.5 Vicinity to Use-Specific Services Profile 6.1.6 Supply Lines / Site Development Link: www.nachhaltigesbauen.de
Further literature ▪ Electromagnetic fields BGV B 11 Link: www.arbeitssicherheit.de ▪ Noise maps: Link: www.umweltbundesamt.de ▪ Information on radon exposure: Link: www.radon-info.de ▪ Germany radon map of the Bavarian State Office for the Environment Link: www.lfu.bayern.de/strahlung/radon_in_gebaeuden ▪ Risk assessment: Cedim Center for Disaster Management and Risk Reduction Technology Link : www.cedim.de ▪ ZÜRS Zoning systems for floods, backwater and heavy rain ▪ Interactive map of the Federal Environment Agency on air pollution in Germany Link: www.gis.uba.de

Tab. 4.3: Information for a sustainable choice of sports hall location

4.2 Planning

Planning a sustainable sports hall requires a holistic approach for the entire planning team. This is because ecological, economic, socio-cultural, functional, technical and site-specific planning aspects that take into account the entire life cycle of a hall must be considered when developing a sustainable sports facility concept.

During the planning phase, the quality of the building is determined on the basis of the specifications of the requirements planning, which must be bindingly implemented in the later implementation planning phase. The objectives set in the requirements planning must be reviewed, adjusted and elaborated in detail in the form of design, approval and implementation plans.

The popular acceptance of a sports hall depends strongly on its integration into the respective social environment. However, building culture and aesthetic factors are just as important as space efficiency and flexibility of use, public accessibility, sustainable outdoor design, energy-efficient technologies and sustainable production methods.

Information on planning competitions, percent for art, space efficiency and conversion capability as well as the design of outdoor facilities of sports halls
Federal Institute of Sport Science (BISp) ▪ Link: www.bisp.de
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 3.1.7 Outdoor Qualities Profile 3.2.2 Space Efficiency Profile 3.2.3 Conversion Capability Profile 3.2.4 Public Accessibility Profile 3.2.5 Cyclist Comfort Profile 3.3.1 Design and Urban Quality Profile 3.3.2 Percent for Art ▪ BNB New Construction of Classroom Buildings Profile 2.1.2 Prevention of Vandalism ▪ Percent for Art Guidelines ▪ Sustainable Building Guidelines ▪ Systematics for sustainability requirements in planning competitions, SNAP recommendations Link: www.nachhaltigesbauen.de ▪ Guidelines for Planning Competitions RPW 2013, version of 31 January 2013 Link: www.bmub.bund.de ▪ Building regulations of the federal states
Laws/Regulations ▪ Building regulations of the federal states
Miscellaneous ▪ UIA/UNESCO Guide for international architecture and urban planning competitions Link: www.uia-architectes.org

Tab. 4.4: Information on planning competitions, percent for art, space efficiency and conversion capability as well as the design of outdoor facilities of sports halls

4.3 Building process and construction

Sustainable construction aims to minimise the consumption of energy and resources in all phases of the life cycle of buildings. The construction work is particularly important in the context of sustainable sports hall construction, as this phase has a direct impact on the surroundings.

As early as the tendering and awarding phase, the foundations for high-quality and sustainable construction of sports halls can be laid. This is achieved by integrating sustainability aspects

- in the tender
- and in the selection of companies.

By including sustainability aspects in the tendering process, the ecological and social building quality of the sports hall can be increased, since the building process decisions are not made solely on economic grounds. The consideration of sustainability aspects in the selection of companies serves the goal of improving the quality of construction, promoting and maintaining jobs in the region and enforcing environmental and social standards in the construction process of the sports hall (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2013).

Fig. 4.1: Construction site of the sports hall "Am Sportpark, Zorneding" | Photo: Natalie Essig

When awarding contracts for public construction measures, such as the construction of a municipal sports hall, the German Construction Contract Procedures – Part A: General provisions for the award of construction contracts (VOB Part A) apply. Here, requirements for construction companies are defined, which must be proven by a prequalification procedure independent of the order and prior to submission of the offer by a company. If VOB Part A is not applicable, there should nevertheless be a prequalification, or an examination of the points required by the regulation for the bidder in order to ensure the quality of the executing companies and thus the sustainable execution of the sports hall.

In order to ensure the quality of construction site procedures and processes, the impacts of the construction of a sports hall must be minimised and at the same time the health of all those involved and residents must be protected, as there are direct impacts on the environment and the neighbourhood during this phase. The basis for a sustainable construction site process must already be defined in the tender and bidding documents and must be verified by quality measurements. In this context, the following construction site processes must be taken into account when building a sustainable sports hall:

- Low-waste construction site
- Low-noise construction site
- Low-dust construction site
- Environmental and soil protection on the construction site
- Quality assurance of the construction work.

Information on construction site procedures and the construction of sports halls
Federal Office for the Environment, FOEN, Switzerland
▪ For effective soil protection in building construction, tips and guidelines for planning
Federal Institute for Occupational Safety and Health
▪ Technical Rules for Hazardous Substances (TRGS)
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB Profile 5.2.1 Building Site / Building Process ▪ BNB Profile 5.2.2 Quality Assurance of the Building Construction Link: www.nachhaltigesbauen.de
German Institute for Structural Engineering (DIBt)
▪ Principles for assessing the impact of construction products on soil and groundwater
Laws/Regulations
▪ Building Site Ordinance (BaustellV): Ordinance on Safety and Health on Construction Sites (Verordnung über Sicherheit und Gesundheitsschutz auf Baustellen) ▪ Federal Soil Protection Act (BBodSchG): § 4 Appendix 2, Assessment of Contaminated Sites ▪ Ordinance on Hazardous Substances (GefStoffV): Ordinance on Protection against Hazardous Substances ▪ Equipment and Machinery Noise Protection Ordinance (32.BImSchV): 32. Federal Emission Control Act ▪ Recycling Management Act (KrWG): Act to Promote Recycling and Ensure the Environmentally Compatible Management of Waste ▪ Federal State Waste Acts (Landesabfallgesetze) ▪ Outdoor Directive 2000/14/EC: Directive on noise emissions into the environment by outdoor equipment ▪ Municipal statutes
Further literature
▪ Recycling resources Link: www.arbeitshilfen-recycling.de ▪ Guidelines for the development of an operational waste management concept (Construction Department of the Canton of Zurich, 2003)

Tab. 4.5: Information on construction site procedures and the construction of sports halls

4.4 Project completion

The systematic commissioning with the functional testing and adjustment of the building services systems by the executing company and an independent third-party specialist planner represents an important component of the sustainability quality of a sports hall in the context of the project completion phase (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2013). In addition to the adjustment and testing of all functions of the technical building equipment of the sports hall, it is necessary for the sustainable operation of a sports hall to hand over a detailed documentation of the planning, construction and commissioning documents to the owner and operator upon completion of the project. Data and documents collected in the course of building certification represent, as a building manual, sustainable documentation of the planning documents for sports halls.

Sustainable documentation of sports halls (building handbook)
General principles ▪ Building description, current planning documents (details, construction, structural analysis, etc.), information on the building owner, specialist planners and users, area and cubage calculations, etc.
Ecological aspects ▪ Material certificates and quantity data (safety data sheets, product declarations and data sheets, manufacturer's data), drinking water and wastewater concepts, waste concepts, analyses of deconstruction and recycling concepts, calculations of land consumption and efficiency, etc.
Economic efficiency ▪ Information and statements on construction and operating costs, proof of usability, etc.
Social factors ▪ Information on accessibility, safety certificates, design concepts, documentation on comfort and health, proof of thermal comfort, lighting simulations and calculations, verification of indoor air quality, acoustic and sound insulation certificates etc.
Energy and technology ▪ Energy concepts and simulations, use of renewable energies, building physics certificates, fire protection certificates, description of technical building equipment etc.
Process ▪ Information on the planning process, integral planning team, evidence of the integration of sustainability-relevant aspects in the tender, description of the construction site procedures, documentation of the commissioning, building manual etc.
Location ▪ Documentation of transport connections, description of site-specific factors, proof of revitalisation of existing areas (“brownfield redevelopment”), information on improving the biodiversity of the site, etc.
Sport functional topics ▪ Sports development plan, sports facility development plan, occupancy plan and times of use, sports equipment plan etc.

Tab. 4.6: Sustainable documentation of sports halls (building handbook)

5 Sports halls – Sports rooms for everyone

Nowadays, sports rooms are used by different groups of people, each with different requirements for the premises and their surroundings. The reasons for this are very diverse. The most important factors are the age, gender, physical conditions or ethnic roots of the sport participants. Forecasts based on sport development research and demographic change show that the share of

- senior sport participants,
- sport participants with a migration background
- and sportswomen

in sports facilities will increase in the future.

Given the social importance of sport, the needs of minorities, such as

- people with physical or mental impairments,
- girls and women with a migration background,
- or children (in poverty, overweight or with motor development deficits)

will have to be paid greater attention in the future, regardless of whether the sport is carried out for rehabilitation purposes, as a leisure activity or as a competitive sport. After all, the opportunity to participate in sports can be an important part of life for those involved.

In the spirit of inclusion, all people should be given equal participation in public life and, with regard to sport, access to sports halls. For this purpose, structural requirements must be met that take into account the needs of all parties involved. This applies to sport participants, as well as to those accompanying them, trainers and spectators. Consequently, sports facilities must be designed in such a way that all people, regardless of gender, age, social background or physical and mental impairments, can participate in sporting life without difficulty. In addition, sports activities can promote encounters between different groups and increase the acceptance of minorities through shared experiences. The aim of sustainable sports hall construction is therefore to minimise fear of thresholds, barriers and obstacles, and to create structural conditions to offer as many people as possible an attractive space for movement (German Olympic Sports Confederation, 2015). To this end, the DOSB, together with the National Paralympic Committee Germany, the Deutscher Gehörlosen Sportverband (German umbrella organization for sport of deaf and people with hearing impairments, DGS) and Special Olympics Deutschland, has published the information paper “Bewegung leben – Inklusion leben” (“Living Movement – Living Inclusion”) and developed the position paper “Inklusion leben – gemeinsam und gleichberechtigt Sport treiben” (“Living Inclusion – Doing Sport Together and Equally”) (German Olympic Sports Confederation, 2015). The approaches described there should further promote the implementation of inclusion in organised sport and provide orientation for sports federations. The aim of the DOSB's strategic concept and situation analysis published in 2015 is to create more opportunities for encounters and sports choices in the future with the aim of promoting an equal, equitable and also joint participation in sport by people with and without disabilities (Gieß-Stüber et al., 2015).

Fig. 5.1: The influence of demographic change on sports halls © LSB NRW | Photo: Andrea Bowinkelmann

5.1 Accessibility

Accessibility of sports facilities describes the ease with which they can be found, accessed and used by all people without the need for help from third parties (Federal Office for Building and Regional Planning, 2005). By implementing the planning principles listed below, persons with physical or mental disabilities should be able to use sports facilities. These include visitors and sport participants

- with visual impairment, blindness or hearing loss,
- with motor impairments,
- who use mobility aids and wheelchairs
- or with mental impairments.

A barrier-free design of the sports venues is also beneficial for other groups of people, such as

- athletes with mild cognitive impairment,
- seniors and senior citizens,
- children
- or visitors with strollers.

The right of people with disabilities to equal participation in social life is laid down by law in the UN Convention on the Rights of Persons with Disabilities and the German Act on Equal Opportunities for Persons with Disabilities (Gesetz zur Gleichstellung behinderter Menschen) (UN Disability Rights Convention: 2006; Disability Discrimination Act: 2002).

"Sports facilities for all" should therefore be planned and operated in a sustainable manner. The building regulations of the federal states set down provisions for the accessibility of publicly accessible facilities, such as sports and leisure facilities. Article 50 of the German Model Building Regulations (Musterbauordnung) states in this respect: "Buildings which are accessible to the public must be accessible in the parts serving general visitor and user traffic". (Musterbauordnung, 2012). The framework conditions for barrier-free construction are laid down in DIN 18040-01 "Barrier-free building – Planning principles – Part 1: Publicly accessible buildings" (DIN 18040-01: 2010-10). This describes requirements for the following topics:

- infrastructure
- internal building development
- warning/orientation/information/learning
- rooms.

Moreover, athletes with disabilities, especially in competitive sports, have additional needs that must be met by the sports premises. These range from increased space requirements for wider sports wheelchairs to rooms for changing prostheses. The DIN 18032-01 "Sports halls – Halls and rooms for sports and multi-purpose use – Part 1: Principles for planning" summarises the basic requirements for barrier-free construction for sports halls and sports rooms based on the described regulations and standards (DIN 18032-01: 2014). Further detailed information can be found in the Federal Institute of Sport Science's (BISp) guideline "Bauliche Voraussetzungen für den paralympischen Sport" (Building Requirements for Paralympic Sports) (Federal Institute of Sport Science, 2010). In order to be able to create optimal premises for sport participants with disabilities, it is essential to ascertain their needs at the very beginning of the planning process and to involve appropriate organisations such as disabled associations and sports clubs.

The rules of construction engineering, standards, building regulations, recommendations and guidelines of the federal states as well as numerous guidance documents must be applied for the removal and avoidance of structural and technical barriers in sports activities. Leisure and sports facilities for people with disabilities are basically the same as for other population groups and should be shared. The needs of users with disabilities must be taken into account at an early stage in the planning of a sports hall by means of demand planning (Meyer-Buck, 2008). This includes good accessibility to the sports facility, as well as a space allocation programme that is coordinated with the planned use. Depending on the needs assessment, sports halls do not have to be completely barrier-free right from the start. In principle, the basic requirements of the aforementioned guidelines and standards apply, but the possibility of simple retrofitting should always be considered, especially for changing rooms or sanitary facilities.

5.2 Social inclusion

In addition to the inclusion of people with disabilities, the integration of people with a migration background in sport plays an important role. About one fifth of the population in Germany has a migration background (Federal Statistical Office, 2015). So far, however, girls, women and older people with a history of migration are underrepresented in sport. In this context, the Federal Office for Migration and Refugees and the German Olympic Sports Confederation launched the "Integration through Sport" programme in 1989 on the initiative of the Federal Government. The aim is to win over people with a migration background to sport. The Federal Ministry of the Interior (BMI) and the Federal Office for Migration and Refugees (BAMF) are available to support the programme as funding agencies and partners (German Olympic Sports Confederation, 2014a).

By specifically addressing people with a migration background, new opportunities are opened up for sports, as this population group is able to contribute special perspectives, experiences, traditions, skills and ideas – and also new sports. The joint participation in sport offers an important field of action for the integration of people with a migration background into German society. However, this integration process in and through sport must be actively shaped by policymakers (German Olympic Sports Confederation, 2014b).

The “mandate” includes creating an appropriate and inclusive building environment. For the inclusion of people with a migration background, the challenge lies mainly in cultural and religious differences, which in turn require special building features. An example of this is the installation of privacy screens for the sports of Muslim women and girls or the possibility of separate rooms and different sports times for men and women.

However, every building project requires targeted consideration and individual solutions with regard to its usability for specific target groups, because "no planning regulations, guidelines or checklists can replace personal commitment and creativity" (Federal Office for Building and Regional Planning, 2005). Therefore, it is important to clarify already in the planning phase whether there is a need for such a system which could have an impact on the structural design.

Information on the topic "Sports for All" in sports halls
Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) ▪ Technical principles for barrier-free building Link: www.bbsr.bund.de
Federal Institute of Sport Science (BISp) ▪ Structural requirements for Paralympic sports, (Federal Institute for Sport Science, 2010) Link: www.bisp.de
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 3.2.1 Public Accessibility Link: www.nachhaltigesbauen.de
Deutscher Blinden und Sehbehindertenverband e. V. ▪ Guidelines for tactile writing – Application of Braille and raised profile writing and pictograms Link: www.dbsv.org
German Institute for Standardization (DIN) ▪ DIN 18032-01: Sports halls – Halls and rooms for sports and multi-purpose use - ▪ DIN 18040-01: Barrier-free building – planning principles, Part 1: Publicly accessible buildings ▪ DIN 18041: Acoustic quality in small and middle-size rooms ▪ DIN 32975: Designing visual information in the public area for accessible use ▪ DIN 32984: Ground surface indicators in public areas
German Olympic Sports Confederation (DOSB) ▪ Information, policy papers, practical examples and funding for inclusion Link: www.dosb.de/de/inklusion ▪ Program: Integration through sport, concept presentation, project examples and information Link: www.integration-durch-sport.de
Laws/Regulations ▪ Disability Equality Act (Behindertengleichstellungsgesetz – BGG): Law on equality for people with disabilities (Disability Equality Act: 2012-04)
Miscellaneous ▪ Planung barrierefreier Sportstätten – Schwerpunkt: Schulsport, Vereinssport und Freizeitsport [Planning of barrier-free sports facilities. Focus: school sports, club sports and leisure sports] (Meyer-Buck, 2008)

Tab. 5.1: Information on the topic “Sports for All” in sports halls

6 Sports halls – Health, comfort and safety

When planning a sustainable sports hall, the focus must be on the sport participants. In addition to the functional requirements of sport, health, comfort and safety with regard to the sustainable use and operation of sports halls must be emphasised.

6.1 Health

When doing sports, athletes want to enhance their physical fitness and not endanger their health. In sports halls, this is achieved by

- the avoidance of building materials that are harmful to health,
- good quality indoor air climate,
- ensuring consistently good water quality
- and measures to promote safety and accident prevention.

Fig. 6.1: Definition of volatile organic compounds

Indoor air quality

The aim of promoting indoor air quality in sports halls is primarily to achieve very good indoor hygiene. The release of substances harmful to health, such as formaldehyde or volatile organic compounds (VOCs), should be avoided and the required air exchange rate should be ensured by a sufficient supply of fresh air. As early as the planning and tendering phase, it is recommended to exclude materials that are harmful to health and the environment and to develop a sustainable ventilation concept. Information on the materials can be found in safety data sheets, technical market sheets, environmental product declarations or the manufacturer's declarations. The final check of the interior hygiene during operation can be done by means of an interior air measurement.

Information on indoor air quality in sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 3.1.3 Indoor Air Quality Link: www.nachhaltigesbauen.de
German Institute for Structural Engineering (DIBt) ▪ Principles for the health evaluation of indoor construction products ▪ Evaluation concepts for special building products: Coatings for parquet and wooden floors ▪ List of general technical approvals, approval area: Sports flooring systems Link: www.dibt.de
Federal Environment Agency (UBA) ▪ Guidelines for indoor hygiene in school buildings ▪ Reference values for indoor air ▪ Construction products: Determining and avoiding pollutants and odours Link: www.umweltbundesamt.de

Tab. 6.1: Information on indoor air quality in sports halls

Water quality

Maintaining very good water quality in sports halls is particularly important in order to protect sport participants from the occurrence of pathogens such as legionella.

Legionella are aerobic bacteria that occur in low concentrations in all surface waters and groundwater. The risk of legionella concentration exists above all in water supply systems where water stagnation occurs occasionally or regularly (Ruhnau, 2012).

Information on water quality in sports halls
Federal Ministry of Health (BMG) ▪ 2nd Ordinance Amending the Drinking Water Ordinance (TrinkwV) (Trinkwasserverordnung: 2016-03)
German Technical and Scientific Association for Gas and Water ▪ Worksheet W 551
Technical regulations ▪ DVGW Worksheet W551: Trinkwassererwärmungs- und Trinkwasserleitungsanlagen; Technische Maßnahmen zur Verminderung des Legionellenwachstums; Planung, Errichtung, Betrieb und Sanierung von Trinkwasser-Installationen (Drinking water heating and drinking water pipeline systems; technical measures to reduce the growth of legionella; planning, construction, operation and rehabilitation of drinking water installations)

Tab. 6.2: Information on water quality in sports halls

6.2 Comfort

The best possible level of comfort and convenience of the sports and ancillary rooms promote the satisfaction of the athletes, make an important contribution to a performance-enhancing sports environment and thus ensure a sustainable utilisation of the hall. For this, the sustainable planning of

- thermal comfort in summer and winter months,
- acoustics and sound insulation,
- visual comfort
- and the user-friendliness of the technical building equipment

is necessary.

The definitions, basic technical rules and limit values to be observed in non-residential buildings in general, but also specifically in sports halls can be found in “DIN EN 15251: Input parameters for indoor climate for the design and evaluation of the energy efficiency of buildings – indoor air quality, temperature, light and acoustics” (DIN EN 15251: 2012-12).

The comfort of sports halls can be ensured and checked by various measures during the planning, execution and utilisation phase. Architects, as well as specialist planners of building physics or energy consultants must be involved in these processes.

The following tools are recommended:

- Planning phase:
  - Preparation of energy and building physics concepts and their design (heating, ventilation, lighting, shading, acoustics etc.)
  - Calculations and execution of simulations (temperature, lighting, ventilation, acoustics etc.) based on the respective standards and norms
- Use phase:
  - Measurements after commissioning
  - Monitoring after commissioning

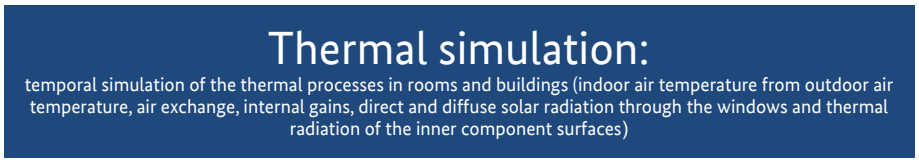

Fig. 6.2: Definition of "Thermal simulation"

Thermal comfort

Basically, the thermal comfort of a sports hall is given if it is neither too warm or too cold for sport participants in the summer months (cooling period) and in the winter months (heating period), and the air is neither too dry nor too humid and no draughts occur. The parameters for defining the perceived thermal comfort are

- air temperature,
- air speed,
- radiation temperature of surfaces surrounding humans
- radiation temperature of the sport participants,
- and air humidity (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2013).

The limit values of these parameters differ for different usage zones of a sports hall (sports rooms, changing rooms, spectator areas, etc.) In sports halls, the sometimes extreme differences in the level of activity of the users must be taken into account. During a competition, athletes perform at their best while the spectators sit motionless in the stands. What's more, different sports, such as yoga or handball, and different age groups, such as senior sports or youth basketball, require different planning and design functions for heating, ventilation and (if necessary) cooling. Depending on the type of sport, the athletes can thus create an additional "heat source".

With the help of calculations and simulations, the thermal comfort can be examined in the planning for the specific case and checked by means of measuring and monitoring procedures during hall operation.

Information on thermal comfort in sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB New Office and Administration Building Profile 3.1.1 Thermal Comfort Profile 3.1.2 Indoor Air Quality Link: www.nachhaltigesbauen.de
Standards
▪ DIN 4108-02: Thermal insulation and energy saving in buildings – Part 2: Minimum requirements for thermal insulation
▪ DIN 18032-01: Sports halls – Halls and rooms for sports and multi-purpose use – Part 1: Principles for planning
▪ DIN EN 12831: Heating systems in buildings – Method of calculating the design heating load
▪ DIN EN 13363-02: Solar protection devices combined with glazing – Calculation of solar and light transmittance Detailed method
▪ DIN EN 15251: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics
▪ DIN EN ISO 7726: Ambient climate – Instruments for measuring physical quantities
▪ DIN EN ISO 7730: Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria
▪ DIN EN ISO 52022-03: Energy performance of buildings – Thermal, solar and daylight properties of building components and elements – Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing
▪ ISO 15099: Thermal performance of windows, doors and shading devices – Detailed calculations
Association of German Engineers (VDI)
▪ Guideline VDI 2078 Calculation of thermal loads and room temperatures (design cooling load and annual simulation)
Regulations
▪ Energy Saving Ordinance (Energy Saving Ordinance, 2007-7)
Further literature
▪ Sporthallen – Planungshilfe, Anregung, Hinweise. Bewegung, Spiel und Sport in der SchuleSports halls - planning aid, suggestions, tips. Exercise, games and sports at school] (Schmidt, 2004)

Tab. 6.3: Information on thermal comfort in sports halls

Acoustic comfort

Many different activities are carried out in sports halls during training and competition events. When running, jumping or gymnastics, athletes must be able to communicate and exchange information among themselves and with the trainer by shouting and with the competition judge by means of cues and signals. Both spectator noise and noise from neighbouring parts of the hall must not impair the athletes' concentration and performance. When the acoustic comfort is low, a visit to a sports hall is perceived as unpleasant or stressful, which also results in a loss of concentration and rapid fatigue.

When planning sports halls, it is advisable to involve specialist planners for the acoustics of the sports hall at an early stage. On the basis of the architecture and equipment concept, they can calculate

- the reverberation times
- and sound insulation requirements,

and make recommendations for improvements.

Information on acoustic comfort in sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB New Office and Administration Building, 3.1.4 Acoustic Comfort Link: www.nachhaltigesbauen.de
Fraunhofer Institute for Building Physics
▪ Acoustic design of sports halls and swimming pools (Fraunhofer Institute for Building Physics) Link: www.ibp.fraunhofer.de
Laws/regulations
▪ Sports Facility Noise Protection Ordinance – 18th BImSchV (Sportanlagenlärmschutzverordnung: 1991-07) ▪ Technical Instructions on Protection against Noise – TA Lärm (Technische Anleitung zum Schutz gegen Lärm: 1998-08)
Standards
▪ DIN 4109-01: Sound insulation in building construction – Part 1: Minimum requirements ▪ DIN 18032-01: Sports halls – Halls and rooms for sports and multi-purpose use – Part 1: Principles for planning ▪ DIN 18032-04: Sports halls – Halls and rooms for sports and multi-purpose use – Part 4: Two-leaf dividing curtains ▪ DIN 18041: Auditory perception in small to medium sized rooms ▪ DIN EN ISO 3382-02: Acoustics – Measurement of room acoustics parameters – Part 2: Reverberation time in ordinary rooms ▪ DIN EN 15251: Input parameters for indoor climate for the design and evaluation of the energy efficiency of buildings – indoor air quality, temperature, light and acoustics ▪ SIA 181:2006 Sound insulation in building construction: Room acoustics of classrooms and sports halls
Further literature
▪ Sporthallen – Planungshilfe, Anregung, Hinweise. Bewegung, Spiel und Sport in der Schule [Sports halls - planning aid, suggestions, tips. Exercise, games and sports at school] (Schmidt, 2004)

Tab. 6.4: Information on acoustic comfort in sports halls

Visual comfort

The sustainable use of daylight, efficient lighting with artificial light for training and competitions and possibilities for glare protection and shading are of great importance for the comfort of the sports hall and its energy efficiency in terms of power consumption.

In the same way as thermal and acoustic comfort, the lighting should be integrated at an early stage in the planning of sports halls and adapted to their use. In addition to lighting simulation in the planning phase, light measurements (daylight and artificial light) should also be carried out during operation for quality assurance purposes.

In principle, a high degree of daylight use is recommended in sports halls. As the proportion of window area in the façade increases, the summer heat input usually increases as well. If there is a glare from daylight, the usability for sports is severely limited. For this reason, glare reduction should be prioritised over natural exposure. In addition to direct glare, cast shadows on the hall floor can impair the playability of the hall. This can be avoided by using an anti-glare shield and, if required, can be integrated into the shading or mounted separately inside or outside. In addition, the visual contact of the sport participants to the outside world should be ensured despite this.

By means of intelligent control of the lighting management system, the artificial light can be automatically or individually adjusted to the respective use. Here, Smart Home solutions with BUS systems for lighting control offer forward looking automation possibilities. In general, it is recommended a standard training function for the light control in the gym is defined, which can then be changed by the training supervisor during competition or for special sports, such as table tennis.

Information on visual comfort in sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New office and administration building,3.1.5 Visual comfort Link: www.nachhaltigesbauen.de
Standards ▪ DIN 18032-01: Sports halls – Halls and rooms for sports and multi-purpose use – Part 1: Principles for planning ▪ DIN 5034-01: Indoor daylight – Part 1: General requirements ▪ DIN 5035: Interior lighting with artificial light ▪ DIN 67526-03: Sports facility lighting – Guidelines for lighting with daylight ▪ DIN EN 1838: Applied lighting technology – Emergency lighting ▪ DIN EN 12193: Light and lighting – Sports facility lighting ▪ DIN EN 14501: Blinds and shutters – Thermal and visual comfort – Performance characteristics and classification
Further literature ▪ Licht.wissen 08 – Sport und Freizeit [Know.light 08 – Sport and leisure time] Link: www.licht.de ▪ Sporthallen – Planungshilfe, Anregung, Hinweise. Bewegung, Spiel und Sport in der Schule [Sports halls - planning aid, suggestions, tips. Exercise, games and sports at school] (Schmidt, 2004) ▪ Leitlinien zum wirtschaftlichen Bauen [Guidelines for economical construction] (Building Department of the City of Frankfurt am Main, 2016)

Tab. 6.5: Information on visual comfort in sports halls

6.3 Safety and accident prevention

Multi-purpose sports halls must be safe for all user groups. This applies both for daily use and in case of emergency. DIN 18032-01 defines protective requirements for sports halls and their equipment (DIN 18032-01: 2014-11). In addition, the subjective feelings of safety and security of the sport participants is promoted by the following measures:

- Safety in case of fire
- Reliable routing
- Protection against burglary and vandalism
- Safety in case of unforeseeable events
- Accident prevention in sports activities.

Information on safety in sports halls
Baden Municipal Accident Insurance Association
▪ Checklist for sports halls Link: http://docplayer.org/32548770-Checkliste-fuer-sporthallen-badischer-gemeindeunfallver-sicherungsverband.html
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB New Office and Administration Building, 3.1.8 Safety Link: www.nachhaltigesbauen.de ▪ BNB New Classroom Building, 3.1.8 Safety and Accident Risks Link: www.nachhaltigesbauen.de ▪ Fire protection guidelines for federal buildings Link: www.bmub.bund.de
Statutory accident insurance
▪ Sports facilities and sports equipment: Notes on safety and testing (GUV-SI 8044: 2007-06) ▪ Checklists for safety in physical education (GUV-SI 8048: 2000-08) ▪ Accident prevention regulation for schools (GUV-V S 1: 2001-05)
Laws/Regulations
▪ Fire protection ordinance of the federal states
Initiative Sicherheit in Schulen e. V.
▪ Guidelines for technical crisis prevention “Amok” Link: www.sicherheit-in-schulen.de
Standards
▪ DIN 58125: School construction – Structural requirements for the prevention of accidents
Unfallkasse Sachsen (Saxony Accident Insurance Fund)
▪ School sports facilities: Safe construction, renovation and operation. Information on all aspects of sports facility renovation and new construction for cost units and planners (GUV-SI 8468 2010-06)
Further literature
▪ Sporthallen. Sicherheitsempfehlungen für Planung und Betrieb [Sport halls. Safety recommendations for planning and operation] (Buchser, 2010)

Tab. 6.6: Information on safety in sports halls

7 Sports halls – Energy concepts

With the adoption of the EU Directive on the energy performance of buildings in 2010, the EU Member States have committed themselves to ensuring that all new buildings are constructed as ultra-low energy buildings by 31 December 2020 (2010/31/EU: 2010-05). This also applies to the building typology 'sports halls'. In order to meet these requirements, sustainability aspects, especially energy efficiency, must be given special attention in new buildings and refurbishments.

7.1 Energy Saving Ordinance

In Germany, all matters relating to energy-saving construction and requirements for new buildings and refurbishment of old buildings are regulated by the Energy Saving Ordinance (Energieeinsparverordnung (EnEV): 2007-07). When building new sports halls, an energy requirement calculation must be carried out on the basis of this and an energy certificate issued. The calculation must be submitted with the building application and verified at commissioning. The main requirement characteristics are the following target values:

- **Annual primary energy demand:**
  The annual primary energy demand represents the amount of energy, including extraction, conversion and transport, that is required to cover the total energy demand of the building over one year.
- **Final energy demand:**
  The final energy demand should not be confused with the annual primary energy demand. This indicates which energy the gym hall uses. The energy costs for operation can be calculated on this basis.
- **Specific transmission heat loss:**
  The specific transmission heat loss provides information about the average insulation quality of the envelope surface of the entire building.

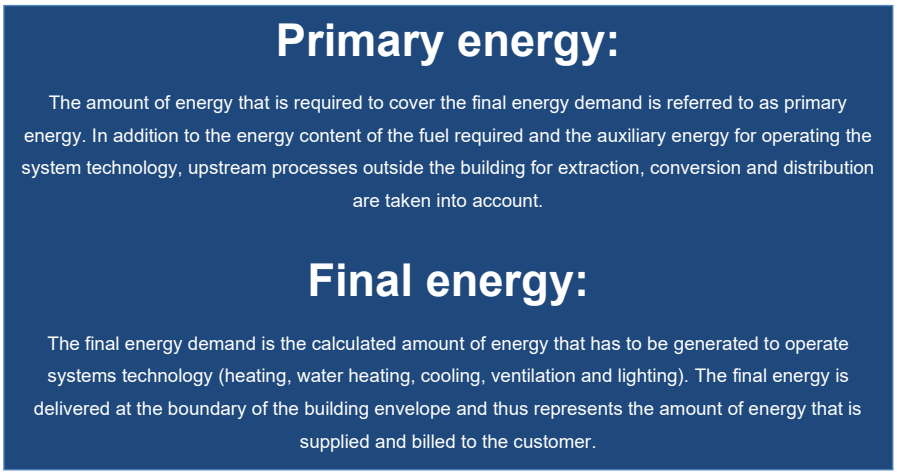

Fig. 7.1: Definition of primary and final energy

The energy demand of a sports hall should not be confused with its energy consumption. The energy demand value is always a calculation based on standard values specified in standards. The energy consumption parameter, in contrast, describes the value that results from the actual energy consumption of the sports hall and can vary due to individual user behaviour and type of hall occupancy.

The energy balance for non-residential buildings, including sports halls, must be drawn up on the basis of DIN V 18599 "Energy evaluation of buildings – Calculation of the useful, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting" (DIN V 18599-01: 2011-12). DIN V 18599 takes into account the amounts of energy required for

- heating,
- the cooling system,
- water heating,
- air conditioning,
- and the lighting

of sports halls, as well as the mutual influence of energy flows from building and plant technology. However, the energy required for user-related equipment, such as electricity for electrical appliances or lifts, is not included in the energy certificate.

For the energetic balancing and optimisation of sports halls and for the creation of energy performance certificates, numerous software programs from different providers are available today, with which statements can be made on the energetic quality and on building physics issues already during the planning stage. Algorithms replace manual calculation, simplify input and plausibility checks minimise sources of error. Different scenarios with different building and system parameters can be mapped.

7.2 Energy efficiency standards and subsidies

In addition to the requirements of the Energy Saving Ordinance, various energy efficiency standards and labels for buildings can be applied. A distinction can be made between government-imposed standards such as

- KfW Efficiency House and
- Efficiency House Plus

and guidelines introduced by institutions, such as

- Passive House,
- Active Plus
- or Solar House.

Energy efficiency standards and labels for sports halls

ActivePlus
- Assessment on the basis of the end-of-year energy demand (ΣQ_e < 0 kWh/(m²a) for the AktivPlus level and ΣQ_e < 30 kWh/(m²a) for the AktivBasic level) and other sustainability criteria, such as user, connectivity and life cycle.
  Link: www.aktivplusev.de

Efficiency House Plus
- Assessment based on the annual primary energy demand (ΣQpΣQe < 0 kWh/(m²a))
  Link: www.forschungsinitiative.de/effizienzhaus-plus

KfW Efficiency House
- Assessment based on the annual primary energy demand and the specific transmission heat loss of the building (comparison with reference buildings)
  Link: www.kfw.de

Passive House
- Assessment on the basis of the annual heating requirement (Qh ≤15 kWh/(m²a)) and the annual primary energy requirement (Qp ≤ 120 kWh/(m²a)), requirements on the condition of external components and plant technology
  Link: www.passivhaus-institut.de

Solar house
- Assessment based on the annual primary energy demand (ΣQp ≤ 15 kWh/(m²a)), the specific transmission heat loss of the building (undercutting the ENEV reference building by at least 15%) and the solar coverage ratio (gross energy demand for space heating and hot water at least

  Link: www.sonnenhaus-institut.de

Tab. 7.1.: Energy efficiency standards and labels for sports halls

Often the new construction as well as the renovation of sports halls represent a considerable financial burden for many communities and sports clubs. Numerous subsidies are available to support the energy-efficient and sustainable planning of sports halls. Possibilities for funding are listed in Table 7.2.

Information on funding programmes for sports facilities with a focus on energy

BINE Information Service
- Online database
  Link: www.energiefoerderung.de

Federal Office of Export Control (BAFA)
- Market incentive programme for the promotion of renewable energies (solar thermal, biomass, heat pump)
  Link: www.bafa.de

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
- Zukunft Bau [Future Building], grants for model projects, funding for educational buildings in Efficiency House Plus Standard
  Link: www.forschungsinitiative.de

German Olympic Sports Confederation (DOSB)
- Guidelines for sports facility funding by the EU

Energy supply companies
- Support programmes of energy suppliers and smaller municipal utilities

Kreditanstalt für Wiederaufbau (KfW)
- KfW Programme Renewable Energies "Standard"
- KfW Urban Rehabilitation Programme – Energy-efficient Rehabilitation
  Link: www.kfw.de

Project Management Jülich
- Climate protection projects in social, cultural and public institutions (municipal guideline)

Unabhängiges Institut für Umweltfragen e. V. (UfU)
- Climate protection sub-concepts in public properties and user projects such as Incentive models for energy-saving behaviour of users e.g. fifty/fifty
  Link: www.fifty-fifty.eu or at the municipality itself, for example www.muenchen.de

Tab. 7.2: Information on funding programmes for sports facilities with a focus on energy

7.3 Building envelope

The building envelope – especially the quality of the structural design – plays an important role in ensuring energy efficiency of the sports hall. Examples of structural engineering measures are listed below:

Compact building geometry

The compactness of a sports hall is represented by the ratio of the building envelope area to enclosed volume and is decisive for determining the required heating energy. The lower the building-envelope area-to-volume ratio, the less heating energy and associated costs are required for the sports hall.

Good insulation standard of the building envelope

In order to minimise heat losses in winter and to improve summer thermal insulation in the summer months, it is necessary to implement a good insulation standard for the sports hall. The transmission through a building component is described by the heat transfer coefficient (U-value). The lower the U-value, the less heat is conducted through the component from the outside to the inside or vice versa. As essential components of the building envelope for sports halls, the floor slab, external walls, roof and windows must be considered. In addition, attention should be paid to the installation of well insulated windows. Since windows with triple glazing have significantly lower U-values than windows with double glazing, heat losses are greatly reduced. In this context, good sun and glare protection is also important for sports halls in order to avoid overheating of the sports hall and glare during ball games.

Reduction of thermal bridges

Heat losses of a sports hall due to heat conduction through the building envelope (transmission heat losses) due to thermal bridges are to be avoided in principle. A thermal bridge describes a weak point of a component through which more heat can flow than through the surrounding surfaces. Thermal bridges cause lower surface temperatures at individual points, which increases the risk of condensation and mould formation.

Airtightness

In order to minimise ventilation heat losses, "buildings must be designed in such a way that the heat-transferring perimeter surface including the joints is permanently airtight in accordance with the recognised rules of technology" (Energy Saving Ordinance: 2007-07). The airtightness of the building envelope of the sports hall contributes to energy saving, as no warm air and therefore no energy can escape through leaks. Even before the start of the interior work, the airtightness of the façade joints of a sports hall should be partially checked with a blower door test (differential pressure measuring method) in order to eliminate deficiencies (e.g. thermal bridges) at an early stage. After completion of the sports hall, it is recommended to carry out an airtightness test of the entire hall and its ancillary rooms.

Information about energy concepts for sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and Administration Building Profile 4.1.2 Heat Insulation and Protection against Condensate Profile 4.1.6 Technical Building Services Profile 5.2.3 Controlled Commissioning ▪ Sustainable Building Guidelines ▪ Guidelines for energy performance certificates for non-residential buildings: Working aid for the preparation of energy certificates based on energy demand and for the assessment of energy efficiency in non-residential construction Link: www.nachhaltigesbauen.de
Federal Ministry of Economics and Energy (BMWi) ▪ Guidelines for monitoring the demonstration buildings in the EnBau and EnSan funding programmes Link: www.enob.info
German Olympic Sports Confederation (DOSB) ▪ Information on energy-efficient sports infrastructure Link: www.klimaschutz-im-sport.de
Deutsche Energie-Agentur GmbH (dena) ▪ Guideline Energy Performance Contracting Link: www.kompetenzzentrum-contracting.de
Society for Rational Energy (GRE) ▪ Guidelines on energy efficiency and renewable energies Link: www.gre-online.de
Forschungsinstitut für Wärmeschutz e. V. (FIW) ▪ Guidelines and publications on building envelopes and insulation Link: www.fiw-muenchen.de
Manufacturer ▪ Information on manufacturer pages
Standards ▪ DIN V 18599: Energy efficiency of buildings ▪ EEG: Act on the fundamental reform of the Renewable Energy Sources Act and on the amendment of further provisions of the Energy Industry Act (EEG: 2014-07) ▪ EEWärmeG: Act on the Promotion of Renewable Energies in the Heat Sector (EE-WärmeG: 2008-08) ▪ Energy Saving Ordinance (EnEV): Ordinance on energy-saving thermal insulation and energy-saving systems engineering for buildings (EnEV: 2007-07)
Eco-Check, information and guidelines of the national sports associations ▪ Overview of the national sports federations Link: www.dosb.de/de/organisation/mitgliedsorganisationen/landessportbuende/
Technical regulations ▪ AMEV brochure no. 111: Notes on the planning and execution of ventilation and air-conditioning systems for public buildings ▪ AMEV Brochure No.113: Planning, execution and operation of sanitary facilities in public buildings ▪ AMEV brochure no. 114: Notes for indoor lighting with artificial light in public buildings
Further literature ▪ Management and modernisation of gymnasiums and sports halls (Spindler, 2007)

Tab: 7.3: Information about energy concepts for sports halls

7.4 Building services

Numerous supply concepts can be used in the design of building services for sports halls. In principle, priority should be given to concepts that rely on renewable energies and have the lowest possible energy consumption. Simple “low-tech” solutions should take precedence to designs with a high proportion of “high-tech” features. However, the following applies to all designs: The better the building services meet the requirements, the higher the energy-efficiency of the sports facility and the easier it is to implement operation, maintenance, inspection, repair or modification measures during operation.

The building services for sports halls essentially comprise the following areas:

- heating,
- water heating,
- ventilation,
- cooling,
- lighting
- and building automation.

Heating and water heating

To build a sustainable sports hall, it is essential to select a future-proof and cost-effective heat supply system. Not only must the type of heating be matched to the sports hall design, but also the heat distribution and hot water supply must be integrated into the planning at an early stage with a view to sustainable operation and comfort of the sport participants.

Systems that use renewable energy sources such as biomass, local and district heating from renewable sources, solar energy or environmental and geothermal heat are suitable for generating heat for sports halls. For heat distribution, surface heating systems such as underfloor heating or radiant ceiling panels should be chosen. With these radiant heaters, heat transfer mainly takes place via thermal radiation.

The hot water supply of sports halls should be implemented via a central hot water supply and storage facilities that take into consideration ecological and economic aspects. In order to minimise distribution losses for hot water preparation, short pipe routes must be observed in the planning and all water-carrying pipes must be insulated.

Ventilation

In addition to health aspects, sufficient air exchange should be ensured in sports halls, taking into account energy efficiency. In principle, natural cross-ventilation should be achieved in sports halls and their ancillary rooms by means of multiple ventilation flaps or bottom-hung windows. Mixed systems using natural and mechanical ventilation with heat recovery are an additional, positive option for the ventilation of sports halls to ensure the required air exchange.

Cooling

In order to ensure pleasant temperatures in the gymnasium during the summer months, construction measures to prevent the gymnasiums from heating up should be provided for at the planning stage. System cooling must be avoided at all costs, as it entails high energy consumption.

Lighting

Since lighting in sports halls is responsible for around 50 percent of power consumption, an efficient lighting concept should reduce the energy consumption of a sports hall (Spindler, 2003). The use of daylight to illuminate the hall is an important component. An impact-resistant artificial light supply serves as a supplement to ensure uniform illumination of the hall in darkness and insufficient light incidence. Energy can also be saved by using energy-efficient light sources such as high-quality fluorescent lamps or LEDs. The installation of presence detectors prevents an empty hall from being unnecessarily lit and consuming energy.

Building automation

In many sports halls today, building services engineering is controlled automatically by means of building automation systems that comprise components and equipment for monitoring, control, regulation and optimisation of the technical building equipment. The aim is to connect the technical units in the building by means of a communication network or BUS system and to carry out functional sequences automatically according to predefined setting values.

The building automation system allows all control processes in the sports hall to be centrally captured, displayed and remotely controlled via a telephone network or the Internet. With an intelligent control system, the energy consumption of the hall can thus be reduced, and operating costs saved by determining and monitoring the consumption of heat, water, gas and electricity meters.

7.5 Use of renewable energies and storage possibilities

In 2009, the German Federal Government enacted the Renewable Energies Heat Act (EE-WärmeG: 2008-08-07) to increase the share of renewable energies in the heating market. When building new sports halls, the heat requirement must be covered by the proportionate use of renewable energies. The regenerative heat generation for sports halls can be provided by biomass, local and district heating, environmental heat or solar energy.

Due to the large roof areas, the installation of solar thermal and photovoltaic systems is particularly suitable for sports halls. The heat generated by solar thermal systems can be used to heat water or to support the heating system of the sports hall, while the photovoltaic system can be used to generate electricity. The German Renewable Energy Sources Act (EEG: 21/07/2014). Plant operators receive a fixed payment for electricity generated from renewable sources and grid operators are obliged to purchase them with priority.

Due to falling feed-in tariffs, however, the focus today is on your own use of the electricity generated. The power requirement for lighting, if required for the mechanical ventilation system and other electrical devices can be covered and stored in whole or in part.

Energy storage systems are required to compensate for fluctuations and time lags between solar supply and demand by providing heat and electricity when the sun is not shining, for example for use by sport participants in the evening.

For the storage of heat by solar thermal systems, the storage tanks differ according to the intended use:

- Pure hot water tanks
- Fresh water tank (hot water in continuous flow principle)
- Buffer storage tank (only for heating-supporting systems)
- Combination storage tank (for hot water and heating).

There are systems available today for

› battery storage of photovoltaic energy.

Thanks to battery storage, the regenerative solar power is available to sports participants when the sun is not shining or in the evening hours. The batteries currently available on the market are divided into lead and lithium storage batteries.

7.6 Measurement and monitoring concept

For sustainable sports hall management, it is essential to record the actual consumption of the various media as well as the users. Internal controls and reference values can reveal deviating values caused by technical defects or leakages. In addition, user behaviour can be analysed and the control of technical systems can be optimised. Incentives for resource-saving behaviour can be provided through communication with users. General principles for sports hall building monitoring are summarised in the "Leitfaden für das Monitoring der Demonstrationsbauten im Förderkonzept EnBau und EnSan" (Guidelines for the monitoring of demonstration buildings in EnBau and EnSan funding programmes) of the Federal Ministry of Economics and Energy (Federal Ministry of Economics and Energy, 2014).

Measurement and monitoring concept in sports halls
Media to be recorded
▪ Sustainable Building Energy Consumption Guideline
▪ Space heating
▪ Hot water
▪ Power consumption
▪ Building lighting
Areas with increased or different requirements
▪ Kitchen
▪ Building services systems
▪ Water heating
▪ Outdoor facilities
▪ User equipment
▪ Miscellaneous

Tab. 7.4: Measurement and monitoring concept in sports halls (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 2013)

8 Sports halls – Resources: Water and material management

Resource efficiency in the construction industry is an important issue, as many raw materials are scarce. Natural resources, such as water, soil and air, are vital assets for humanity. However, many resources are finite and the mining and processing of raw materials is usually associated with high environmental pollution (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2015).

Buildings are among the largest consumers of resources worldwide; the construction industry must therefore be addressed if fossil fuels are to be saved in the long term and environmental pollution reduced. This also applies to the construction of sports facilities. The goal of a sustainable sports hall must therefore be to save valuable raw materials over the entire life cycle. Not only energy consumption but also drinking water and materials must be reduced in planning, operation and demolition.

8.1 Drinking water and wastewater concepts

Drinking water is a scarce resource. Sports halls must therefore aim to reduce the consumption of drinking water and the discharge of wastewater. Savings potentials range from simple solutions, such as the infiltration of rainwater or the installation of water-saving fittings, to complex concepts such as the use of greywater.

Sport participants' usage behaviour also makes a significant contribution to drinking water consumption. In addition to the positive environmental impact, the reduction in drinking water requirements also leads to savings in the costs of fresh water supply and process water disposal.

Information on the reduction of drinking water demand and wastewater
Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities (AMEV)
▪ Sanitäranlagen – Planung, Ausführung und Bedienung (Sanitary facilities – planning, execution and operation) (2011, brochure no.: 113)
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB New Office and Administration Building Profile 1.2.3 Fresh Water Demand and Quantity of Wastewater Link: www.nachhaltigesbauen.de
German Institute for Standardization (DIN)
▪ DIN 1988: Technical rules for drinking water – Installations
▪ DIN 1989-01: Rainwater harvesting systems – Part 1: Planning, execution, operation and maintenance
▪ DIN 2000: Central drinking water supply – Guidelines regarding requirements for drinking water, planning, construction, operation and maintenance of supply plants
▪ DIN EN 1717: Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow
▪ DIN EN 246: Sanitary tapware – General specifications for flow rate regulators
▪ DIN EN 806-01 and -02: Technical rules for drinking water installations
German Technical and Scientific Association for Gas and Water
▪ Worksheet W 551: Drinking water heating and drinking water pipeline systems, technical measures to reduce the growth of legionella, planning, construction, operation and rehabilitation of drinking water installations
Further literature
▪ Guidelines for economical construction (Building Department of the City of Frankfurt am Main, 2016)

Tab. 8.1: Information on the reduction of drinking water demand and wastewater

8.2 Lifecycle-based material concepts

New technologies must be developed and implemented to increase the material efficiency of sports halls. This also requires changes in process and planning procedures as well as thinking patterns. Numerous means and information tools are available for this purpose. The right materials for sports halls can be selected by comparing variants through life cycle assessments, environmental product declarations, databases, quality seals and guidelines. Fundamental decisions regarding the execution of variants should be made in the early planning process and taken into account in the context of the entire life cycle of a sports hall (see chapter 4).

The entire life cycle of a sports facility comprises the following phases

- production (extraction of raw materials, processing and transport),
- construction,
- use
- and end of life.

Currently, however, the life cycle in its entirety does not play a decisive role in the planning of sports halls. While, for example, the building phase is used to calculate the costs, the energy assessment is based only on the use phase. In the interests of efficient use of resources, however, this view must be abandoned and the entire life cycle analysed.

Fig. 8.1: Definition of life cycle assessment

For planners and decision-makers in the planning and construction of sports halls, life cycle assessment is a suitable tool for comparing different planning variants in terms of their environmental impact. Basically, the life cycle assessment of buildings (LCA) is the compilation and evaluation of the input and output flows and the potential environmental impacts during the life cycle of a building (DIN EN ISO 14040: 2009-11).

Specially developed software programs or Excel spreadsheets, which calculate the environmental impact on the basis of mass determination, are suitable for preparing a life cycle assessment. The dimensions of the individual components must be linked to data that provide information on their environmental impact for production, use and disposal for the purpose of impact assessment. There are various databases for this purpose, some of which are already integrated into the software programs.

Information on life cycle assessment of sports halls
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) ▪ BNB New Office and administration Building Profile 1.1.1 Global Warming Potential (GWP) Profile 1.1.2 Ozone Depletion Potential (ODP) Profile 1.1.3 Ozone Creation Potential (POCP) Profile 1.1.4 Acidification Potential (AP) Profile 1.1.5 Eutrophication Potential (EP) Profile 1.2.1 Primary Energy Demand, Non-renewable (PE_{nr}) Profile 1.2.2 Total Primary Energy Demand and Amount of Renewable Primary Energy (PE_r) Link: www.nachhaltigesbauen.de
Standards ▪ DIN EN ISO 14024: 2001-02, environmental labels and declarations (Type I environmental labelling) – principles and procedures ▪ DIN EN ISO 14025: Environmental labels and declarations – Type III environmental declarations – Principles and procedures ▪ DIN EN ISO 14040: Environmental management – Life cycle assessment – Principles and framework ▪ DIN EN ISO 14044: Environmental management – Life cycle assessment – Requirements and guidance ▪ DIN EN 15643-02: Sustainability of construction works – Sustainability assessment of buildings – Part 2: Framework for the assessment of environmental quality ▪ DIN EN 15804: Sustainability of construction works – Environmental product declarations – Basic rules for the product category construction products ▪ DIN EN 15978: Sustainability of construction works – Determination of the environmental performance of buildings – Method of calculation

Tab. 8.2: Information on life cycle assessment of sports halls

9 Sports halls – economic efficiency and life cycle costs

For many municipalities, clubs and private investors, the construction of a new sports hall is a lengthy planning process, which can take several years, from the initial idea to the commissioning of the sports facility, and until all planning-relevant and cost issues have been resolved. One reason for this is that a sports hall generates high costs over its entire life cycle, which relate not only to the construction but also to its use up to its demolition.

Fig. 9.1: Definition of life cycle costs (LCC)

Up to now, only the construction costs usually play a role in the conventional planning and construction process. Operating costs over the entire life cycle often receive little attention and are often not taken into account in the decision-making process. In the interest of a sustainable sports hall, however, it is necessary to assess not only the manufacturing costs but also the expected costs of use (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2013). Life Cycle Costing (LCC) is a suitable instrument for checking and comparing the costs incurred by a sports hall over its entire life cycle in terms of its economic efficiency (Kalusche, 2008). The early phases of the design process, especially, have a significant impact on the costs of the entire life cycle of a sports hall. This is where the highest potential for optimisation for sustainable and cost-efficient construction is to be found. With the help of life cycle cost calculations, it is possible to effectively influence the overall economic efficiency, i.e. the costs of construction, operation and demolition, in this planning phase (Ebert et al., 2010).

9.1 Principles of life cycle cost calculation

Life cycle cost calculations show the costs of a sports hall over its entire life cycle, serve as a decision-making aid and basis for investment and as a controlling instrument (König et al., 2009).

The international standard ISO 15686-05 “Buildings and constructed assets – Service life planning – Part 5: Life cycle costing” is the basis for life cycle calculations (ISO 15686-05: 2008-06). In Germany, however, life cycle cost calculations are mainly based on the “Sustainable Building Guidelines” (“Leitfaden Nachhaltiges Bauen”) of the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, as the ISO standard currently still has many gaps (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2016). In the Sustainable Building Guidelines, costs are differentiated according to initial investment and subsequent construction costs, both of which are included in the overall assessment. In addition, it provides specific information on the period under consideration as well as on calculation variables and parameters.

9.2 Construction and usage costs

The following selected costs are taken into account in the life cycle costing:

- Construction costs at the beginning of the period under review
- Usage costs with regular costs for maintenance, supply and disposal of the building and irregular costs for repair.

Demolition and disposal costs (end-of-life) are currently not yet included in the life cycle cost calculation due to a lack of reference values.

Production costs

For the calculation of the production costs, the structure of the cost groups according to DIN 276-01 "Costs in construction – Part 1: Building construction" (DIN 276-01: 2008-12).

The construction costs are based on

- cost group 300 "Building structure – Building construction"
- and cost group 400 "Building structure – Technical installations".

The life cycle cost assessment for the construction of a sports hall is made within the scope of planning, based on costing after hall completion by means of a cost statement (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2016).

Fig. 9.2: Present value (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2013)

Costs of use

The costs of using a sports hall include all costs incurred from the beginning of the use of a building until its demolition (DIN 18960: 2008-02). For this purpose, a utilisation scenario is developed for the utilisation phase and selected cost groups according to DIN 18960 "Utilisation costs in building construction" with direct reference to the building are included in the calculation (DIN 18960: 2008-02). On the basis of the usage scenario, the present value of the sports hall for operation can be calculated with predefined rates of price increase and a predefined discount rate over the observation period of 50 years.

The present value is the value that future payments have in the present. This is determined by discounting the future costs and then adding the amounts over the specified period under consideration. With the observation period of 50 years and a specified discount rate, the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety (BMUB) has specified standardised parameters on the basis of which buildings can be compared in terms of their life cycle costs (Federal Ministry for Environment, Nature Conservation, Construction and Nuclear Safety 2013).

The future costs of use are divided into annual

- regular costs, such as energy, cleaning and maintenance costs
- and irregularly occurring costs, such as maintenance costs.

(Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety, 2016).

Information on life cycle costs of sports halls
Working Group for Mechanical and Electrical Engineering of State and Municipal Administrations
▪ Characteristic values for the maintenance of the technical building equipment Link: www.amev-online.de
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
▪ BNB New Office and Administration Building Profile 2.1.1 Building-related Life Cycle Costs
▪ Sustainable Building Guidelines Link: www.nachhaltigesbauen.de
Standards
▪ DIN 276-01: Costs in construction – Part 1: Building construction
▪ DIN 277-01: Areas and volumes in construction – Part 1: Building construction
▪ DIN 18960: Utilisation costs in building construction
▪ DIN 31051: Fundamentals of maintenance: Definition of terms: Maintenance, servicing, inspection, repair and improvement
▪ DIN 32736: Facility management – Terms and services: Definition of terms: technical, infrastructural and commercial building management
▪ ISO 15686-05: Buildings and constructed assets – Service life planning – Part 5: Life cycle costing
Association of German Engineers (VDI)
▪ Series of guidelines VDI 2067 Economic efficiency of building installations Link: www.vdi.de
Further literature
▪ Leitlinie zum wirtschaftlichen Bauen [Guidelines for economical construction] (Building Department of the City of Frankfurt am Main, 2016)
▪ ARGE Benchmark (costs of use)
▪ Baukosteninformationszentrum deutscher Architektenkammern [Construction Costs Information Centre of the German Chamber of Chambers of Architects] – BKI (production and utilisation costs)
▪ sirAdos – Construction data (production costs)

Tab. 9.1: Information on the life cycle costs of sports halls

10 Outlook

With the support of the Federal Institute of Sports Science (BISp), a valuable tool for the sustainable development of sports facility construction was created with the guidelines "Sustainable Sports Facility Construction – Criteria for the Construction of Sustainable Sports Halls".

The guidelines focus on the typology of the sports hall and considers the entire life cycle – from design, planning, construction and operation, all the way to demolition – with equal consideration of the ecological, economic and social factors.

In addition to fundamentals for the construction of sustainable sports facilities, they deal separately with special aspects of sustainable planning processes, providing information on topics such as health, comfort, sports spaces for all, as well as energy, water and material management, and also touch on the topic of economic efficiency of sports halls.

In the course of the research, it became apparent that although the promotion of sustainability in the building industry is a key objective of the German Federal Government, sports facilities have not been adequately considered so far.

The guidelines thus represent a significant step in promoting the sustainable planning, construction and operation of sports facilities. The sustainability criteria of the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety for office, administration and school buildings were derived for sports hall construction, but specific, nationally valid guidelines and target values are still missing in sports facility construction. In particular, there is still a great need for research on topics such as life cycle costs and on aspects of building physics such as convenience, health, comfort and environmental impact. The methodology for sustainable sports hall construction developed in the guidelines provides a good starting point for further developing the sustainability criteria for other types of sports facilities such as swimming pools or stadiums as well as for the renovation of sports facilities. The increasing pressure to renovate and modernise the sports facilities owned by municipalities, sports clubs and private providers, as well as the need for new sports facilities and exercise areas, which must meet the requirements of both competition-based and directive-dependent competitive sports and the growing needs of mass sports, underline the demand.

In order to implement sustainable sports facilities in a practical way, a well-founded sports facility specific education and further training in architecture and engineering is urgently required. However, German universities and colleges do not currently offer specialisation in sports facility construction. There is an urgent need for action here.

11 Annex

Criteria for sustainable sports hall construction		
Ecological quality	**Effects on the global and local environment**	
	1.1.1	Global warming potential (GWP)
	1.1.2	Ozone depletion potential (ODP)
	1.1.3	Ozone creation potential (POCP)
	1.1.4	Acidification potential (AP)
	1.1.5	Eutrophication potential (EP)
	1.1.6	Local environmental impact
	1.1.7	Sustainable resource extraction/wood
	1.1.8	Light pollution
	Resource consumption	
	1.2.1	Non-renewable primary energy demand (PEnr)
	1.2.2	Total primary energy demand (PEtot) and proportion of renewable primary energy
	1.2.3	Potable water demand and waste water volume
	1.2.4	Land use
	1.2.5	Waste
	1.2.6	Energy efficiency of the building equipment
Economic quality	**Life cycle costs**	
	2.1.1	Life cycle costs
	Economic development	
	2.2.1	Third party use
Socio-cultural and functional quality	**Health, comfort and user satisfaction**	
	3.1.1	Thermal comfort in winter (athletes and spectators)
	3.1.2	Thermal comfort in summer (athletes and spectators)
	3.1.3	Indoor air quality (athletes and spectators)
	3.1.5	Acoustic comfort (athletes and spectators)
	3.1.6	Visual comfort (athletes and spectators)
	3.1.7	User control (athletes and spectators)
	3.1.8	Quality of outdoor spaces
	3.1.9	Safety and hazardous incident risks
	3.1.10	Water quality

	Functionality	
	3.2.1	Inclusion (accessibility)
	3.2.2	Space efficiency
	3.2.3	Flexibility and conversion
	3.2.4	Accessibility
	3.2.5	Comfort for cyclists and pedestrians
	Design quality	
	3.3.1	Design and urban development quality
	3.3.2	Art in architecture
	3.3.3	Cultural, historical and regional context
	3.3.4	Innovation
Technical quality	**Technical design**	
	4.1.1	Fire safety
	4.1.2	Sound insulation
	4.1.3	Thermal insulation and protection against condensation water
	4.1.4	Cleaning and maintenance
	4.1.5	Dismantling, separation and recycling
	4.1.6	Technical building services
	4.1.7	Consumption measurement
	4.1.8	Resilience
Process quality	**Planning process**	
	5.1.1	Project preparation
	5.1.2	Integral planning
	5.1.3	Complexity and optimization of planning
	5.1.4	Tendering and contracting
	5.1.5	Requirements for optimum management
	Construction	
	5.2.1	Construction site/construction process
	5.2.2	Prequalification of executing companies
	5.2.3	Quality assurance of the construction
	5.2.4	Systematic commissioning

Location quality	**Site characteristics**	
	6.1.1	Risks at the micro-location
	6.1.2	Conditions at the micro-location
	6.1.3	District characteristics
	6.1.4	Transport access
	6.1.5	Access to amenities
	6.1.6	Attached media / development
	6.1.7	Extension options
	6.1.8	Site ecology
Sports functional quality	**Sports functional characteristics**	
	7.1.1	Sports facility development plan
	7.2.1	Structural sports functionality
	7.3.1	Multifunctionality
		New criteria

12 List of sources

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