GHP GREEN HOSPITAL STUDY

STAGE 1 - DETERMINATION OF BASICS

STUDY OF CITERIA - EVALUATION MATRIX

german healthcare partnership

CONTENT

CONTENT

CONTENT

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INTRODUCTION | TARGET + TASK

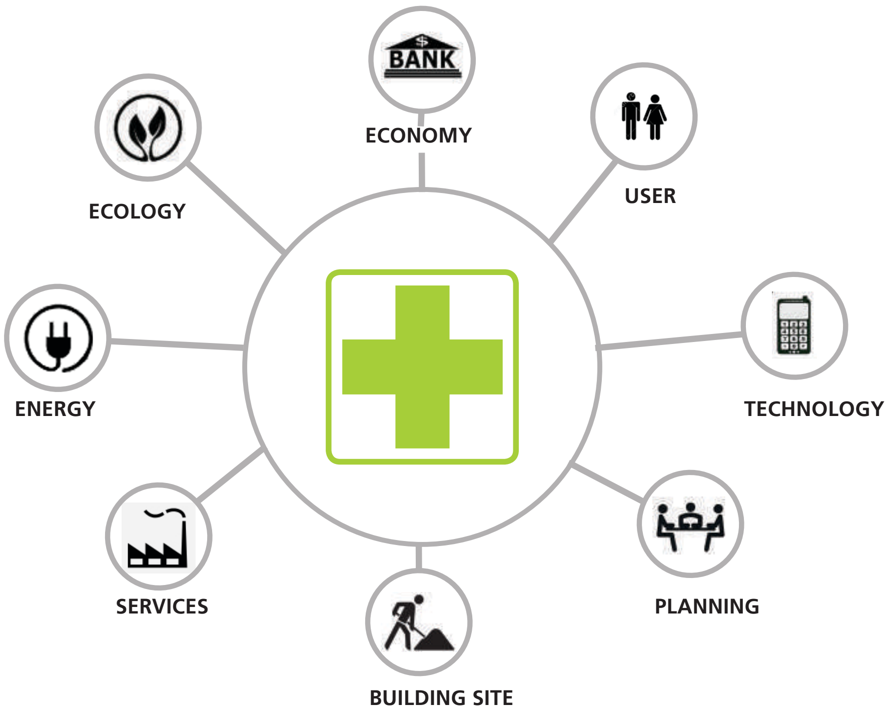
The *Green* Hospital Study is essentially composed of two phases. While phase 1 can be viewed as the determination of basics and study of criteria, phase 2 checks the feasibility and applicability based on regional features of a fixed partner country.

Thus, for phase 2, the present document represents the basis for the parameters for the sustainable and energy-efficient development of hospital abroad.

The aim of this first phase of the study is the holistic view of an ideal hospital, which is characterized by energy and resource efficiency and allows contamination of the environment, which is reduced to a minimum. Thereby economic interests represent an equally relevant aspect as the comfort needs of the users, which relate to both, the patient and the hospital staff. The entire life cycle of the hospital building is observed, which extends from the extraction of raw materials required for the preparation of the operation up to its end of life and end of life phase. Due to the specific usage requirements and usually high energy consumption levels, the process-related parameters and interactions are also investigated in the operation phase.

Starting point of the study is the analysis of the corresponding state of technology of the hospital and health care buildings in Germany. Due to high normative standards in terms of energy technologies and building equipment, potential qualitative and quantitative suggestions or reference guidelines that result from this, are to be checked in phase 2.

Here, the degree of technologisation and other conditions in developing or emerging countries need to be especially taken into account. Including in relation to already implemented national and international certification systems in Germany, such as the DGNB or LEED system, relevant aspects are taken into account in phase 1. The focus is on energy-efficiency. In addition, however, other sustainability-related aspects, especially those that correlate on energy-efficiency, can be used for a holistic research approach.



Pict.1 Valuation parameters for energy efficiency and sustainability in the hospital over its entire life cycle

INTRODUCTION | RESUME

The present study serves as a first overview and description of all essential criteria and technologies for the assessment of the quality of sustainability and energy efficiency of hospital buildings in Germany. With this developed catalog of criteria, assessments of maintenance-and repair-related construction work on existing buildings can be done as well as new construction projects. In particular, the criteria matrix created is used as a decision aid to illustrate the effects of different measures on certain parameters such as energy demand, ecology, economics, user comfort, and others.

At the beginning of the study, various existing hospital-specific concepts based on an extensive preliminary study (Appendix 2) were compared and similarities, which are relevant for energy efficiency and sustainability aspects as well as important criteria from the different concepts were identified. Accordingly, an initial assessment of the priorities of different aspects could be made. The certification systems DGNB and LEED have been considered here, as well as the guide „energy-saving hospital" which was developed by BUND, the concept of the VDE „Blue Hospital" and the guide „energy efficiency for hospitals" by the Energy Agency of North Rhine-Westphalia.

On this basis and the experiences of the project involved specialist planners and experts (Fig. 2), the valuation-relevant criteria have been summarized and their primary content has been compiled. In addition to a general description of the criteria, their importance was shown in terms of the considered parameters. The focus of the elaboration forms the respective rating scale, which allows an assessment using the German state of the art and in some cases the certification tools can be done. The conclusion of each criterion is the list of criteria that are considered to be in interaction and should be taken into account during a comprehensive analysis.

In the processing of Phase 1, it has become evident that only a holistic approach is productive. The effect of optimization of a single criterion can achieve only marginal changes in terms of increasing efficiency and improving the sustainability of a hospital. To check the applicability of the individual criteria abroad, respective requirements are needed by which a specification can be done of as many criteria set out in this phase as possible. For this purpose, phase 2 is being used in the further course of the study.

Fig. 2 Rehab clinic and medical specialist centre in Großenhain, Germany, 2014 DGNB Silver certification, iproplan®

LIST OF | ABBREVIATIONS

ABBREVIATION	DESCRIPTION
AgBB	Committee for the health assessment of construction products
BHKW	Block heat and power plant
BUS	Binary Unit System
CHP	Cogeneration plant, combined heat and power
CT	Computer tomography
DVGW	German Technical and Scientific Association for Gas and Water
EEWärmeG	German regenerative energy and heat ordinance
EnEV	Energy Saving Ordinance
EPD	Environmental product declaration
CFC	Chlorofluorocarbon substances
HCFC	Halogenated chlorofluorocarbons
IT	Information Technology
LED	Light Emitting Diode
MRT	Magnetic resonance imaging
PV	Photovoltaik
RLT	Air conditioning system
TGA	Technical facility
USV	Uninterruptible power supply
BIM	Building information modeling

SYMBOLS

SYMBOL	DESCRIPTION	UNIT
A	Envelope of a building	m²
A_R	Equivalent sound absorption area of a room	m²
D	Day light factor	%
g	Total energy transmittance	%
n_{50}	Air exchange rate	*h-1*; (m³/h)/m³
Q_p	Primary energy demand	kWh/(m²·a); kWh/a
$Q_{p,Ref}$	Primary energy demand of reference building	kWh/(m²·a)
R_a	Color Rendering Index	%
S	Solar transmission value	-
S_i	Sub-areas of a room	m²
T	Reverberation time	s
U	Heat transfer coefficient	W/(m²·K)
$\bar{U}$	Weighted mean heat transfer coefficient	W/(m²·K)
UGR_L	Unified glare rating limit	%
V	Building volume	m³
V_R	Room volume	m³

GREEK SYMBOL	DESCRIPTION	UNIT
α	Sound absorption coefficient of the subareas Si	-
τ	Light transmittance	%

EVALUATION PARAMETERS MATRIX

SHEET 4

For the structuring of the present formulation and a clear presentation of results, a criteria matrix was designed as part of the GHP Green Hospital study. In this matrix, the investigated criteria of each group are reported in terms of eight fixed evaluation parameters. The following selected evaluation parameters take different qualities of sustainability and energy-efficiency into account:

ENERGY EFFICIENCY

The building energy efficiency of a hospital shall be considered here. The structural heat protection and efficiency of technical systems will be investigated. This includes heating, warm water generation, ventilation and air conditioning, refrigeration as well as process technologies used. The effect of the use of renewable energies is also being considered. The aim is to reduce the primary and final energy demand.

ECOLOGICALLY

The overall impact on the environment and the local risks shall be considered here, that are connected with construction, maintenance, operation and disposal of a building throughout its lifecycle. The aim is to reduce the polluting emissions, minimizing the burden on flora, fauna and humans, biodiversity protection and sustainable resource conservation.

ECONOMICALLY

The costs incurred during the life cycle of a building shall be considered here. This includes manufacturing, operating and disposal costs of a building. The operating costs such as costs of supply, maintenance, cleaning and energy are taken into account. In addition, hospital-specific utilization costs are included. Furthermore, buildings are long-term investments. A positive increase in value is therefore an important feature of economic quality. The goal is also to reduce the cost in € / m² Gross Floor Area/a

SOCIOCULTURALLY

The comfort of the building occupants shall be considered primarily. Here, the well-being of hospital employees and their quality of work is studied firstly. On the other hand the well-being of patients and the influence on their progress in recovery is highly relevant. In addition, the socio-cultural quality affects the public image, the image of the hospital and on its possible corporate design. The aim is to increase the thermal, acoustic and visual comfort as well as maximizing the security and user ex-perience while minimizing accident risks. For indicators of high user influence on the success of in-dividual actions, participation and motivation of patients and employees is as an evaluation criterion of major importance.

TECHNICALLY

The quality and degree of mechanization shall be considered, which is relevant for operating the building. The technical building equipment is considered, as well as IT and use-specific processes and systems such as medical devices. The goal is a high degree of automation in many areas, their linkage and high regulating accuracy of the components. The aim is to reflect the state of the art in the choice of technical equipment and replace old equipment because of the increase in efficiency.

IN PLANNING

The effort and the quality of planning shall be considered here, which is relevant for the construction, operation and end-of-life phase of a hospital. The planning process has a huge impact on the quality of the building and its technical equipment. The goal is an integral and holistic planning, a high level of detail and the easiest possible feasibility of the planned measures. The integration of sustainability aspects in the planning and procurement is thereby essential.

IN EXECUTION

The quality of construction and construction supervision shall be considered, as well as requirements on the site. The goal is the most accurate, clean and economical implementation of the planned measures. Of particular importance are also the documentation of the construction and a continuous quality control. A low-emission construction (reduction of waste, noise and dust) and the protection of soil is a precondition.

QUALITY ASSURANCE

The long-term quality of the building shall be considered, the technology and processes. The aim here is to ensure, through regular controlling and monitoring processes, an increase in efficiency, an optimization of operations and the maintenance of the building.

EVALUATION PARAMETERS MATRIX

SHEET 5

The impact of the criteria on the different measurement parameters were thereby evaluated in a three-stage classification. The following symbols were used:

● ●	**HIGH IMPACT** on the valuation parameters
●	**LOW IMPACT** on the valuation parameters
○	**NO IMPACT** on the valuation parameters

This evaluation is based on the experience of all stakeholders' previously planned and carried out projects in the health sector.

In addition to the criteria, the indicators are shown, with which the quantitative or qualitative assessment of the individual criteria can be carried out.

The matrix serves as an overview of the examined groups and rating criteria. The evaluation of each criterion can be rediscovered in the notes of Chapter 3. As subgroups of the evaluation criteria, a sorting in building, interior, energy, facility management and other reference points can be found hereafter.

SHEET 6

TOPIC	CRITERIAS	EVALUATION PARAMETERS							
		ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
EXTERIOR	EXTERIOR DESIGN	●	●●	●	●●	○	●●	●●	●
	PUBLIC ACCESSIBILITY	○	○	●	●●	○	●●	○	○
	TRANSPORT CONNECTION	○	●●	●	●●	○	●	○	○
BUILDING	CUBATURE	●	●	●	○	○	●	○	○
	NATURAL LIGHTING	●●	●	●	●●	●	●●	○	○
	AIRTIGHTNESS	●●	●●	●	●	●●	●●	●●	●●
	MOISTURE PROTECTION	●●	●	●	●●	●●	●●	●●	●●
	OPAQUE COMPONENTS	●●	●	●	●	●●	●●	●●	●●
	TRANSPARENT COMPONENTS	●●	●	●	●●	●●	●●	●●	●●
	BUILDING MATERIALS & RECYCLING	●	●●	●●	●●	●●	●●	●	○
INTERIOR	FIRE PROTECTION	○	●	●●	○	●●	●●	●●	●
	SOUNDPROOFING	○	○	●	●●	●	●●	●●	●
	ACOUSTIC COMFORT	○	○	●●	●●	●	●●	●	○
	VISUAL COMFORT	●	○	●	●●	●	●●	○	○
	THERMAL COMFORT	●●	●	●●	●●	●	●●	○	●
	HYGIENE & INDOOR AIR QUALITÄT	●●	●	●●	●●	●	●●	●	●
	ACCESSIBILITY	○	○	●●	●●	●	●●	●	●
	SECURITY	●	○	●●	●●	○	●●	●●	●
	INTERIOR DESIGN	●	○	●●	●●	○	●●	●	●
ENERGY	ENERGY REQUIREMENTS - BUILDING	●●	●●	●●	●	●	●●	○	○
	HEATING	●●	●	●●	●	●	●●	●	●●
	HOT WATER	●●	●	●●	●●	●	●●	●	●●
	BUILDING COOLING	●●	●●	●●	●	●	●●	●	●
	VENTILATION	●	○	●●	●●	●	●●	●	●●
	DE- AND HUMIDIFICATION	●●	●	●●	○	●●	●	●●	●●
	LIGHTING	●●	●	●●	●●	●●	●●	●	●
	STORAGE	●●	●	●●	●	●●	●	●	●
	PROCESS ENERGY	●●	●	●●	●	●●	●●	●	●●
	INTERNAL LOADS	●●	●	●	●	●●	●●	●	●●
	RENEWABLE ENERGY	●●	●●	●●	●	●●	●●	●●	●●
FACILITY MANAGEMENT	REGULATION & CONTROL	●●	●	●●	●	●●	●●	●●	●●
	CLEANING & MAINTENANCE	●	●●	●●	●	●	●●	●●	●●
	WATERSUPPLY & WASTE WATER DISPOSAL	●	●●	●●	●	●●	●●	●	●●
	WASTE MANAGEMENT	○	●●	●●	●	●	●●	●	●●
	INFLUENCE OF THE USER	●	○	●	●●	●	●●	○	○

Fig.3 Evaluation criteria - MATRIX Stage 1

EVALUATION CRITERIA 1. EXTERIOR

1.1 EXTERIOR DESIGN

DEFINITION / DESCRIPTION

Outdoor lying common areas in the immediate vicinity of the building offer individually usable break, communication and retreat areas and thus serve the common welfare and different needs of individual user groups. They promote the exchange between the different users and support the recovery process (reduction of pain/ reducing medication distribution) with a view into the surrounding green environment. Additionally, it can contribute to the general acceptance of a building.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	●	● ●	○	● ●	● ●	●

EVALUATION & EVALUATION STANDARD
The assessment is divided into **quantitative**:

- Roof greening (flat roofs
  $R_{IST} = R_{MAX} - NR$
  R_{MAX} = Total roof area minus the various roof structures and roof construction (attica formation, technology constructions, skylights, etc.)
  ND = Roof area without qualitative assessment (gravel strips, bitumen surfaces, etc.),
- Facade-integrated outdoor spaces (balconies, terraces loggias),
- Guilding integrated outdoor areas / grassed interior areas (atria, covered patios, etc.),
- Facade greenery,

and **qualitative**:

- Design concept for outdoor facilities including the integration of technical facilities,
- Use of native plants for planting,
- Use of outdoor facilities for the general public,
- Features of the outdoor surfaces,
  (seating and resting facilities, water elements, sun protection, etc.)

INTERACTION WITH OTHER CRITERIA
1.2, 1.3, 3.7 – 3.9, 4.4, 6.1 – 6.3

1.2 PUBLIC ACCESSIBILITY

DEFINITION / DESCRIPTION
Through a good publicly accessible building with a diverse range of use, the societal as well as its integration into the urban context, is promoted. Principally publicly accessible is understood as the free access to the building and to the reception area in connection with other facilities and premises (outdoor facilities, cafeteria, etc.) that are available for usage to the general public.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	●	●	● ●	○	● ●	●	●

EVALUATION CRITERIA 1. EXTERIOR

EVALUATION & EVALUATION STANDARD

- Accessibility for the public,
- Opening internal building facilities (cafeteria, canteens, leisure facilities, etc.),
- Use of outdoor facilities for the general public,
- Mixed use of the public areas,
- Renting of premises by third parties (doctors' offices, etc.)

INTERACTION WITH OTHER CRITERIA
1.1, 1.3, 3.7 – 3.9, 6.1 – 6.3

1.3 TRANSPORT CONNECTION

DEFINITION / DESCRIPTION
To ensure quality of the site, the connection of a building to different means of transport - ecofriendly private transport - is an important criterion. For a hospital, the connection to the public transport is of particularly high importance.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	●●	●	●●	○	●	○	○

EVALUATION & EVALUATION STANDARD

Accessibility of the nearest access point of public transport (bus, train, tram, etc.) - > max. 500m:
Development of the site by bicycle paths:

- Short (max.600m) accessibility to the closest point of public transport (bus, tram, train, etc.),
- Quality of the road connection (connection to the developed main road, motorway access via a good arterial road),
- Individual parking concept (parking for people with mobility limitation, bicycle parking/ taking shelter facilities, temporary parking for emergency physician, delivery, etc.),
- Good accessibility (no crossing without traffic lights or use of multi-lane roads that are desig-ned solely for motorized traffic),
- Development of the site by existing bicycle network

INTERACTION WITH OTHER CRITERIA
1.1,1.2, 3.7, 3.8, 6.1, 6.2

2.1 CUBATURE

DEFINITION / DESCRIPTION
The cubature of a structure describes its shape and volume. In terms of energy efficiency in particu-lar the compactness of the building is relevant..

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	●	●	○	○	●	○	○

EVALUATION CRITERIA 2. BUILDING

EVALUATION & EVALUATION STANDARD
For the energetic evaluation, the A / V ratio of a building is considered. Here the thermal envelope surface of the building is divided by its volume. At constant volume, this means, the smaller the quotient, the smaller is the heat transferring outer surfaces of the building. In addition to the A / V ratio also the shape of the building has a significant influence on the transmission heat loss. Inclined facades have, for example, in clear nights a higher proportion of long-wave heat radiation.

INTERACTION WITH OTHER CRITERIA
2.2, 3.9, 4.1, 4.2, 4.4, 4.11, 6.3, 6.4

2.2 NATURAL LIGHTING

DEFINITION / DESCRIPTION
The natural lighting is being guaranteed by sufficiently large windows, skylights or other transparent components. Due to a high amount of natural lighting, a reduction in lighting energy and cost needed for artificial light can be obtained. In addition, a visual connection to the outside has also a psychological impact on the well-being of users.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	●	● ●	●	● ●	○	○

EVALUATION & EVALUATION STANDARD

- Geometric conditions (size % position of the window openings, room depth), DIN 5034,
- Spatial orientation,
- External shading by vegetation or neighboring buildings,
- Day light factor D
  D_{MIN} = 0,75 % (bed rooms, work areas)
  D_{MEDIUM} = 0,9 % (bed rooms, work areas)
  D ≥ 2 % (work areas with skylight),
- glare / sun protection,
- Operation of the glare / sun protection (automatic, manual),
- Daylight supply when sunlight or glare protection is activated,
- transparent internal components, design of surfaces (color, roughness)

INTERACTION WITH OTHER CRITERIA
2.1, 2.6, 3.4 – 3.6, 3.9, 4.1, 4.2, 4.4, 4.7

2.3 AIRTIGHTNESS

DEFINITION / DESCRIPTION
The thermal envelope shall be designed in such a way that the heat transferring surrounding surfaces including the joints are permanently airtight. Otherwise, unwanted ventilation heat losses lead to in-creased heating demand or noticeable drafts occur at high wind loads. In addition, an air-tight construction prevents outflow of the usually humid room air into the insulation level of the external compo-nents where it can condense below the dew point and cause massive structural damage.

RELEVANCE

EVALUATION CRITERIA 2. BUILDING

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TTECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	●	●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD
The airtightness of a building can be examined using a blower door test. Here, the measured air ex-change at a pressure difference between the inside and outside of 50 Pa below shall not ex-ceed:

n_{50} ≤ **3,0 h^{-1}** in buildings without air-conditioning systems
n_{50} ≤ **1,5 h^{-1}** in buildings with air-conditioning systems

In addition to the tightness of the building envelope, a minimum air exchange must be guaranteed according to valid Energy Saving Ordinance. In special cases (eg facades towards busy roads) natu-ral ventilation is normally not possible or only with cost-intensive measures (eg. baffles, etc.), due to noise and the outside air quality.

INTERACTION WITH OTHER CRITERIA
2.4 - 2.7, 3.1, 3.2, 3.6 – 3.7, 3.9, 4.1, 4.2, 4.4, 4.5

2.4 MOISTURE PROTECTION

DEFINITION / DESCRIPTION
In principle, we distinguish between constructive and climate-induced moisture protection. The former deals with construction waterproofing to protect against precipitation events, stagnating groundwater or the like. The climate-induced protection against moisture investigates condensa-tion and mold formation as well as material corrosion in or on components. Non-compliance of humidity protection can lead to massive damage, deterioration of indoor air quality, reduced heat protection or infestation by insects or fungi.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	●	● ●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD

Constructive moisture protection:
construction waterproofing according to DIN 18195, ISO 13788
- soil moisture DIN 18195-4,
- non-pressing water DIN 18195-5,
- Externally pressing water DIN 18195-6,
- internally pressing water DIN 18195-7,

climate-induced moisture protection:
- formation of condensation according to DIN 4108-3, DIN EN ISO 13788,
- heat transfer resistances of external components according to DIN ISO 6946,
- airtight construction,
- air change according to room usage (moisture loads),
- Use of heat and humidity coupled dynamic simulations (WUFI, DELPHI), especially in interior insulation and complex existing structures

INTERACTION WITH OTHER CRITERIA
2.3, 2.5 – 2.7, 3.5 – 3.7, 3.9, 4.1, 4.2, 4.5

EVALUATION CRITERIA 2. BUILDING

2.5 OPAQUE COMPONENTS

DEFINITION / DESCRIPTION
Opaque components are made of opaque materials and form usually the largest surface area of the thermal building envelope. This includes exterior walls, roofs and floor slabs. In most cases, these components are made up of several layers.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	●	●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD
To evaluate the energetic quality of the surrounding surfaces, heat transferring the heat transfer coefficient U [$W/(m^2 \cdot K)$] is used in accordance with DIN EN ISO 6946. To evaluate according to EnEV, the weighted average U-value $\bar{U}$ is considered. This is composed of all heat transfer coefficients of the opaque exterior components of the building, depending on the area fractions. The influence of the thermal properties of the ground contact components is weighted with 0.5.

Limit: Compliance with minimum thermal insulation **DIN 4108 – 2** ($U \leq 0{,}73$ $W/(m^2 \cdot K)$)
Reference value*: $\bar{U} \leq 0{,}35$ $W/(m^2 \cdot K)$ (EnEV 2014)
Target value*: $\bar{U} \leq 0{,}28$ $W/(m^2 \cdot K)$ (EnEV 2016) * for rooms with target temperatures ≥ 19 °C

The reflective properties of the surface of opaque component parts and the associated thermal heat input play a rather minor role in Germany. Due to the high insulation quality of the thermal building envelope and the low average temperatures outside, the thermal heat inputs generated by means of opaque component parts are generally not recognized or recorded in the balance. In hot climatic regions, however, the impact of the solar radiation on opaque component parts may be considerably higher, which, again, calls for an appropriate solution with respect to the night cooling and the conflicting goals as the ultimate goal is the insulation of an opaque building envelope.

INTERACTION WITH OTHER CRITERIA
2.3, 2.4, 2.7, 3.5, 3.6, 3.9, 4.1, 4.2, 5.2

2.6 TRANSPARENT COMPONENTS

DEFINITION / DESCRIPTION
Transparent components are translucent. These include, for example, windows and glass facades. While the insulation quality of these is generally worse than that of the opaque insulated components, energy in the form of solar radiation can pass into the building due to the transparency. This results in additional demands on the summer heat protection to avoid the overheating of rooms. In addition, the use of daylight is ensured in the building through transparent components. The quality of the stay and significantly the energy required for lighting depend on this.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	●	● ●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD
To evaluate the transmission heat transfer through the transparent devices, the U-value [W / (m • K)] is used. In addition the total energy transmittance g, as a measure of the permeability of the transparent components for energy, the light transmittance value U is a measure for the radiation in the visible range that passes perpendicularly through the glazing. An important planning task is to

EVALUATION CRITERIA 2. BUILDING

optimize the physical properties of the transparent components for the winter and the summer. Through the use of automatic sun protection devices, the interaction between the parameters in summer and winter can be optimized.

U-value [W/(m²·K)]:
Limit: $U_f \le 2,9$ (DIN 4108 – 2)
Reference value*: $\bar{U} \le 1,90$ (EnEV 2014)
Target value*: $\bar{U} \le 1,50$ (EnEV 2016)

*for rooms with target temperatures ≥ 19 °C

Solar transmission **value S**:
Reference value / limit: $S_{vorh} \le S_{zul}$
Target value: $S_{vorh} \le 0,8\ S_{zul}$

INTERACTION WITH OTHER CRITERIA
2.2 – 2.4, 2.7, 3.5, 3.6, 3.9, 4.1, 4.2, 4.4, 4.5, 4.7,5.2

2.7 BUILDING MATERIAL & RECYCLING

DEFINITION / DESCRIPTION
The choice of materials has an influence on many characteristics of a building (optics, haptics, costs, interaction with environment, etc.). Depending on the configuration of certain components, corresponding materials are to be selected. Here, for example, structural, building physical or economic aspects can be decisive. In order to promote material cycles and reduce the burden on the environment, it is desirable to use recyclable materials.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	● ●	● ●	● ●	●	○

EVALUATION & EVALUATION STANDARD
For the evaluation of a building material, the following criteria are to be considered, regardless of its functional requirements:

- Energy and resource consumption in manufacturing and disposal (EPD),
- Potential risk for the environment and the user (GISCODE, EMICODE, Blauer Engel, AgBB),
- Environmental and human toxicity (heavy metals, CFCs, HCFCs, car-cinogenicity, etc.),
- Durability and economy,
- Behavior in case of fire,
- Recyclability and the effort required for this (energy, time, cost, etc.)

In order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

INTERACTION WITH OTHER CRITERIA
2.3 – 2.6, 3.1, 3.3, 3.4, 3.6, 3.9, 4.1, 4.11, 5.2

EVALUATION CRITERIA 3. INTERIOR

3.1 FIRE PROTECTION

DEFINITION / DESCRIPTION
Fire incidents threaten people, cause damages to the building and may produce hazardous emissions. The minimum requirements are in the respective building regulations, the specifically created fire pro-tection plan of a building or the special building codes, such as the high-rise building policy. Through structural and technical measures, fire protection can be planned, that goes beyond the minimum requirements.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	●	● ●	○	● ●	● ●	● ●	●

EVALUATION & EVALUATION STANDARD
Compliance with legal provisions/ conditions relating to fire protection of the building permit (including deviation requests and approvals in each individual case).

Structural fire protection:
- Training of fire and smoke compartments,
- Undercutting the max. permissible escape route lengths by 20%,
- Exceeding the in the building regulations required escape route width by at least 25%,
- Prevention of fire gas risks (PVC in building materials),

Plant fire protection:
- Installation of extensive fire alarm system,
- Installation of security lighting,
- Installation of air vents for automatic smoke exhaust system,
- Installation of a BOS-building radio system for the fire department,
- Marking of safety equipment (fire extinguishers, fire hydrants, etc.),
- Prevention of fire gas risks (halogen-free cables/ lights)

INTERACTION WITH OTHER CRITERIA
2.3, 2.7, 3.2, 3.8, 3.9, 4.2 – 4.7, 5.1 – 5.3, 6.3, 6.4

3.2 SOUNDPROOFING

DEFINITION / DESCRIPTION
For a hospital, the insurance of a minimum audible quality is an indispensable prerequisite to the creation of the necessary peace and the protection of legitimate expectations for patients. A high sound insulation technical quality is an essential part of the comfort and satisfaction of the users. The set minimum requirements by the building regulation must be met.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	●	● ●	●	● ●	● ●	○

EVALUATION & EVALUATION STANDARD
Compliance with legal provisions/ requirements according to the generally recognized rules of technology.

EVALUATION CRITERIA 3. INTERIOR

- DIN 4109 „hospitals, sanatoriums" (minimum requirement),
- Sound insulation requirements against external noise,
- Noises from domestic installations,
- Formation of a higher sound insulation (compliance with minimum requirement) in accordance with Bblt. 2 to DIN 4109

Evaluation variables:
- Air damping characteristics:
- Sound level from domestic installations

INTERACTION WITH OTHER CRITERIA
2.3, 3.1, 3.9, 4.2 – 4.6, 5.2, 6.3, 6.4

3.3 ACOUSTIC COMFORT

DEFINITION / DESCRIPTION
The room acoustic properties of a hospital have a major impact on the comfort of users. Firstly, the performance of the hospital staff will be affected and on the other hand the room acoustic quality affects the well-being and recovery of patients. In particular, the speech intelligibility in working and meeting rooms and the background noise level can be used as an assessment parameter. The acoustic comfort interacts with the noise reduction measures in kitchens, dining rooms, laundries and noise-sensitive communal areas.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	● ●	● ●	●	● ●	●	○

EVALUATION & EVALUATION STANDARD

In order to evaluate the acoustic comfort, the reverberation time T of the unfurnished space in the frequency range of 125 - 4000 Hz is determined:

small rooms ($A_{netto} \leq 50m^2$)
eg. treatment rooms
$T \leq 0{,}8$ s (good room acoustics)
$T \leq 0{,}5$ s (comfortable room acoustics)

bigger rooms ($A_{netto} > 50\ m^2$)
eg. operating theaters
$T \leq 1{,}0$ s (good room acoustics)
$T \leq 0{,}5$ s (comfortable room acoustics)

For larger rooms, such as dining rooms and living areas the ceiling reflection prevails.
Here, the **A_R/V_R-ratio**
(effective absorbing room surface $A_R = \sum_{n} \alpha \cdot S_i$) of a room according to DIN 18041 (for office areas VDI 2569) and DIN EN 12354-6 is being determined. Whereas A_R is the overall equivalent sound absorption area in a room and V_R its volume.

$A_R / V_R \geq 0{,}23\ m^{-1}$ (good room acoustics)
$A_R / V_R \geq 0{,}28\ m^{-1}$ (comfortable room acoustics)

INTERACTION WITH OTHER CRITERIA
2.7, 3.9

EVALUATION CRITERIA 3. INTERIOR

3.4 VISUAL COMFORT

DEFINITION / DESCRIPTION
Like the acoustic comfort, visual comfort massively influences the quality of the indoor climate. The working conditions of hospital employees are to be addressed, just like patient satisfaction. In the visual comfort both natural lighting and artificial lighting is considered. The aim is to provide high quality lighting with low energy use.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	●	●●	●	●●	○	○

EVALUATION & EVALUATION STANDARD

- Daylight availability evaluation through daylight factor D,
- Light level
  room specific, according to use, e.g.:
  Corridors, bed rooms: eye level 500 lx, ground 200 – 300 lx
  Examination and treatment rooms: 1000 lx, ground 200 – 1000 lx,
- Visual contact to the outside,
- Light distribution of artificial light by means of combined direct / indirect lighting,
- Absence of glare
  glare protection for daylight
  for artificial light UGR_L = 19,
- Color rendering (for artificial light color rendering index R_a 80 – 90 %)

INTERACTION WITH OTHER CRITERIA
2.2, 2.7, 3.8, 3.9, 4.1, 4.4, 4.7, 5.5

3.5 THERMAL COMFORT

DEFINITION / DESCRIPTION
The thermal comfort takes into account the ambient air temperature, the air humidity, drafts and radiation asymmetries occurring through different surface temperatures (ISO EN DIN 7730). Only an optimal range of all components mentioned ensures the thermal comfort of the users. In this case, it acts both on the job situation of the employees as well as on the well-being or the quality of patient recovery. Additional requirements on thermal comfort may result from therapeutic or diagnostic targets.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●●	●	●●	○	●

EVALUATION & EVALUATION STANDARD

Operational temperature:
- Thermal room or building simulation
- Measurement
- heating load calculation according to DIN EN 12831 (winter case)
- Cooling load calculation according to VDI 2078 (summer case)

Draft:
- indoor air flow simulation

EVALUATION CRITERIA 3. INTERIOR

Radiation asymmetries:
- Surface temperatures according to VDI 3804

Relative humidity:
- In case of mechanical ventilation air humidity requirements according to DIN EN 15251

Under certain circumstances, additional requirements for thermal comfort may result from therapeutic or diagnostic targets.

INTERACTION WITH OTHER CRITERIA
2.2 – 2.6, 3.9, 4.1 – 4.10, 5.1, 5.6

3.6 HYGIENE & INDOOR AIR QUALITY

DEFINITION / DESCRIPTION
A high indoor air quality is to ensure that the well-being and health of the users are not affected. Especially in permanent employment and living spaces hygiene is to be ensured. Concentrations of harmful substances and olfactory perceptions that are perceived as unpleasant must be avoided. By the appropriate design of a neces-sary ventilation rate using openable windows or a ventilation system, a high-quality indoor air is sought. Fur-thermore, additional odors and emissions can be avoided through a targeted building product selection.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	● ●	•	● ●	●	●

EVALUATION & EVALUATION STANDARD

Volatile organic connections (VOC):
- Use of low-emission declared building products („Blue Angel“, EmiCode, admission test of the „Committee for health-related evaluation of building products“ (AgBB),
- Measurement after completion of the building,

Ventilation rate:
- DIN EN 15251 – Determining the ventilation rate in dependency of the function,
- DIN EN 13779 (CO_2 - concentration outdoor air 400 ppm),
- Up to 800 ppm = high indoor air quality / 800-1000 ppm = medium indoor air quality

INTERACTION WITH OTHER CRITERIA
2.2 – 2.7, 3.9, 4.1 – 4.6, 4.9, 5.1 – 5.4, 6.3, 6.4

3.7 ACCESSIBILITY

DEFINITION / DESCRIPTION
For the pioneering and sustainable use of a building, a maximum accessibility of the indoor area as well as the associated outdoor areas is of critical quality. The entire built environment with the variety of different situations should be accessible and usable for every human being without any difficulties and without any outside assistance. This especially applies for public usage areas, for the outer and inner development of a building and for the specifically usage designated areas. Through predictive solutions in the planning phase, costs for additional adjustments can be largely avoided. In comparison, hospitals are used by an above average number of people with physical limitations as also different user groups (patients, staff, visitors).

EVALUATION CRITERIA 3. INTERIOR

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	●●	●●	●	●●	●	●

EVALUATION & EVALUATION STANDARD

- Compliance with the general accepted rules of technology in accordance with § 4 / § 8 para. 1BGG and the currently valid building model of all paragraphs and requirements concerning accessibility (minimum requirement),
- DIN 18040-1,
- DIN 18040-3 (Replacement DIN 18024-1:1998-1: „Accessible building - part 1: streets, plazas, paths, public transport, parks, playgrounds and planning basics.",
- Technical rules for workplaces (ASR) in accordance with § 3a paragraph 2 of the Labour Ordinance „barrier-free design of workplaces [cf. ArbStättV (2004)],
- Disabled/ handicapped-accessible design of the patient (care, examination & treatment, etc.), visitor (hallways, lounges, etc.) and personnel areas (workplaces, lounges, etc.),
- Barrier-free design of the exterior

INTERACTION WITH OTHER CRITERIA
1.1 – 1.3, 2.3, 2.4, 3.8, 3.9, 4.3, 4.5, 4.7, 5.1, 5.2, 6.3, 6.4

3.8 SECURITY

DEFINITION / DESCRIPTION
A high sense of security fundamentally contributes to human comfort. Measures that increase the sense of security are usually also suitable for the reduction of risk of attacks by other people. The aim is to avoid dangerous situations and to reduce the impact of a non-preventable damage caused by force majeure as much as possible.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	●●	●●	○	●●	●●	●

EVALUATION & EVALUATION STANDARD

Protection against attacks / Improved sense of security:
- Clear routing (visibility, signalization),
- Illuminate the paths to public outdoor spaces and corridors in the building,
- Paths to security-enhanced parking/ bicycle parking spaces (short distances, lighting),
- Technical safety installations (video equipment, emergency telephones)
- Safety also outside of the normal working and opening times (gatekeeper, janitor)

Reducing the extent of damage in the event of loss event:
- Evacuation plans (event of damage outside the building e.g. bomb threat)
- Evention of the risk of fire gases due to various building materials (Halogen, PVC)
- Barrier-free escape ways (additional measures beyond legal requirements)
- Operating instructions for the ventilation and air-conditioning technology (HVAC-Systems) for the case of polluted air (in the event of fire)

INTERACTION WITH OTHER CRITERIA
1.1 – 1.3, 3.1, 3.4, 3.7, 3.9, 4.7, 5.1, 5.2, 6.1, 6.3

EVALUATION CRITERIA 3. INTERIOR

3.9 INTERIOR DESIGN

DEFINITION / DESCRIPTION

Especially in the health care system very specific demands are placed on the floor plan and interior design, as these have a significant impact on its functionality and flexibility in terms of different usages. Additionally, both of these factors significantly contribute to the spatial and aesthetic quality, acceptability and value stability of a building, which can promote the sustainability of a property in the long term. By planning as many transparent and visible areas as possible, additional spatial and functional features and a high quality of design of the functional areas can increase the well-being of each user group.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	● ●	● ●	○	● ●	●	●

EVALUATION & EVALUATION STANDARD

Mix of various usage possibilities:

- Additional potential uses (use of traffic and access area as lounge and communication zones,
- Community installations (seating, multi-purpose rooms),
- Additional services for users (cafeteria, gym, child care, etc.),

Quality of the usage area:

- Lounge and seating possibilities in the internal entrance and reception area,
- Natural lighting,
- Visual references, visibility in the interior and connection to the exterior spaces,
- Overall design/ ability of flexible furnishing,
- Storage and placing space,

INTERACTION WITH OTHER CRITERIA

1.1, 1.2, 2.1 – 2.7, 3.1 – 3.8, 4.2 – 4.7, 4.10, 6.3, 6.4

EVALUATION CRITERIA 4. ENERGY

4.1 ENERGY REQUIREMENTS - BUILDING

DEFINITION / DESCRIPTION
The energy demand of a building is determined by calculation and the energy consumption is being captured by measurement. It is composed of the energy demand for heating, ventilation, air conditioning, hot water and lighting. In addition, auxiliary energy sources are recognized, which are needed for energy supply. Not considered is the energy requirement for use-related systems or processes such as medical equipment in the building. For the distinction between final and primary energy requirements, the calculated final energy demand is multiplied by a primary energy factor for the respective power supply form, whereby amounts of energy from the upstream process chain (production, transformation and distribution) are being considered.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●●	●●	●	●	●●	○	○

EVALUATION & EVALUATION STANDARD

Final energy demand:
Calculation by reference building method according Energy Saving Ordinance and DIN V 18599 „Energy performance of buildings"

Primary energy demand:
The use of renewable or fossil energy is accounted for by the primary energy factor.
Comparison with primary energy demand of the reference building according to Energy Saving Ordinance 2014: $\mathbf{Q_p \leq Q_{p,Ref}}$

n order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

INTERACTION WITH OTHER CRITERIA
2.1 – 2.7, 3.4, 3.6, 4.2 – 4.11, 5.1 – 5.3, 6.2 – 6.4

4.2 HEATING

DEFINITION / DESCRIPTION
Heat generation systems, including distribution and storage have a great influence on the energetic quality of the building. The dimensioning of the heating generation systems is based on the transmission heat losses (through the thermal envelope including thermal bridges) and the ventilation heat losses (through infiltration and the use-related air exchange). The design temperatures of the heat generation have a direct influence on the thermal comfort in winter.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●	●	●●	●	●●

EVALUATION CRITERIA 4. ENERGY

EVALUATION & EVALUATION STANDARD

- **Producer:**

Fossil: Constant temperature boilers, condensing boilers *, low temperature boilers, combined boiler
Regenerative: geothermal, solar thermal

* For improved condensing boilers with higher temperatures, exhaust gas heat exchanger help in increasing the efficiency.

- **Energy sources**:

Oil, natural gas, LPG, coal, wood / pellet, biogas, solar, electricity

- **Heating system / heating energy transfer:**

The following heating systems are possible: surface heating, free heating surfaces (radiators), thermally activated components, electric blankets, heating and air through the HVAC
Position of the transfer (radiators): in front of inner walls / external walls

- **Heating times:**

The heating times are calculated for particular rooms depending on utilization and as a function of degree days, which result from the outside temperatures. A night and weekend setback in certain zones reduces the energy consumption.

- **Heating distribution:**

One / two-pipe system,
Before-and return temperature,
Pipe length and cross-section,
circulation pump,
Hydraulic balancing
Non-insulated pipes U ≤ 1,00 W/(m·K) (distribution / sections / connection)
insulated pipes U ≤ 0,200 W/(m·K) (distribution)
U ≤ 0,255 W/(m·K) (sections / connection)

- **Control:**

Inertia of the heating medium (example underfloor heating),
Zones / room-side control,
Intermittent heating mode / room-by-room reduction

INTERACTION WITH OTHER CRITERIA
2.1 – 2.6, 3.1, 3.2, 3.5, 3.6, 3.9, 4.1, 4.5, 4.8 – 4.11, 5.1 – 5.3

4.3 HOT WATER

DEFINITION / DESCRIPTION
In hospitals, high demands are being made on domestic hot water systems and their quality. Due to the use, large hot water distribution systems with central domestic hot water production are often installed in the buildings. Large storages ensure the hot water supply in compliance with the security of supply and seasonal demand at any time. The design temperatures of the production and distribution result from hygienic requirements for the absence of Legionella. By appropriate insulation of the wires and insulated reservoirs, heat loss must be avoided and the energy requirements reduced. An energy efficient support of the production of hot water is possible through the use of solar thermal systems.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●●	●	●●	●	●●

EVALUATION CRITERIA 4. ENERGY

EVALUATION & EVALUATION STANDARD

- **Production:**

Outlet temperature at the domestic hot water generator: ≥ 60 ° C (DVGW W 551)
Centralized and decentralized

- **Distribution:**

Hot water temperature in circulation systems: ≥ 55°C (DVGW -work sheet W 551)
Temperature reduction max. 8h/24h (DVGW -work sheet W 551)
Implementation of a hydraulic balancing to avoid pressure and distribution losses

length and cross-section of the piping	
Non-insulated pipes	U ≤ 1,00 W/(m·K) (distribution / sections / connection)
insulated pipes	U ≤ 0,200 W/(m·K) (distribution)
	U ≤ 0,255 W/(m·K) (sections / connection)

- **Energy sources:**

Oil, natural gas, LPG, coal, wood / pellet, biogas, solar

- **Circulation pump:**

Regulated, unregulated, demand-driven, over-sized, electric power, pump expenditure figures

INTERACTION WITH OTHER CRITERIA
3.1, 3.2, 3.5 – 3.7, 3.9, 4.1, 4.8 – 4.11, 5.1 – 5.3

4.4 BUILDING COOLING

DEFINITION / DESCRIPTION
With increasing internal heat loads caused by medical devices, etc., and increased requirements for the reduction of transmission heat losses of the building envelope, energy-efficient building cooling is gaining on significant importance. For new, increasingly complex buildings in the health sector, the factor ‚cold' is already more important than heating. The conventional technical building services via compression chillers or the combination of cogeneration with absorption chillers are available energy efficient alternatives based on evaporation processes. Passive cooling of buildings on roof and facade greening complement the technical systems. Another option is the greening of facades with climbing plants that are deciduating in autumn. In the summer they offer shading, with the shading proportion being determined by how the climbing ropes are placed. Furthermore, evaporative cooling is generated by the plant.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	● ●	●	●	● ●	●	●

EVALUATION & EVALUATION STANDARD

- Adiabatic cooling in air conditioning systems,
- Construction of an energy efficient cooling network via hybrid cooler for year-round free cooling,
- Decentralized waste heat management for process energy and medical equipment,
- Building greening, high vegetation proportion in the building environment

DIN V 18599 „Energy performance of buildings", EEWärmeG, EnEV

When it comes to the choice of the refrigerant, the check of the environmental compatibility of the coolant is indispensable. This goes in particular for the global warming potential (GWP) and the ozone depletion potential (ODP). The use of CFC-, HFC-, PFC-, HFC-containing coolants has already

EVALUATION CRITERIA 4. ENERGY

been pro-hibited in Germany, resp. allowed to a limited extent. Alternative coolants come in the form of propane, propylene, ethane, and isobutene.

INTERACTION WITH OTHER CRITERIA
1.1, 2.1 – 2.3, 2.6, 3.1, 3.2, 3.4 – 3.6, 3.9, 4.1, 4.5, 4.6, 4.8 – 4.11, 5.1 – 5.3, 6.3, 6.4

4.5 VENTILATION

DEFINITION / DESCRIPTION
Basically, ventilation can be divided into free window ventilation and mechanical ventilation through room ventilation equipment. Air conditioning systems are being planned for certain areas in hospitals, as there are special requirements for indoor air quality. This is especially true in operating rooms and intensive care units. Here germs, odors or other air pollution can be selectively discharged. In addition, the supply air can be conditioned with regard to heat, cold, or humidity.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	● ●	● ●	●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Energy demand air transportation,
- Dependent on flow rate, time-and use-dependent, depending on cooling load (if applicable),
- Daily operating hours,
- Energy demand air conditioning,
- Draft risk,
- Room Conditioning:
  heating,
  cooling,
  humidification & dehumidification,
- recovery system
  heat recovery (≥ 75 %),
  moisture recovery

INTERACTION WITH OTHER CRITERIA
2.3, 2.4, 2.6, 3.1, 3.2, 3.5 – 3.7, 3.9, 4.1, 4.2, 4.4, 4.6, 4.9 – 4.11, 5.1, 5.2

4.6 DE- & HUMIDIFICATION

DEFINITION / DESCRIPTION
The conditioning of the air in hospitals can lead to a considerable energy demand. This is in particular due to the high demand for humidification and dehumidification in combination with high air change rates. In humidification and dehumidification, the phase change of water, between liquid and gaseous state, is overcome with 700 kWh/m³. The humidification via steam is exergetically expensive. At a direct high-pressure humidification, a heat demand is created for post-heating. The dehumidification of the supply air via the summer chillers should also be avoided. As an energy-efficient alternative, sorption processes on silica gel (rotary heat exchangers) or liquid salt solutions can be considered.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	○	● ●	●	● ●	● ●

EVALUATION CRITERIA 4. ENERGY

EVALUATION & EVALUATION STANDARD

The air exchange rates are to be limited to the hygienic minimum and to be steered presence-dependent e.g. by CO_2 measurements. Wherever possible humidification and dehumidification should be avoided in most functional departments. Wherever necessary, the humidification should be oriented on the humidity of the air. The latent heat recovery in winter through sorption with indirect transmission of exhaust air humidity with simultaneous heat recovery is aiming at. Additionally to so far widespread sorption wheels, liquid and at the same time sanitizing salt solutions for complete separation of supply and exhaust air is preferable. In summer, the salt solutions of energy-efficient dehumidification can deliver the potential of regeneration of the brine solution, ambient heat or waste heat utilization.

INTERACTION WITH OTHER CRITERIA
3.1, 3.2, 3.5, 3.6, 3.9, 4.1, 4.4, 4.5, 4.9 – 4.11, 5.1 – 5.3, 6.3, 6.4

4.7 LIGHTING (ARTIFICIAL LIGHT)

DEFINITION / DESCRIPTION
The illumination by artificial light ensures the coverage of areas with little or no natural light. Typical of hospitals are the long periods of use. It is being used here also during nights and weekends. The energy demand for artificial light is highly dependent on the individual components of the illumination. The more efficient they are, the higher the energy savings.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●●	●●	●●	●	●

EVALUATION & EVALUATION STANDARD

- **Required illuminance (at the height of the utilization level)**

Specific room according to use, for example,
Corridors: 100 lx,
Bed room (general / simple bedside examinations): 100/300 lx,
Examination and treatment rooms (general / examination place): 500/1000 lx

- **Illuminants:**

halogen spotlight:	ca. 95 % heat / 5 % light
Fluorescent lamp:	ca. 60 % heat / 40 % light
Energy saving lamps:	ca. 75 % heat / 25 % light
LEDs:	ca. 10 % heat / 90 % light

LEDs are characterized not only by their efficiency and low energy consumption but also by their long service life and mechanical insensitivity.

- **Presence detector:**

Due to their high detection quality, these are well suited for indoor areas and register even the smallest change in the thermal image within the room.

- **Constant light control:**

The adjustment of the lighting level can be made via dimmable actuators using light sensors.

- **Daylight-supplied areas**

Operating time:
Use of daylight hours
Use to daylight hours

EVALUATION CRITERIA 4. ENERGY

- **Ballasts:**

Electronic ballasts (EB) should be preferable to low-loss devices (LLB) & conventional devices (CB).

INTERACTION WITH OTHER CRITERIA
2.2, 2.6, 3.1, 3.4, 3.5, 3.7 – 3.9, 4.1, 4.9 – 4.11, 5.1, 5.2

4.8 STORAGE

DEFINITION / DESCRIPTION
The storage of heat and hot water is for large buildings such as hospitals of high relevance. This guar-antees a daytime independent provision of hot water or heating. Especially with the use of renewable energies, the storage of heating in buffer storage is important because the heat demand is not time-coincident with the production in some cases. Likewise, in the operation of CHP modules, the storage allows a time-varying current production taking account load peaks in the National power grid. Furthermore, the storage of electricity both in the use of PV as well as to ensure security of supply during power outages is possible as a combination with UPS.
As a relatively new method, the storage of latent heat via sorption systems is possible.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	○	●●	●	●	●

EVALUATION & EVALUATION STANDARD

- Standby heat loss,
- Insulation / self-discharge,
- Storage temperature and storage content,
- Location (in or outside the thermal envelope),
- Energy density

INTERACTION WITH OTHER CRITERIA
3.5, 4.1 – 4.4, 4.9 – 4.11, 5.1 – 5.3

4.9 PROCESS ENERGY

DEFINITION / DESCRIPTION
With process energy, the energy requirement for the building services is captured here and the energy requirement, which is relevant for the use, such as for medical devices. The Technical facility-related energy requirements include the provision of energy for lighting, air conveying and auxiliary energy, which for example is required for the operation of pumps or the like. For the user-side process energy, a high energy demand occurs in the cooling of medical devices, such as MRI and CT scanners. Depending on the device type, a large energy requirements also results from the base load of the equipment (MRI, CT).

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●	●●	●●	●	●●

EVALUATION CRITERIA 4. ENERGY

EVALUATION & EVALUATION STANDARD

Technical facility:

- Demand-based ventilation by flaps or flow compensators,
- Prevention of oversized ventilation systems,
- Design of compact duct networks, channel lengths as short as possible,
- Usage -oriented arrangement of the air handling units reduces pressure losses,
- Use of process energy through heat recovery systems,
- Implementation of hydraulic balancing in water-bearing pipe networks,
- Proportion use of renewable energy,

Usage:

- Use of efficient equipment components such as power supplies and cooling for medical devices.
- Reduction of standby time of the equipment (MRI, CT) by high capacity utilization.
- Better coordination of the radiation intensity of CT images,
  --> The lower the radiation dose, the lower the energy requirements.
- Use of energy-efficient cooling systems for the storage of medicines, blood bags etc..
- Use of IT technologies corresponding to the state of art (consideration in tenders).

Uninterrupted power supply:

- To supply the facilities which are relevant to safety according to building regulations (security lighting, smoke extraction) and areas with increased security of supply (operating rooms, intensive care units, etc.), an emergency power system should be used (fossil driven motor with a coupled generator). This switches on upon failure of the general energy supply within 15 seconds automatically, thus ensuring the correctly continued operation of the facility.
- Uninterruptible power supplies (UPS) are being used for uninterrupted power supplies for critical computing and medical technology (intensive care unit, operating room, fire alarm systems).

INTERACTION WITH OTHER CRITERIA
3.5, 3.6, 4.1 – 4.11, 5.1 – 5.3

4.10 INTERNAL LOADS

DEFINITION / DESCRIPTION
Internal loads are incurred by waste heat of technical equipment, people, lighting and poorly insulated heating or domestic hot water pipes. In hospitals are incurred particularly high internal loads at certain times. This occurs for example by medical equipment (MRI, CT), which are relevant for its use.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●	●●	●●	●	●●

EVALUATION & EVALUATION STANDARD

- Use of efficient equipment (medical, IT),
- Adequate insulation of water pipes and storage,
- Coupling of arising waste heat in low temperature heating systems,
- Energy efficient transfer of heat through evaporation processes,
- Use of LED lighting

Compensation of the internal loads can be carried out on the one hand by **active ventilation** of the Air conditioning systems. On the other hand **thermal storage materials** can use their thermal storage capability to dampen the temperature fluctuations. An energy efficient form of transfer of

EVALUATION CRITERIA 4. ENERGY

internal loads is the direct cooling as a year-round free cooling via hybrid cooler.

INTERACTION WITH OTHER CRITERIA
3.5, 3.9, 4.1 – 4.9, 4.11, 5.1, 5.2

4.11 RENEWABLE ENERGY

DEFINITION / DESCRIPTION
The use of renewable energies such as solar and wind energy reduces dependence on external sources providing finite resources. They can contribute to increasing the security of supply and the economic security by reducing the dependence from price increases and from the availability of finite resources. The use of biomass has to be weighed depending on local availability and concurrent applications. Energy-efficient building cooling by the evaporation of water is considered to be renewable energy, as are the use of waste heat from heat recovery systems and CHPs.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●●	●●	●	●●	●●	●●	●●

EVALUATION & EVALUATION STANDARD
The evaluation is done on primary energy factors of the individual energies. Required auxiliary energy must be added. The not always permanently available sources of renewable energy, especially wind energy and solar energy, imply storage technologies which can be combined to form a synergy with the existing building (see 3.4.8 „retention“).

DIN V 18599 „Energy performance of buildings“, EEWärmeG, EnEV

In order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

Evaluated are:
- solar thermal energy
- photovoltaics
- energie of wind
- evaporative cooling
- utilization of waste heat

INTERACTION WITH OTHER CRITERIA
2.1, 2.7, 4. – 4.10, 5.1, 5.2, 6.3, 6.4

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.1 REGULATION & CONTROL

DEFINITION / DESCRIPTION
With the help of a building automation system, which includes the monitoring, control and regulation technology, functional processes can be automated and optimized. Through automated or demand-based control systems, an increase in efficiency of the overall system and large economic savings can be achieved. The equipment of the respective trades with modern sensor technology (metrology) and accurate actuators (adjusting elements) is the basis for it.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	● ●	●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD

- **Control heating system:**

The control accuracy has a high impact on the energy efficiency. The more precise the control is, the lower the heating energy demand, and the lower the temperature fluctuations in the room, which has a positive effect on the comfort. The lowest accuracy and efficiency thus has a centralized supply and return temperature control. An increase in the efficiency occurs with a proportional control (2 - 1 K accuracy) to a PI (proportional-integral) control with room-by-room control.

- **Control ventilation:**

Variable air volume control with reference variable (e.g. CO_2),
Constant volume flow control with set point adjustment (on - off)

- **Lighting control:**

Daylight-and presence-dependent control through the use of presence detectors.

The controller should have low intrinsic energy consumption in order to keep the process energy re-quirements as low as possible. The use of e.g. Piezo elements is recommended.

With regard to an optimal operating management, a cross-disciplinary building automation makes sense (DIN V 18599-11). Here, all information will be merged into information points (cabinets). The individual information areas are brought together via a bus system. Via a central computer, all information of the building services can be read and necessary adjustments can be made.

INTERACTION WITH OTHER CRITERIA
3.1, 3.5 – 3.8, 4.1 – 4.11, 5.2, 5.5, 6.1 – 6.4

5.2 CLEANING & MAINTENANCE

DEFINITION / DESCRIPTION
The question of how a building can be cleaned and maintained has a large effect on the cost and environmental impact of a building during its use. Building components that can be maintained at an optimum have a longer service life. Surfaces that can be cleaned easily require less detergent and cause lower cleaning costs. The aim must therefore be to keep the operating expenses for cleaning and maintenance as low as possible and at the same time to ensure a long service life of the materials used.

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	●	●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD

- Maintenance of relevant parts of the supporting structure,
- Maintenance of relevant parts of non-supporting exterior structure (service lifts and und cleaning catwalks for facades),
- Maintenance of relevant parts of non-supporting interior structure (uniform, joint-free surfaces and disinfectant-resistant materials , Formation of plinth and impact protection),
- Dirt trap zone for main and side entrances,
- Barrier free floor plans (Installation of heaters (min. distance of 15 cm from the floor, wall mounted toilet and sink, etc.),
- Ensuring accessibility of maintenance relevant parts

INTERACTION WITH OTHER CRITERIA
2.5 – 2.7, 3.1, 3.2, 3.6 – 3.8, 4.1 – 4.9, 4.11, 5.1, 5.3 – 5.5, 6.3, 6.4

5.3 WATER SUPPLY & WASTE WATER DISPOSAL

DEFINITION / DESCRIPTION
Hospitals have a high demand for drinking water, but also a need for industrial water with lower quality standards for different uses. At the same time, hospitals make a significant point source of endocrine substances/ drugs that do not or hardly degrade in municipal wastewater treatment plants. The different requirements for cleaning, hygiene, toilet flushing, cooling buildings, irrigation of outdoor installations, etc. are to be connected with the locally available resources and in particular the use of cascades through recycling. For this purpose it is necessary to separate different waste streams at their sources and feed them into the recycling to minimize wastewater and the resource consumption of water. Using rain water for evaporation purposes such as cooling of buildings is one of many options. Separate collection and recycling of yellow/ black/ gray water are further measures.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	●	● ●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Separate collection and recycling of black/ grey/ yellow and rain water,
- Reduction of waste water, decentralized rain water management,
- Evaporation of the highest possible proportion of the resulting water resources for the closure of the natural water circuit,
- Installation of water-saving taps,
- Visualization of water resources

DIN 1986, DIN 1989, ATV-DVWK 138

INTERACTION WITH OTHER CRITERIA
3.1, 3.6, 4.1 – 4.4, 4.6, 4.8, 4.9, 5.2, 5.5, 6.3, 6.4

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.4 WASTE MANAGEMENT

DEFINITION / DESCRIPTION
Hospitals have a variety of different wastes that need to be separated carefully during collection and distribution. In particular infectious and radioactive waste shall be collected strictly separate to avoid additional strain of unencumbered waste volumes and the high expenses of disposal.
Waste prevention is the first priority, recycling is the second priority.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	● ●	● ●	●	●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Prevention of quantities of waste by multiple usages,
- Separate collection and recycling of preferably unmixed waste,
- Strict control and separate disposal of infectious and/ or radioactive waste

INTERACTION WITH OTHER CRITERIA
3.6, 5.2, 5.5, 6.3, 6.4

5.5 INFLUENCE OF THE USER

DEFINITION / DESCRIPTION
Patients and workers sojourn in the hospital for a long time. The user satisfaction/ the well-being, among other things, depends on the possibility of the individuals to influence the building's technology. The individual override of the sun protection is desirable, for example, though it does not lead to a higher energy-efficiency. Other criteria include being able to manually open the window and have an influence on presence-dependent artificial lighting.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	●	● ●	●	● ●	○	○

EVALUATION & EVALUATION STANDARD

- Manual override of automatic sun protection,
- Possibility of window ventilation,
- Influence on presence-dependent artificial lighting

INTERACTION WITH OTHER CRITERIA
3.4, 3.5, 5.1 – 5.4, 6.3, 6.4

EVALUATION CRITERIA 6. REFERENCE POINTS

6.1 QUALITY OF PLANNING

Through early requirements planning (definition of framework conditions, needs of the individual user groups, goals) with detailed formulations for necessary requirements and fixation of specific project goals in the very early planning stages, optimized planning results and costs of rescheduling, etc. can be avoided.

The early requirements planning (evidence-based design method) requires an interdisciplinary planning barrier team, that, together with the users and builders, examines different holistic concepts (waste, energy, water and exposure concepts) and develops a sustainability-oriented overall strategy for the respective project. This procedure should be maintained throughout the planning and implementation phase to obtain better results.

For complex construction projects, such as hospitals, BIM (Building Information Modeling) is a new method to create transparent planning and decision-making processes.

The overall draft- and design quality can be considered positively with respect to the assessments of the control gear system and implementation of design competitions. The assessment of the artistic-cultural element which are in the works and those considered with respect to future implementation are subject to both the number of the individual measures to be taken in connection with artistic construction and the financial efforts provided for this purpose. Regarding this, the vital criteria to be considered are not only the quality with respect to the urban environment, but also the existing structure along with the acceptance and opinion of the people living there.

6.2 CONSTRUCTION PHASE & COMMISSIONING

The continuous feedback during the construction from the professional planners and architects and good building site documentation are essential for a smooth construction process. Highly complex buildings such as hospitals require particular transparent decision-making processes and immediate feedback of problems in construction. As an integrated design and construction supervision and project documentation, BIM (Building Integrated Manufacturing) is a promising approach to create transparency in highly complex planning and decision-making processes.

An extensive number of sensors, such as an energy meter, are already provided for commissioning as well as the optimization of an energy-efficient operation in the planning and construction phases. Furthermore, malfunctions of the TGA can be detected and corrected as well as planning assumptions can also be reviewed and corrected.

The systematic start-up of the plant is subject to prior consultation with the building owner in order to arrange the time period of the regulation and post-adjustment, trainings and instructions to be provided to technical, medical-technical, and medical staff. The independent consulting of third parties for a check of the usage specifications is considered admissible.

Among others, it should be provided for an extensive number of sensors and energy quantity counters in order to ensure the appropriate integration of the start-up into a process that includes a continuous inspection and advancement of an energy-efficient operation. Both of afore-mentioned aspects are in the works and execution of construction works, already. By means of this, it is possible to detect and remove malfunctions of the TGA, and to check and correct design drafts.

EVALUATION CRITERIA 6. REFERENCE POINTS

6.3 LOCATION

For the choice of location, various environmental influences (floods, storms, earthquakes), which are partly predetermined by the geographical constellations, have to be considered in the decision process and the subsequent planning. Since environmental conditions are not always predictable and rarely influenceable, structural measures can possibly help to minimize or improve the effects on the health and well-being of users.

Before deciding on a location/ inventory/ existing building a comprehensive site and market analysis should be prepared by an appraiser to determine the general social acceptance and perception, existing synergies or potential conflicts, as well as the care and conservation status, as these points are an important indicator for the later acceptance of the building in any particular location.

Therefore existing infrastructure, such as a well-developed road network, existing open spaces, as well as intact local amenities (restaurants, supermarkets, public facilities, etc.) contribute to the improvement of the acceptance.

6.4 AREA OCCUPATION

Alongside the location, the criterion of area occupation plays an important role for the determination of where to establish the building or which existing property to consider for usage. The goal is to be as efficient as possible and take advantage of already developed land, so that no additional transport and residential areas, which would increase the degree of sealing of the surface, must be formed.

If, due to a variety of reasons, an extension of the building surface or infrastructure cannot be abstained from, appropriate compensatory measures (e.g. formation green roof etc.) should be aimed for. Furthermore, it should be examined whether the property is afflicted with various inherited wastes (pollution of ground with harmful substances, etc.), as this is an exclusion criterion for the construction of a hospital.

6.5 MEDICAL DEVICES

During the planning and preparation of a sustainable hospital, the medical facilities are also to be considered, since most savings in the operating costs (facility-specific and usage-related energy savings) and the increasing of the treatment methods (patient satisfaction) lay here.

Therefore, especially modern, energy-saving medical systems for ecofriendly operations should be used. In order to reduce energy consumption, the use of refurbished systems is a meaningful way, as these contribute to the more efficient use of existing resources in the saving of high acquiring cost as also high operating costs due to outdated equipment.

FUTURE PERSPECTIVE STAGE 2

The requirements for a building, and more particularly for hospitals, are becoming increasingly complex. Today, not only the recognized technical rules are necessary for the planning, but also the optimization in terms of di-verse, sometimes concurrent goals. The goal is to prepare, implement and organize the planning, construction and operation of the project in such a way that

- the environment and natural resources are conserved,
- a maximum level of environmental and social compatibility is achieved,
- as also permanently healthy living and working conditions are realized or secured.

To illustrate resource efficiency for complex buildings such as hospitals in germany, one should not only take into account technical components but the wholesome building should be taken into construction including its inner functions.The thermal and erergy performance ot the building will though the building physics ventiltion heat loss, airtightness, heat oads, solar depositions, transmis-sion heat loss from the building cover, shadow and cubature characterise.

The development of standard specifications for the design, construction and operation of public and publicly funded construction projects has also the objective of

- the cost reduction in the planning and construction,
- and minimizing future operating costs and life cycle costs of a building.

With this indicator matrix, the planning team from Nickl & Partner, Iproplan and TU Berlin already evaluated and further developed existing evaluation systems in terms of transferring these onto hospitals. With the aim of trans-ferring the „Status Quo" of Germany onto hospitals in developing countries and emerging economies, no weighting has been allocated to the individual indicators opposed to the certification systems.

Fig. 4 University hospital Hamburg - Eppendorf - entrance hall, architecture price BDA; Nickl & Partner AG

FUTURE PERSPECTIVE STAGE 2

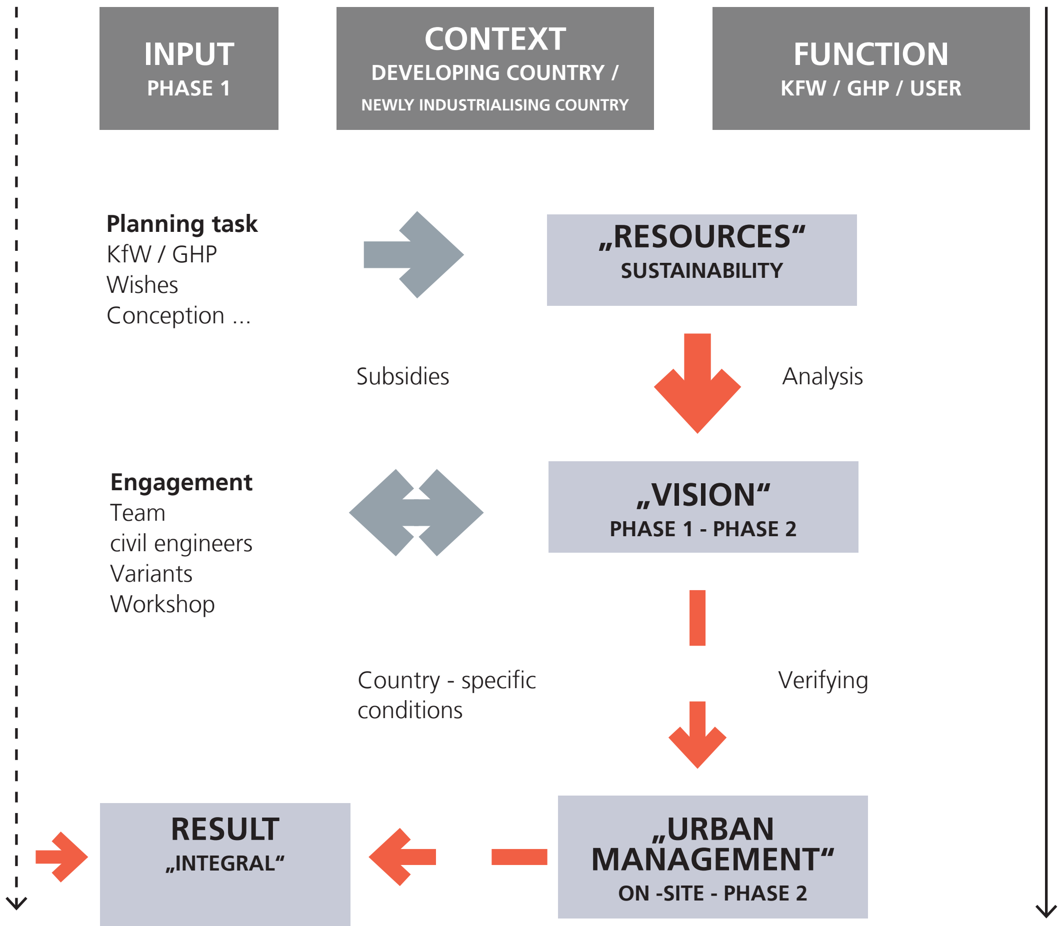


Fig.4 Schema workflow Stage 2

The conditions in developing countries and emerging markets can be extremely different, so that the focus of individual indicators can shift significantly from, for example, questions of energy-efficiency to the sustainable management of water resources.

In Phase 2, it will be necessary to introduce weightings with the aid of a concrete example. It is already foreseeable that the German trend of increasingly more technology building equipment (TBE) has to be broken and „smart" building based on robust („ resilient „) technologies had to be propagated. The reasons for doing so include reasons of affordability, the operating cost reduction and security of supply.

GHP GREEN HOSPITAL STUDY

STAGE 1 - DETERMINATION OF BASICS

APPENDIX

Nickl & Partner

APPENDIX 1 SHEET 1

Topic	Criterias	Indicator / valuation	Valuation parameters							
			energy efficiency	economically	ecologically	socio culturally	technically	in planning	in execution	quality assurance
Exterior	Exterior design		●	● ●	●	● ●	○	● ●	● ●	●
	Public accessibility		○	○	●	● ●	○	● ●	○	○
	Transport connection		○	● ●	●	● ●	○	●	○	○
Building	Cubature	SA/vol ratio	●	●	●	○	○	●	○	○
	Natural lighting		● ●	●	●	● ●	●	● ●	○	○
	Airtightness	Ventilation	● ●	● ●	●	●	● ●	● ●	● ●	● ●
	Moisture protection	Constructive/climate-induced shading coefficient	● ●	●	●	● ●	● ●	● ●	● ●	● ●
	Opaque components	U-value	● ●	●	●	●	● ●	● ●	● ●	● ●
	transparent components	U-value, τ-value, g-value	● ●	●	●	● ●	● ●	● ●	● ●	● ●
	Building materials & recycling		●	● ●	● ●	● ●	● ●	● ●	●	○
Interior	Fire protection		○	●	● ●	○	● ●	● ●	● ●	●
	Soundproofing		○	○	●	● ●	●	● ●	● ●	●
	Acoustic comfort		○	○	● ●	● ●	●	● ●	●	○
	Visual comfort		●	○	●	● ●	●	● ●	○	○
	Thermal comfort		● ●	●	● ●	● ●	●	● ●	○	●
	Hygiene & indoor air quality	VOC concentration	● ●	●	● ●	● ●	●	● ●	●	●
	accessibility		○	○	● ●	● ●	●	● ●	●	●
	security		●	○	● ●	● ●	○	● ●	● ●	●
	interior design		●	○	● ●	● ●	○	● ●	●	●
Energy	Energy requirements - building	Final and primary energy requirement	● ●	● ●	● ●	○	●	● ●	○	○
	Heating	Generation, distribution, delivery	● ●	●	● ●	●	●	● ●	●	●
	Hot water	Generation, distribution, delivery	● ●	●	● ●	● ●	●	● ●	●	●
	Building cooling		● ●	● ●	● ●	●	●	● ●	●	●
	Ventilation	Generation, distribution, delivery	●	○	● ●	● ●	●	● ●	● ●	●
	De- & humidification		● ●	●	● ●	○	● ●	●	● ●	● ●
	Lighting	Interior / outdoor lighting	● ●	●	● ●	●	● ●	● ●	●	●
	Storage		● ●	●	● ●	○	● ●	●	●	●
	Process energy		● ●	●	● ●	●	● ●	● ●	●	● ●
	Internal Loads	Usage profile & process	● ●	●	●	●	● ●	● ●	●	● ●
	renewable energy		● ●	● ●	● ●	●	● ●	● ●	● ●	● ●
Facility Management	regulation & control		● ●	●	● ●	●	● ●	● ●	● ●	● ●
	cleaning & maintenance		●	● ●	● ●	●	●	● ●	● ●	● ●
	Watersupply & water waste disposal		●	● ●	● ●	●	● ●	● ●	●	● ●
	Waste management		○	● ●	● ●	●	●	● ●	●	● ●
	Influence of the user		●	○	●	● ●	●	● ●	○	○
Reference points	Quality of planning									
	Construction phase & Commissioning									
	Location									
	Area occupation									
	Medical devices									

Fig. 1 Evaluation matrix

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APPENDIX 2 SHEET 1

No.	Characteristics (*DGNB)		LEED		BUND	VDE	EnergieAgentur.NRW
	Category	Citerias	category	criteria	"Energy saving Hospital"	"Blue Hospital"	"Energiy efficiency in hospitals"
1	energy efficiency	ultimate energy demand	Energy & Atmosphere	optimize energy performance, Demand response	continuous decrease of the energy demand, long-time optimally energy usage, execute energy management		accurate & current heat demand determination
2		primary energy demand					
3		transmission heat source					insulating wiring and taps, insulation AW
4		Airtightness					
5		moisture protection					
6		heating demand (transmission+ventilation+Solar+internal loads)					
7		power supply					power factor correction, optimisation elect. hardware, purchase energy-saving hardware
8		percentage renewable energy	Energy & Atmosphere	renewable energy production		use sustainable energy source	fitting heat recovery system
9		energy demand and De- & Humidification	Energy & Atmosphere	optimize energy performance, Demand response	long-time optimally energy usage, continuous decrease of the energy demand		
10		energy demand IT-Systems and medical - & laboratory devices		optimize energy performance, Demand response		efficient use of IT- systems	
11		Building cooling	Energy & Atmosphere	enhanced refrigerant Mgmt			zentral regulation, adiabatic cooling
12		daylight availability evaluation	Indoor Environmental Quality	daylight			
13	ecological quality*	ecobalance	Energy & Atmosphere	green power and carbon offsets	reduce CO_2-usage through corresponding sanction		
14			Material & Resources	building life cycle impact reduction			
15		risiks for the locale enviroment (ecological evaluation of installed building material on the basis of data- and safty data sheet, GISCODE, etc.)	Material & Resources	PBT source reduction - mercury			
16			Material & Resources	building product disclosure and optimization - environmental product declarations			
17			Material & Resources	building product disclosure and optimization - material ingredients			
18			Material & Resources	PBT source reduction - lead, cadmium and copper			
19			Indoor Environmental Quality	low emitting materials			
20		ecologically sensitive material extraction	Material & Resources	building product disclosure and optimization - sourcing of raw materials			
21		drinking water demand and waste water disposal	Water Efficiency	outdoor water use reduction			use water saving hardware minimize & self-closing brace
22				indoor water use reduction			
23				cooling tower water use			
24				water metering			
25			Sustainable Sites	rainwater Mgmt			
26			Sustainable Sites*	heat island reduction			
27			Sustainable Sites	light pollution reduction			

Fig. 2 Evaluation criterias energy efficiency and sustainability

APPENDIX 2 SHEET 2

No.	Characteristics (*DGNB) Category	Citerias	LEED category	LEED criteria	BUND "Energy saving Hospital"	VDE "Blue Hospital"	EnergieAgentur.NRW "Energiy efficiency in hospitals"
28	economical quality*	area occupation	Location & Transportation	reduced parking footprint			
29				sensitive land protection			
30			Sustainable Sites	environmental site assessment			
31				site assessement			
32				site development			
33				open space			
34		life cycle costs					
35		third party usability					
36	sociocultural quality*	thermal comfort (winter)	Indoor Environmental Quality	thermal comfort			
37		thermal comfort (summer)	Indoor Environmental Quality	thermal comfort			
38		interior - hygiene	Indoor Environmental Quality	minimum IAQ performance			
39			Indoor Environmental Quality	environmental tobacco smoke control			
40			Indoor Environmental Quality	enhanced IAQ			
41			Indoor Environmental Quality	low emitting materials			
42			Indoor Environmental Quality	construction IAQ Mgmt plan			
43			Indoor Environmental Quality	IAQ assessement			
44		acoustique Comfort	Indoor Environmental Quality	acoustic performance			
45		visual Comfort	Indoor Environmental Quality	interior lighting			
46			Indoor Environmental Quality	daylight		application of presence detector and day light sensors für day light control	EVGs, use energy saving lamp and mirrored reflector, presence detector
47		influence of the user	indoor environmental quality	quality views, thermal comfort		intelligent monotoring	information and motivation the whole staff to a energysaving behaviour
48		exterior design					
49		security & source of irritation	sustainable sites	direct exterior acces			
50		Accessibility					
51		area efficiency					
52		conversion	material & resources	design for flexibility			
53		Fahrradkomfort	location & transportation	bicycle facilities			
54		urbanistic & artistic Design					
55		Art					
56	technical quality*	fire protection					
57		soundproofing	Indoor Environmental Quality	acoustic performance			
58		qualität building cover	Energy & Atmosphere	optimize energy performance			
59		cleaning & maintenance					
60		demolition, recycling, removal	Material & Resources	construction and demolition waste Mgmt			
61		*(technical facility)*				integrated uniform IT- infrastructur (building services management system, air conditioning, cross linking medical hardware, IT- application system, integrated data network) / "Smart Building"	automatically regulationsystems
62		qualität project preliminary					

Fig. 2 Evaluation criterias energy efficiency and sustainability

Nickl & Partner

APPENDIX 2 SHEET 3

No.	Characteristics (*DGNB)		LEED		BUND	VDE	EnergieAgentur.NRW
	Category	Citerias	category	criteria	"Energy saving Hospital"	"Blue Hospital"	"Energiy efficiency in hospitals"
63	quality of the process*	integral Planning	energy & atmosphere	optimize energy performance		cooperation of a multi disciplinary planning - team in all phases of the process	
64				integrated project planning and design, integrative process			
65		improvment approach in planning	sustainable sites	advanced energy metering	execute energy management	transparency and continuous monitoring of the usage (integrate energy - management - rig)	Regelmäßige Verbrauchskontrolle mittels Strom- und Wärmemengenzählern
66		protection sustainability issues for advertisement and allocation					
67		establishment requirements for a optimal use and management					
68		construction phase / commissioning	sustainable sites	construction activity pollution prevention			
69		quality assurance commissioning	energy & atmosphere	fundamental commissioning and verification			
70		regular commissioning	energy & atmosphere	enhanced commissioning,fFundamental commissioning and verification			
71	quality of the location*	micro location	location & transportation	LEED for neighborhood development location			
72		image and condition location		high priority site			
73		transport connection		surrounding density and diverse uses			
74		proximity to relevant objects and infrastructure		acces to quality transit			
75				green vehicles			
76	other	interior & utilisation	sustainable sites	places of respite (recreation area)			
77			material & resources	furniture and medical furnishings			
78						innovative medical technology	
79						reduction exposure dose for patients (depending on medical technology)	
80			appearance of waste (utilisation)				

Fig. 2 Evaluation criterias energy efficiency and sustainability

APPENDIX 3 SHEET 1

General

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Object specifications	Object	Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
	Year of manufacture/Restoration	2013	2012	1998	Current status: in the works, Building completion: Fall 2016
	Floors	5	5	5	5
	GFA	14.497 m²	8.204 m²	46.200 m²	49.400 m²
	NFA	12.689 m²	7.134 m²	22.400 m² (NF)	37.200 m²
	GV	39.102 m³	24.785 m³	182.500 m³	222.900 m³
	Construction method	massive (Ferroconcrete)	massive (Brick work)	massive (steel frame construction / brick work)	massive (steel frame construction)
	Number of beds	ca. 135	118	476	314
	Space efficiency factor	0.546	0.52	0,48	0,40

Building thermal envelope

Rehabilitation center

Structure	Exterior wall	Roof	Floor to soil	Windows	Exterior doors
Insulation	Composite heat insulation system				
Air tightness measurement	outstandng				
U-value [W/(m²·K)]	0,30	0,23	0,36	1,30	1,80
Cost gross [€/m²]	474,4	559,4	237,5	366,0	1165,5
Cost net [€/m²]	398,6	470,1	199,6	307,6	979,4
Building area [m²]	4147	4654	4491	1461	19
Building area [%]	28,1%	31,5%	30,4%	9,9%	0,1%
H_T [W/K]	1277	1087	574	1901	35
H_T [%]	26,2%	22,3%	11,8%	39,0%	0,7%
H_T [W/ m²·K]	0.37				
HV,inf [W/ m²·K]	0.23				
A/V	0,42				
Orientation	N	S	O	W	
Exterior wall area [m²]	1319,10	983,20	921,00	1154,50	
Exterior wall area [%]	30,13	22,46	21,04	26,37	
Windows area [m²]	403,50	285,20	330,50	454,90	
Windows area [%]	27,37	19,35	22,42	30,86	
Windows area [%]	24				

Clinical center

Structure	Exterior wall – Existing facilities								Exterior wall – New building	Roof – Existing facilities	Roof – New building	Floor to soil – Existing facilities	Floor to soil – New building	Windows, casement doors – Existing facilities	Windows, casement doors – New building
Insulation	Composite heat insulation system														
Air tightness measurement	outstanding														
U-value [W/(m²·K)]	0.37	1,44	1,33	1,14	1,00	0.76	0.26	0,32	New building: [illegible]	Existing facilities: 0,21	New building: 0,27	Existing facilities: 3.26	New building: 0,36	Existing facilities: 1.8	New building: 1.3
Cost gross / net [€/m²]	-									-		-		-	
Building area [m²]	220	428	264	1271	342	105	19	69	1426	932	1319	1558	960	580	900
Building area [%]	2,1%	4,1%	2,5%	12,2%	3,3%	1,0%	0,2%	0,7%	13,7%	9,0%	12,7%	15,0%	9,2%	5,6%	8,7%
H_T [W/K]	81	617	349	1448	341	80	3	11	410	167	328	1777	86	1043	1169
H_T [%]	1,0%	7,8%	4,4%	18,3%	4,3%	1,0%	0,0%	0,1%	5,2%	2,1%	4,1%	22,5%	1,1%	13,2%	14,8%
H_T [W/ m²·K]	0,84														
HV,inf [W/ m²·K]	0,2														
A/V	0.42														
Orientation	N									S		O		W	
Exterior wall area [m²]	956,50									1120,30		1185,40		883,50	
Exterior wall area [%]	23,07									27,02		28,59		21,31	
Windows area [m²]	407,60									397,40		421,30		254,00	
Windows area [%]	27,54									26,85		28,46		17,16	
Windows area [%]	35.71														

General supplier with respect to hospital

Structure	Exterior wall	Roof	Floor to soil	Windows, casement doors
Insulation	heat-insulating panels,weather boarding			
Air tightness measurement	outstanding			
U-value [W/(m²·K)]	0,42	0,35	0,39	2,77
Cost gross [€/m²]	-	-	864,0	-
Cost net [€/m²]	-	-	699,8	-
Building area [m²]			13915	
A/V	0,25			
Orientation	N	S	O	W
Exterior wall area [m²]	2590,00	2755,00	2846,00	2923,00
Exterior wall area [%]	23,30	24,79	25,61	26,30
Windows area [m²]	5310,00	5520,00	3931,00	3767,00
Windows area [%]	28,66	29,79	21,22	20,33
Windows area [%]	62,50			

University hospital

Structure	Exterior wall / Exterior wall to soil	Roof	Floor to soil	Windows, casement doors	Curtain walls
Insulation	Vacuum insulation; Insulation by means of VIPs; opaque cladding/facade: WLG 040 -26cm				
Air tightness measurement	-				
U-value [W/(m²·K)]	0,16 / 0,23 / 0,24 (Roof center)	0,15 / 0,25 (Garden for in-patients)	0,27 / 1,62 (Garage)	0,9 | 1,8	1,0 (profiles) / 0,7 (triple glazing)
Cost gross [€/m²]	-	-	-	-	-
Cost net [€/m²]	-	-	-	-	-
A/V	0,22				
Orientation	N	S	O	W	
Exterior wall area [m²]	-	-	-	-	
Exterior wall area [%]	-	-	-	-	
Windows area [m²]	-	-	-	-	
Windows area [%]	-	-	-	-	

Building´s interior area

			Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Room acoustics	Patient rooms	Reverberation time [s]	0.6	0,9	-	-
	Restaurant	Reverberation time [s]	1,09	-	-	-
Building material	Lateral surface of component areas	Flooring	Floors, patient rooms, offices: PVC-flooring, sanitary facilities: Tiles	Floors, patient rooms, offices: PVC-flooring; Examination rooms: Vinyl flooring; sanitary facilities: Floor tiles, Staircase: Concrete building block	Streets: Cut stone, p. floors, staircases, patient rooms, Restaurant: Parquet ,floors, U+B, office rooms: Linoleum; Sanitary areas: tiles	Streets, separate areas: Parquet; Staircases: Cut stone; Floors, U+B, office rooms: Linoleum; Special U+B: highly-compressed PCV-flooring, Sanitary areas: tiles
		Walls	Floors, patient rooms, etc.: Dispersion paint, sanitary facilities: Tiles	Floors, patient rooms: Fiber glass wallpaper; offices: Dispersion paint; Surgical areas and sanitary facilities: Wall tiles and anti-mold paint	Floors, patient rooms; office rooms, U+B: Shielding fleece + Latex paint; Surgical rooms: HPL-cladding; sanitary areas: Wall tiles	Floors,patient rooms; office rooms, U+B: Shielding fleece + Latex paint; Surgical rooms: HPL-cladding, Sanitary areas: Wall tiles
		Ceilings	Floors, patient rooms, sanitary facilities, etc.: Dispersion paint	Floors, patient rooms, sanitary facilities, etc.: RAL 9016 traffic-white	Floors, patient rooms, office rooms, U+B: Dispersion paint	Floors, patient rooms, office rooms, U+B: Dispersion paint
	Air pollution control measurement of interior building	TVOC, averaged	558 µg/m³	-	-	-
		Formaldehyde, averaged	15,2 µg/m³	-	-	-

Energy

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Energy	Threshold primary energy (based on EnEV-Vol)	179,5 kWh/(m²·a)	286 kWh/(m²·a)	355,2 kWh/(m²·a)	411 kWh/m²a
	Primary energy	164,9 kWh/(m²·a)	202,5 kWh/(m²·a)	355 kWh/(m²·a)	282,00 kWh/m²a
	Σ End energy consumption (EE)	174,5 kWh/(m²·a)	248,5 kWh/(m²·a)	269,6 kWh/(m²·a)	-
	EE - thermal heat	93,1 kWh/(m²·a)	198,1 kWh/(m²·a)	163,5 kWh/(m²·a)	84,10 kWh/m²a
	EE - hot water	43,6 kWh/(m²·a)	33,0 kWh/(m²·a)	163,5 kWh/(m²·a)	-
	EE steam - air humidification	-	-	860MWh/a	35.979,9 kWh/m²a (Total power consumption in 2011)
	EE - air conveyance	11,0 kWh/(m²·a)	3,5 kWh/(m²·a)	Air heating 729 MWh/a, End energy consumption: Ventilation system 1.273 MWh/a	
	EE - ambient cooling	9,1 kWh/(m²·a)	0,0 kWh/(m²·a)	272 MWh/a Absorption refrigerating system	
	EE - lighting	17,7 kWh/(m²·a)	13,8 kWh/(m²·a)	577 MWh/a End energy consumption	
	EE - auxiliary energy	1,2 kWh/(m²·a)	1,6 kWh/(m²·a)	-	Heat consumption for transmission: LEG: 1.090.340 kWh/a
	Reading of EnEV-calculation (02/07/09)	EnEV 2009	EnEV 2007	EnEV 2009	EnEV 2009 (30%-deviation)

Technical facilities

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Heat supply	Type of power generation	Local heat, Block heat and power plant- waste heat system	District heat (KWK)	Block heat and power plant- waste heat system	District heat from adjacent coal-fired power station
	Years of service	Year of manufacture 2013	unknown	15 years	-
	Energy source	fossile	fossile	fossile (gas)	fossile (primary energy factor: 0.54)
	Maintenance interval	each year	unknown	unknown	quarterly
	Heating system	Central heating system	central	central	central
	Thermal storage	Heat buffer storage tank (V = 6000 l)	no	no	no
	Storage tank temperature	45°C	-	-	-
	Heat recovery	no	no	yes (Waste heat recovery - block heat and power plant)	no
	Distributing system	Double-pipe system with internal wires	Double-pipe system with internal wires	Double-pipe system with internal wires	Double-pipe system with internal wires
	Line insulation	Heat transfer coefficient U: 0,200-0,255 W/(m·K)	Heat transfer coefficient: Ui: 0,200-0,255 W/(m·K)	available	Heat transfer coefficient: Ui: 0,35 W/(m·K)
	Flow/Return [°C]	70°C / 50°C	70°C / 50°C	90/70°C / 60/40°C	Distribution areas: heating elements / heating register RLT 70/50°C; Wall heating system surgical rooms/ Activation of component parts in patient rooms 35/32°C
	Heat transfer	Open heating space, panel heating	Open heating space	Open heating spaces	Open heating spaces
	hydraul. compensation?	yes	yes	yes	yes
Hot water generation	Type of water generation	Local heat, Block heat and power plant- waste heat	District heat (KWK)	Block heat and power plant- waste heat system	Steam turbine for energy usage from district heat supply unit
	System	central hot water supply with circulation system	central hot water supply with circulation system	central hot water supply with circulation system	central hot water grid - Post-heating (district heat) of entire complex
	Storage	Hot water storage tank (V = 6000 l)	Hot water storage tank (V = 1000 l)	not available	-
	Storage temperature	60°C	60°C	-	-
	Solar thermal energy	no	no	no	-
	Line insulation	Heat transfer coefficient U: 0,200-0,255 W/(m·K)	Heat transfer coefficient Ui: 0,200-0,255 W/(m·K)	available	Heat transfer coefficient: Ui: 0,200-0,255 W/(m·K)
	Tapware	Control system: Single lever-mixer basin tap , p. non-contact operation	unknown	Standard	Standard
Refrigeration supply	Type of refrigeration	Direct heat exchanger, Refrigerating plant, cold water	not available	Absorption units (2)	Absorption refrigeration unit (9%), compression cooling unit (91%), screw compressor unit, adiabatic cooling
	Years of service	Year of manufacture 2013		1998	2012
	Refrigerant	R410A		LiBr	
	Operating temperature	6/12°C		6/12°C	Cooling loop at average temperature level 8/14°C ; Activation of component parts at average temperature level 16/19°C
	Maintenance interval	each year		each year	quarterly
	Heat recovery	no		no	yes (disconnection from the brine circuit of the WRG might be required in winter)
	Central control	yes		yes	Substitution of elect. refrigeration by means of central chilled water distribution grid
Power supply	Type of power generation	Block-heat and power-plant waste heat unit	Connected to local energy grids	Block heat and power plant - waste heat system (100%)	Steam turbine (as of 2011)
	Load peak (Time?)	with full-time operation to be anticipated in the winter months	unknown	unknown	Load peak: relatively equally distributed
	energy-intensive areas/devices	Intensive care unit, radiology		Radiology, Intensive care unit, cardiology (LHC), radiation therapy (2014)	Special U+B rooms ENT / eyes
	Substitute supplies (Emergency standby system, storage battery grid)	Storage battery grid system available	Storage battery grid system available	Storage battery grid system, i.e. substitute devices available	Storage battery grid system, i.e. substitute devices available
	energy-intensive areas/devices	CT X-Ray unit	CT-unit, Magnetic resonance imaging system, X-Ray unit	CT-unit, MRI-unit, X-Ray units, LHCs	CT-unit, MRI-unit, X-Ray units
	regen. power generation	Use of a block-heat and power-plant waste heat unit	nein	no	no
Ventilation system	Type of ventilation	mech. ventilation system with heat recovery (60%)	partially mech. ventilation system with heat recovery (45%)	partially mech. ventilation system with heat recovery (60%)	mech. ventilation system with heat recovery
	Areas supplied	all areas	Sanitary areas	Surgical rooms, intensive care units, U+B-rooms, LHCs, radiology	Surgical rooms, intensive care units
	Maintenance interval	In general once a year, fan wheels twice a year	unknown	jährlich	each year
	Supply air conditioning	partially pre-heating or cooling of supply air	Supply air heating system by means of a supply register	pre-heating or cooling of supply air	pre-heating or cooling of supply air
	Heat recovery	Heat recovery level: 60 %	Heat recovery level: 60 %	Circulating heat exchanger WRG-level: 60 %	yes (heat circulating system - heat recovery coefficient 75%)
	Adiabatic cooling	no	no	no	yes
	Steam	no	no	one fraction is supposed to be converted to raw steam (490kW) for sterilization purposes	Humidification: Sorptive
Lighting and daylight	Type of electronic control gears	Electronic control gears	Electronic control gears	elect. control gear units	energy-efficient ventilation system
	Type of lighting	rod-shaped fluorescent lamps	rod-shaped fluorescent lamps	rod-shaped fluorescent lamps	Floors | Offices: High-Efficiency lighting systems , meeting rooms | support points and restrooms on wards: LED downlights
	direct/indirect/combinated	combinated	direct	direct/indirect	direct/indirect
	Reverberators	available (integrated in lamps)	available (integrated in lamps)	available (integrated in lamps)	available (integrated in lamps)
	Regulation (depending on daylight, stepless)	no	no	partially depending on daylight, not steplessly variable	depending on daylight, steplessly variable
	Presence detector	in restrooms for disabled persons	in restrooms for disabled persons	in public restrooms	Control in office- U+B-, laboratory-, patient rooms depending on daylight and presence Control mechanism depending on presence with traffic areas restrooms and wet rooms, staff rooms, meeting rooms and ward kitchen
	Sun protection	external sun protection, visual sight unhindered with active sun protection unit	external sun protection, visual sight unhindered with active sun protection	external sun protection, visual sight with active sun protection unit not possible	external translucent sliding shutters
	Daylight factor DF	1% - 1,5%	unknown	unknown	0,90%
	Areas supplied with daylight	60%	57%	unknown	Requirement for natural illumination for compactness purposes
Building automation	Grid system (central/peripheral)	central grid of components by means of a building management system	central building management system	central building management system	central building management system
	Automation of control processes	to take place in the assembly sections: heating system, refrigeration, hot water, ventilation and air conditioning, medical gases	400 physical. Data points, Activation by means of BUS-system	400 physical. Data points, activation by means of BUS-system	400 physical. Data points, activation by means of BUS-system
Fire protection	technical fire protection measures	Fire detection plant (BMA), smoke-heat-outlet plants (RWA)	Fire detection plant (BMA), Smoke-heat-outlet plants (RWA)	Fire detection plant (BMA), smoke-heat-outlet plants (RWA), partially sprinkler units (streets)	Fire detection plant (BMA), smoke-heat-outlet plants (RWA), partially sprinkler units (streets)
	Maintenance interval	BMA: quarterly, RWA: yearly	unknown	each year	each year

Abbreviations:

A / V Proportion of therm. cladding area to the building volume
AW Exterior wall
EE End energy
H_T Heat loss due to transmission

Fig. 3 Evaluation assessment internal projects

APPENDIX 4 SHEET 1

Functional areas	Medical devices	Medical Equipment	Weight kg	Dimensions (LxBxH) in cm	Energy consumption	Waste heat	Costs Euro	Hospital 300-500 beds	Hospital Ningbo No. 6
X-RAY RADIOGRAPY									
	X-ray workstation (digital or conventional)	Digital X Ray machines control / examination room	700 (heavily dependent on configuration!)	Room size: min 600 x 430; machine:143 x 400 x 240	max 150 kVA during illumination, Standby 1 kVA	500 W	ca. 600 €	2 to 3	3
	Mammography device	Mammography	500	118 x 92 x 203	Illumination: 14 kW, Standby: 600 W		ca. 500 €	1 to 2	
	Fluoroscopy device	Fluoroscopy	1000	242 x 192 x 207	long-term: max.1250 W, short-term: 2500 W max.	Generator: 1400 W; Tube: max 350 W	ca. 800 €	1	1
	Lithotriptor	Lithotriptor						1	1
	Dental x-ray	Dental Radiography						1	
	Urological x-ray	Urography	1300	237 x 275 x 245	max 150 kVA at individual illumination (Radiography); max 6.6 kVA for Fluoroskopy	1700 W in U + B - Room, 3800-5000 W by generators and regulation	ca. 800 €	1	
INTERVENTIONAL									
X-RAY RADIOGRAPY									
	Card angiography unit (single plane)	Monoplane Angiography	2450	299 x 99 x 145	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	1
	Card angiography unit (biplane)	Biplane Angiography	2950	317 x 115 x 215	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	
	Left heart catheterisation laboratory	[left (LHC) or right] Catheterisation Laboratory	2950	317 x 115 x 215	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	
	Hybrid OR		2450	299 x 99 x 145	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	1
CT / Nuc Med									
	16-slice CT	CT 16 Slice	3450	Room size: 570 x 360; machine: 380 x 238 x 200	During operation: 35 kVA over 90 sec.; Standby: 3 kW	5,3 kW	3,000 € - 4,000 €	1	2
	128-slice CT	CT 128 Slice	3500	Room size: 590 x 350; machine: 381 x 274 x 198	During operation: max. 15 kVA; Standby 3 kVA	5,9 kW	3,000 € - 4,000 €	1	1
	PET-CT	PET CT			max. 15 kVA continuous	26000 BTU	ca. 4,000 - 5,000 €	0 to 1	
MR			4250	Room size: 27 m²; Height 2,5 m	Standby 5.5 kW, Average 17kW, Max. 34 kW		ca. 18,000 €		
	1.5T MRT	MRI 1,5 T	5700	Room size: 30 m²; Height 2,5 m	Standby 9kW; Average 19 kW, Max. 50 kW		ca. 20,000 €	1	1
	3T MRT	MRI 3 T							
Radiotherapy								1	
	Linac	Linear Particle Accelarator							
STERILISATION									
	Autoclaves	Autoclave						2	2
	Disinfectors	Disinfector						5	
	Trolley washer	cart washing facility						1	1
ENDOSCOPY									
	Digital fluoroscopy workstation for ERCP	Endoscopic Retrograde Cholangio - Pancreatography work						1	2

Notes:

The information given may differ from actual values in some hospitals. This is due to equipment variations among individual hospitals as well as to different usage rates and different configuration options of the devices used.

Especially for large devices it is uncommon to specify the size of the device. This is due to the fact that the required room size is also determined by the space required for installation and the space required for providing sufficient airflow. In addition, the size of the device depends on its configuration and changes when parts of the device are displaced.

For many devices it is difficult to specify average energy consumption values since they typically work at maximum power only for short exposure times of less than one second.

Like energy consumption, also exhaust heat is usage-dependent. Only for MRT devices, which must be continuously cooled, a reliable value can be assumed. Our datasets usually contain maximum values; we therefore cannot indicate average values.

All information has been compiled in collaboration with Philips Deutschland GmbH, BU Healthcare. We do not warrant its correctness or completeness.

Fig. 4 Evaluation medical equipement

GHP GREEN HOSPITAL STUDY

STAGE 2 - APPLICATION OF STAGE 1

EVALUATION CRITERIAS - MATRIX - MEASURES

CONTENT

CONTENT

IMPRINT

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INTRODUCTION | TARGET + TASK

The *Green* Hospital Study is essentially composed of two phases. While phase 1 can be viewed as the determination of basics and study of criteria, phase 2 checks the feasibility and applicability based on regional features of a fixed partner country.

Thus, for phase 2, the present document represents the basis for the parameters for the sustainable and energy-efficient development of hospital abroad.

The aim of this first phase of the study is the holistic view of an ideal hospital, which is characterized by energy and resource efficiency and allows contamination of the environment, which is reduced to a minimum. Thereby economic interests represent an equally relevant aspect as the comfort needs of the users, which relate to both, the patient and the hospital staff.

The entire life cycle of the hospital building is observed, which extends from the extraction of raw materials required for the preparation of the operation up to its end of life and end of life phase. Due to the specific usage requirements and usually high energy consumption levels, the process-related parameters and interactions are also investigated in the operation phase.

Starting point of the study is the analysis of the corresponding state of technology of the hospital and health care buildings in Germany. Due to high normative standards in terms of energy technologies and building equipment, potential qualitative and quantitative suggestions or reference guidelines that result from this, are to be checked in phase 2.

Here, the degree of technologisation and other conditions in developing or emerging countries need to be especially taken into account. Including in relation to already implemented national and international certification systems in Germany, such as the DGNB or LEED system, relevant aspects are taken into account in phase 1.

The focus is on energy-efficiency. In addition, however, other sustainability-related aspects, especially those that correlate on energy-efficiency, can be used for a holistic research approach.

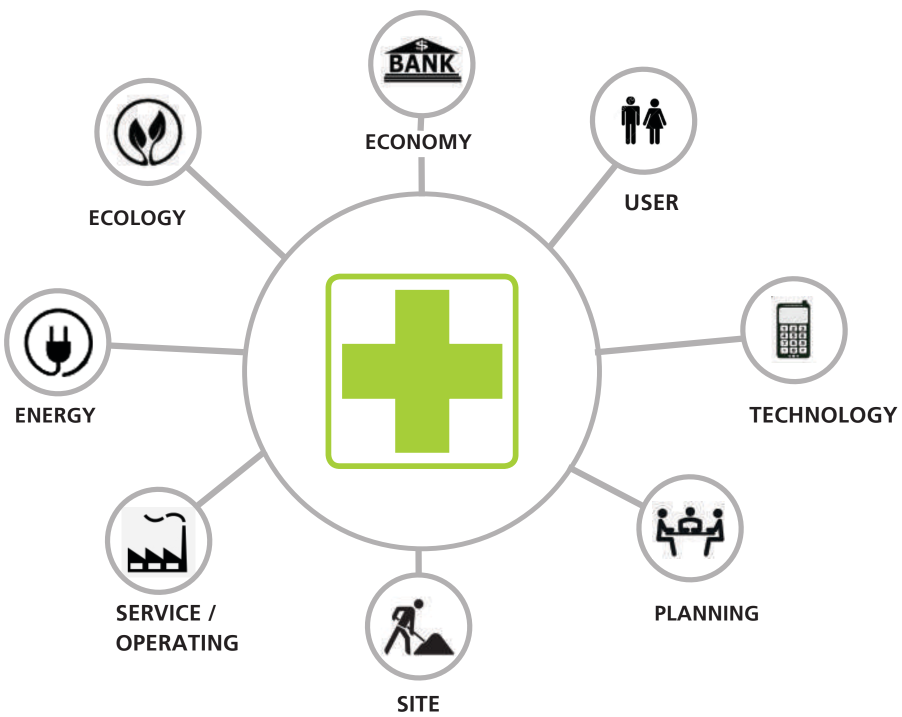

Fig.1 Valuation parameters for energy efficiency and sustainability in the hospital over its entire life cycle

INTRODUCTION | RÉSUMÉ

The requirements and demands to buildings and especially with respect to hospital are becoming increasingly challenging. When it comes to the planning, not only the compliance with the recognized rules of engineering, but also the optimization of various, partly conflicting goals take on an important role and need to be considered. The aim is to provide for the preparation, implementation, and coordination of the planning, development, and realization of the projects in such a way, that

- both the environment and natural resources are protected
- the highest degree possible is reached with respect to the environmental and social compatibility
- the facilitation of continuously appropriate life- and work conditions is realized or given.

So as to point out the resource efficiency of complex buildings, as is the case with hospitals in Germany, it´s not only the technical components but also the building as a whole incl. its internal functions that need to be taken into account when it comes to the optimization.

The thermal and energetic characteristics of buildings are defined by the structural-physical values such as heat loss due to ventilation, airtightness, thermal load, solar load, transmittance heat loss through the building envelope, opacity, and cubature (A/V proportion) of the building. The elaboration of standard specifications to be applied to the planning, development, and realization of public and publicly funded construction measures also serves the purpose of

- cutting costs with respect to the planning and realization
- and the minimization of the anticipated operating costs or life-cycle costs of a building.

Phase 1 of the study comprised the development of an indicator matrix based on existing assessment systems and to be applied to "Green Hospitals", which was realized by the project group consisting of Nickl & Partner, Iproplan, and the TU Berlin. Other than is the case with the certification systems, the emphasis is not put on the individual indicators, as the focus of this project was rather aimed at the transfer of those indicators relevant in Germany to hospitals in emerging and newly industrialized countries.

The conditions in the emerging and newly industrialized countries may vary to a considerable extent, resulting in a significant shift of the emphasis concerning the individual indicators like, for instance, from aspects related to the energy efficiency to a sustainable water resources management.

The application of the indicator matrix to the chinese hospital has already shown that the criteria selected from the existing assessment systems are not only applicable to German hospital standards but also to hospitals in newly industrialized countries. Basically, it´s possible to represent all requirements related to hospitals by means of the compiled indicator matrix.

This applies particularly to the present circumstances in China, namely, in the south of Shanghai, as the overall concepts implemented at those places comply with the objectives pursued in Western countries. Hence, on the basis of the several compiled criteria, it was also possible to draw a comparison among one another of the buildings in order to set up a compliance matrix with respect to the objectives to be fulfilled.

In doing so, the chinese hospital showed various deficits when compared with the German hospitals. This can, however, also be ascribed to the fact that the German buildings assessed in terms of their sustainability by the project group were considered as lighthouse projects in the course of their planning and commissioning, already. Nine times out of ten, these hospitals turned out to deviate from a 100 percent degree of goal achievement to a larger or lesser extent due to the sophisticated criteria of the assessment matrix.

INTRODUCTION | RÉSUMÉ

SHEET 3

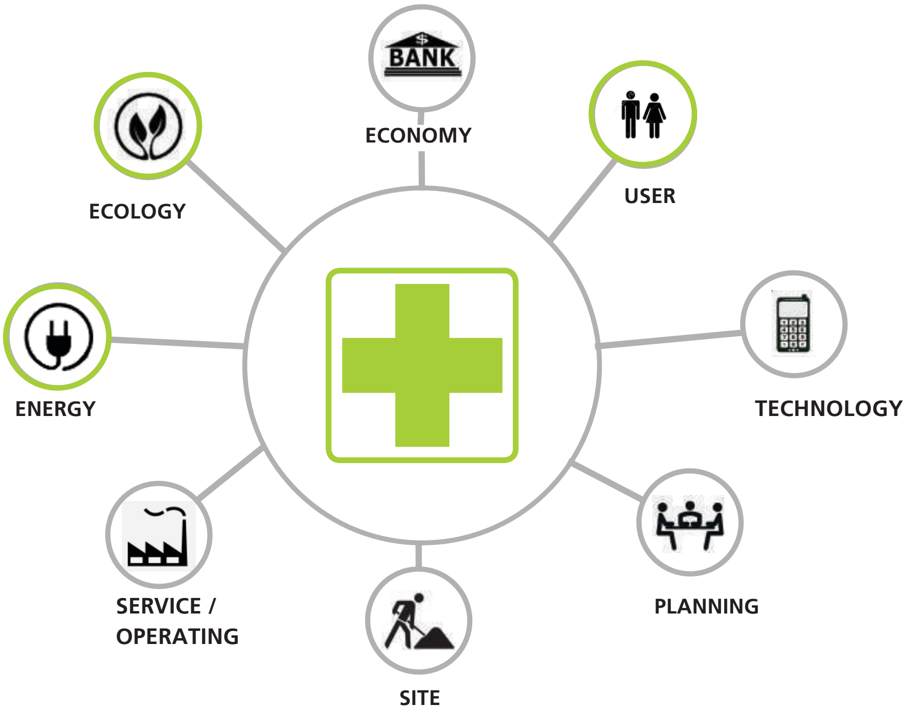

Fig.2 Valuation parameters for energy efficiency and sustainability in the hospital over its entire life cycle -
Most potential of adaptation for emerging countries.

Another important aspect to mention is, that the compiled indicator matrix must not result in an increasingly engineered building equipment, but which, for reasons of the financial feasibility, reduction of operating costs, and the security of supply, should rather aim at the promotion of an "intelligent" building engineering concept based on robust ("resilient") technologies.

As for low-standard hospitals in emerging countries like one of those that were afflicted by war, such as the hospital in Kandahar (Afghanistan), and which also formed a part of the TU Berlin´s set of tasks, the study would require a more detailed elaboration. In this case, the indicator matrix would be subject to evidence of a complete evaluation of all criteria and the reasonableness concerning the assessment of the goal achievement level with respect to the sustainability under consideration of the aspects described above.

LIST OF | ABBREVIATIONS

ABBREVATION	DESCRIPTION
AgBB	Committee for the health assessment of construction products
BHKW	Block heat and power plant
BUS	Binary Unit System
CHP	Cogeneration plant, combined heat and power
CT	Computer tomography
DVGW	German Technical and Scientific Association for Gas and Water
EEWärmeG	German regenerative energy and heat ordinance
EnEV	Energy Saving Ordinance
EPD	Environmental product declaration
CFC	Chlorofluorocarbon substances
HCFC	Halogenated chlorofluorocarbons
IT	Information Technology
LED	Light Emitting Diode
MRT	Magnetic resonance imaging
PV	Photovoltaik
RLT	Air conditioning system
TGA	Technical facility
USV	Uninterruptible power supply
BIM	Building information modeling

SYMBOLS

SYMBOL	DESCRIPTION	UNIT
A	Envelope of a building	m²
A_R	Equivalent sound absorption area of a room	m²
D	Day light factor	%
g	Total energy transmittance	%
n_{50}	Air exchange rate	*h-1*; (m³/h)/m³
Q_p	Primary energy demand	kWh/(m²·a); kWh/a
$Q_{p,Ref}$	Primary energy demand of reference building	kWh/(m²·a)
R_a	Color Rendering Index	%
S	Solar transmission value	-
S_i	Sub-areas of a room	m²
T	Reverberation time	s
U	Heat transfer coefficient	W/(m²·K)
$\bar{U}$	Weighted mean heat transfer coefficient	W/(m²·K)
UGR_L	Unified glare rating limit	%
V	Building volume	m³
V_R	Room volume	m³

GREEK SYMBOL	DESCRIPTION	UNIT
α	Sound absorption coefficient of the subareas Si	-
τ	Light transmittance	%

EVALUATION PARAMETERS MATRIX

SHEET 5

For the structuring of the present formulation and a clear presentation of results, a criteria matrix was designed as part of the GHP Green Hospital study. In this matrix, the investigated criteria of each group are reported in terms of eight fixed evaluation parameters. The following selected evaluation parameters take different qualities of sustainability and energy-efficiency into account:

ENERGY EFFICIENCY

The building energy efficiency of a hospital shall be considered here. The structural heat protection and efficiency of technical systems will be investigated. This includes heating, warm water generation, ventilation and air conditioning, refrigeration as well as process technologies used. The effect of the use of renewable energies is also being considered. The aim is to reduce the primary and final energy demand.

ECOLOGICALLY

The overall impact on the environment and the local risks shall be considered here, that are connected with construction, maintenance, operation and disposal of a building throughout its lifecycle. The aim is to reduce the polluting emissions, minimizing the burden on flora, fauna and humans, biodiversity protection and sustainable resource conservation.

ECONOMICALLY

The costs incurred during the life cycle of a building shall be considered here. This includes manufacturing, operating and disposal costs of a building. The operating costs such as costs of supply, maintenance, cleaning and energy are taken into account. In addition, hospital-specific utilization costs are included. Furthermore, buildings are long-term investments. A positive increase in value is therefore an important feature of economic quality. The goal is also to reduce the cost in € / m² Gross Floor Area/a

SOCIOCULTURALLY

The comfort of the building occupants shall be considered primarily. Here, the well-being of hospital employees and their quality of work is studied firstly. On the other hand the well-being of patients and the influence on their progress in recovery is highly relevant. In addition, the socio-cultural quality affects the public image, the image of the hospital and on its possible corporate design. The aim is to increase the thermal, acoustic and visual comfort as well as maximizing the security and user ex-perience while minimizing accident risks. For indicators of high user influence on the success of in-dividual actions, participation and motivation of patients and employees is as an evaluation criterion of major importance.

TECHNICALLY

The quality and degree of mechanization shall be considered, which is relevant for operating the building. The technical building equipment is considered, as well as IT and use-specific processes and systems such as medical devices. The goal is a high degree of automation in many areas, their linkage and high regulating accuracy of the components. The aim is to reflect the state of the art in the choice of technical equipment and replace old equipment because of the increase in efficiency.

IN PLANNING

The effort and the quality of planning shall be considered here, which is relevant for the construction, operation and end-of-life phase of a hospital. The planning process has a huge impact on the quality of the building and its technical equipment. The goal is an integral and holistic planning, a high level of detail and the easiest possible feasibility of the planned measures. The integration of sustainability aspects in the planning and procurement is thereby essential.

IN EXECUTION

The quality of construction and construction supervision shall be considered, as well as requirements on the site. The goal is the most accurate, clean and economical implementation of the planned measures. Of particular importance are also the documentation of the construction and a continuous quality control. A low-emission construction (reduction of waste, noise and dust) and the protection of soil is a precondition.

QUALITY ASSURANCE

The long-term quality of the building shall be considered, the technology and processes. The aim here is to ensure, through regular controlling and monitoring processes, an increase in efficiency, an optimization of operations and the maintenance of the building.

EVALUATION PARAMETERS MATRIX

The impact of the criteria on the different measurement parameters were thereby evaluated in a three-stage classification. The following symbols were used:

● ●	**HIGH IMPACT** on the valuation parameters
●	**LOW IMPACT** on the valuation parameters
○	**NO IMPACT** on the valuation parameters

This evaluation is based on the experience of all stakeholders' previously planned and carried out projects in the health sector.

In addition to the criteria, the indicators are shown, with which the quantitative or qualitative assessment of the individual criteria can be carried out.

The matrix serves as an overview of the examined groups and rating criteria. The evaluation of each criterion can be rediscovered in the notes of Chapter 3. As subgroups of the evaluation criteria, a sorting in building, interior, energy, facility management and other reference points can be found hereafter.

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TU berlin

Nickl & Partner

SHEET 7

TOPIC	CRITERIAS	EVALUATION PARAMETERS							
		ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
EXTERIOR	EXTERIOR DESIGN	●	●●	●	●●	○	●●	●●	●
	PUBLIC ACCESSIBILITY	○	○	●	●●	○	●●	○	○
	TRANSPORT CONNECTION	○	●●	●	●●	○	●	○	○
BUILDING	CUBATURE	●	●	●	○	○	●	○	○
	NATURAL LIGHTING	●●	●	●	●●	●	●●	○	○
	AIRTIGHTNESS	●●	●●	●	●	●●	●●	●●	●●
	MOISTURE PROTECTION	●●	●	●	●●	●●	●●	●●	●●
	OPAQUE COMPONENTS	●●	●	●	●	●●	●●	●●	●●
	TRANSPARENT COMPONENTS	●●	●	●	●●	●●	●●	●●	●●
	BUILDING MATERIALS & RECYCLING	●	●●	●●	●●	●●	●●	●	○
INTERIOR	FIRE PROTECTION	○	●	●●	○	●●	●●	●●	●
	SOUNDPROOFING	○	○	●	●●	●	●●	●●	●
	ACOUSTIC COMFORT	○	○	●●	●●	●	●●	●	○
	VISUAL COMFORT	●	○	●	●●	●	●●	○	○
	THERMAL COMFORT	●●	●	●●	●●	●	●●	○	●
	HYGIENE & INDOOR AIR QUALITÄT	●●	●	●●	●●	●	●●	●	●
	ACCESSIBILITY	○	○	●●	●●	●	●●	●	●
	SECURITY	●	○	●●	●●	○	●●	●●	●
	INTERIOR DESIGN	●	○	●●	●●	○	●●	●	●
ENERGY	ENERGY REQUIREMENTS - BUILDING	●●	●●	●●	●	●	●●	○	○
	HEATING	●●	●	●●	●	●	●●	●	●●
	HOT WATER	●●	●	●●	●●	●	●●	●	●●
	BUILDING COOLING	●●	●●	●●	●	●	●●	●	●
	VENTILATION	●	○	●●	●●	●	●●	●	●●
	DE- AND HUMIDIFICATION	●●	●	●●	○	●●	●	●●	●●
	LIGHTING	●●	●	●●	●●	●●	●●	●	●
	STORAGE	●●	●	●●	●	●●	●	●	●
	PROCESS ENERGY	●●	●	●●	●	●●	●●	●	●●
	INTERNAL LOADS	●●	●	●	●	●●	●●	●	●●
	RENEWABLE ENERGY	●●	●●	●●	●	●●	●●	●●	●●
FACILITY MANAGEMENT	REGULATION & CONTROL	●●	●	●●	●	●●	●●	●●	●●
	CLEANING & MAINTENANCE	●	●●	●●	●	●	●●	●●	●●
	WATERSUPPLY & WASTE WATER DISPOSAL	●	●●	●●	●	●●	●●	●	●●
	WASTE MANAGEMENT	○	●●	●●	●	●	●●	●	●●
	INFLUENCE OF THE USER	●	○	●	●●	●	●●	○	○

Fig.3 Evaluation criteria - MATRIX Stage 1

EVALUATION CRITERIA 1. EXTERIOR

SHEET 8

1.1 EXTERIOR DESIGN

DEFINITION / DESCRIPTION
Outdoor lying common areas in the immediate vicinity of the building offer individually usable break, communication and retreat areas and thus serve the common welfare and different needs of individual user groups. They promote the exchange between the different users and support the recovery process (reduction of pain/ reducing medication distribution) with a view into the surrounding green environment. Additionally, it can contribute to the general acceptance of a building.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	●	● ●	○	● ●	● ●	●

EVALUATION & EVALUATION STANDARD
The assessment is divided into **quantitative**:

- Roof greening (flat roofs
  $R_{IST} = R_{MAX} - NR$
  R_{MAX} = Total roof area minus the various roof structures and roof construction (attica formation, technology constructions, skylights, etc.)
  ND = Roof area without qualitative assessment (gravel strips, bitumen surfaces, etc.),
- Facade-integrated outdoor spaces (balconies, terraces loggias),
- Guilding integrated outdoor areas / grassed interior areas (atria, covered patios, etc.),
- Facade greenery,

and **qualitative**:

- Design concept for outdoor facilities including the integration of technical facilities,
- Use of native plants for planting,
- Use of outdoor facilities for the general public,
- Features of the outdoor surfaces,
  (seating and resting facilities, water elements, sun protection, etc.)

INTERACTION WITH OTHER CRITERIA
1.2, 1.3, 3.7 – 3.9, 4.4, 6.1 – 6.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ surrounding green space area in place
+ high vegetation diversity
- no qualitative usage detectable
- no greening of the roofs or facades, nor any amenities

Pict.1 Green Area,
watersite behind the building

CONFLICTING GOALS WITH OTHER CRITERIA
1.3 Transport connections
Area of car park – no max. utilization of the area available for this purpose

MEASURES TO ENHANCE THE SUSTAINABILITY
- Preparation of a design concept for exterior facilities incl. connection to river
- Expansion of green area at the backside of the building owing to removal of lateral parking spaces
  Provision of accessibility to the public (visitors, patients, etc.)

EVALUATION CRITERIA 1. EXTERIOR

SHEET 9

1.2 PUBLIC ACCESSIBILITY

DEFINITION / DESCRIPTION
Through a good publicly accessible building with a diverse range of use, the societal as well as its integration into the urban context, is promoted. Principally publicly accessible is understood as the free access to the building and to the reception area in connection with other facilities and premises (outdoor facilities, cafeteria, etc.) that are available for usage to the general public.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	●	●	● ●	○	● ●	●	●

EVALUATION & EVALUATION STANDARD

- Accessibility for the public,
- Opening internal building facilities (cafeteria, canteens, leisure facilities, etc.),
- Use of outdoor facilities for the general public,
- Mixed use of the public areas,
- Renting of premises by third parties (doctors' offices, etc.)

INTERACTION WITH OTHER CRITERIA
1.1, 1.3, 3.7 – 3.9, 6.1 – 6.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATE
\+ well visible, centrally located main entrance
\- no publicly accessible amenities in place

CONFLICTING GOALS WITH OTHER CRITERIA
1.3 Transport connections

MEASURES TO ENHANCE THE SUSTAINABILITY
- Provision of publicly accessible amenities in order to improve both the recognition and image of the hospital
- Provision of leasing areas in order to make for additional revenue
- Installation of an "Info-Health-Box" in order to provide for general and specific information on health

Pict.2
Main entrance chinese Hospital

EVALUATION CRITERIA 1. EXTERIOR

SHEET 10

1.3 TRANSPORT CONNECTION

DEFINITION / DESCRIPTION
To ensure quality of the site, the connection of a building to different means of transport - ecofriendly private transport - is an important criterion. For a hospital, the connection to the public transport is of particularly high importance.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	● ●	●	● ●	○	●	○	○

EVALUATION & EVALUATION STANDARD

Accessibility of the nearest access point of public transport (bus, train, tram, etc.) - > max. 500m:
Development of the site by bicycle paths:

- Short (max.600m) accessibility to the closest point of public transport (bus, tram, train, etc.),
- Quality of the road connection (connection to the developed main road, motorway access via a good arterial road),
- Individual parking concept (parking for people with mobility limitation, bicycle parking/ taking shelter facilities, temporary parking for emergency physician, delivery, etc.),
- Good accessibility (no crossing without traffic lights or use of multi-lane roads that are designed solely for motorized traffic),
- Development of the site by existing bicycle network

INTERACTION WITH OTHER CRITERIA
1.1,1.2, 3.7, 3.8, 6.1, 6.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Erection of new subway access next to the hospital (to be commissioned in the near future)
+ Existence of several bus stops in close vicinity to main entrance
+ Hospital provides direct connection to the main traffic roads (junction)
+ Roofed parking spaces for conventional and elect. bicycles, incl. charging point (fossil)
+ Underground car park/ parking spaces for staff available
- Insufficient number of parking spaces for visitors (lack of a general concept with respect to parking)

Pict.3 Parking space by green area

CONFLICTING GOALS WITH OTHER CRITERIA
1.1 Quality of exterior facilities
The maximum number of parking spaces conflicts with the planned expansion of the green area.

6.5 Area utilization
Additional parking spaces would involve an increase in the areas to be sealed (deterioration of microclimate).

MEASURES TO ENHANCE THE SUSTAINABILITY
- Preparation of an area- and parking concept for patients and visitors under consideration of the exterior facilities or potential expansion areas in place.
- Improvement of the overall quality concerning parking / areas, main entrance

Pict.4 bycicle parking facilities

EVALUATION CRITERIA 2. BUILDING

SHEET 11

2.1 CUBATURE

DEFINITION / DESCRIPTION
The cubature of a structure describes its shape and volume. In terms of energy efficiency in particular the compactness of the building is relevant..

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	●	●	○	○	●	○	○

EVALUATION & EVALUATION STANDARD
For the energetic evaluation, the A / V ratio of a building is considered. Here the thermal envelope surface of the building is divided by its volume. At constant volume, this means, the smaller the quotient, the smaller is the heat transferring outer surfaces of the building. In addition to the A / V ratio also the shape of the building has a significant influence on the transmission heat loss. Inclined facades have, for example, in clear nights a higher proportion of long-wave heat radiation.

Limiting value: A/V <= 0,7
Reference value: A/V <= 0,5
Target value: A/V <= 0,3

INTERACTION WITH OTHER CRITERIA
2.2, 3.9, 4.1, 4.2, 4.4, 4.11, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Buildings (simulation) have a very well-balanced A/V proportion (0.22)

CONFLICTING GOALS WITH OTHER CRITERIA
None

MEASURES TO ENHANCE THE SUSTAINABILITY
- Provision for a well-balanced A/V proportion with all new planning projects to be impleme ted in the future

Pict.5 Hospital area - Simulation

Pict.6 Elevation main entrance / Wards

EVALUATION CRITERIA 2. BUILDING

SHEET 12

2.2 NATURAL LIGHTING

DEFINITION / DESCRIPTION

The natural lighting is being guaranteed by sufficiently large windows, skylights or other transparent components. Due to a high amount of natural lighting, a reduction in lighting energy and cost needed for artificial light can be obtained. In addition, a visual connection to the outside has also a psychological impact on the well-being of users.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	●	● ●	●	● ●	○	○

EVALUATION & EVALUATION STANDARD

- Geometric conditions (size % position of the window openings, room depth), DIN 5034,
- Spatial orientation,
- External shading by vegetation or neighboring buildings,
- Day light factor D
  D_{MIN} = 0,75 % (bed rooms, work areas)
  D_{MEDIUM} = 0,9 % (bed rooms, work areas)
  D ≥ 2 % (work areas with skylight),
- glare / sun protection,
- Operation of the glare / sun protection (automatic, manual),
- Daylight supply when sunlight or glare protection is activated,
- transparent internal components, design of surfaces (color, roughness)

INTERACTION WITH OTHER CRITERIA

2.1, 2.6, 3.4 – 3.6, 3.9, 4.1, 4.2, 4.4, 4.7

DESCRIPTION OF ACTUAL STATUS

+ large window cases in patient rooms and offices
- natural lighting is partly missing at permanent work areas (workspace clean, nurse meeting room, offfice supervisory nurse / physician, archive, etc.)
- Very poor lighting conditions in hallways due to missing transparent interior component parts & ground plan layout
- Very poor lighting conditions in lobby due to covered domed roof light
- No shades in place
- No solar protection in place

STRUCTURAL SURVEY

Pict.7 Light dome main entrance

Pict.8 Fassace ambulance

CONFLICTING GOALS WITH OTHER CRITERIA

3.5 Thermal comfort

Deterioration of thermal comfort and increase in energy consumption due to solar load, resulting in problems with respect to the temperature compensation

MEASURES TO ENHANCE THE SUSTAINABILITY

- Retrofitting of shades- and sun protection installation systems
- With new planning projects (expansions, retrofitting), it should be seen to it that the ground plan layout includes a lighting scheme for all permanent work areas (reduction of cost for expensive artificial lighting and energy consumption involved in the use of such kind of lighting, increase in visual comfort on the part of the user groups)

EVALUATION CRITERIA 2. BUILDING

2.3 AIRTIGHTNESS

DEFINITION / DESCRIPTION
The thermal envelope shall be designed in such a way that the heat transferring surrounding surfaces including the joints are permanently airtight. Otherwise, unwanted ventilation heat los-ses lead to in-creased heating demand or noticeable drafts occur at high wind loads. In addition, an air-tight construction prevents outflow of the usually humid room air into the insulation level of the external compo-nents where it can condense below the dew point and cause massive structural damage.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TTECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	●	●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD
The airtightness of a building can be examined using a blower door test. Here, the measured air ex-change at a pressure difference between the inside and outside of 50 Pa below shall not exceed:

$n_{50} \le 3{,}0\ h^{-1}$ in buildings without air-conditioning systems
$n_{50} \le 1{,}5\ h^{-1}$ in buildings with air-conditioning systems

In addition to the tightness of the building envelope, a minimum air exchange must be gua-ranteed according to valid Energy Saving Ordinance. In special cases (eg facades towards busy roads) natural ventilation is normally not possible or only with cost-intensive measures (eg. baffles, etc.), due to noise and the outside air quality.

INTERACTION WITH OTHER CRITERIA
2.4 - 2.7, 3.1, 3.2, 3.6 – 3.7, 3.9, 4.1, 4.2, 4.4, 4.5

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- New building: Some leaks in connection of split units
- Old building: Leaks in sash windows in patient rooms

CONFLICTING GOALS WITH OTHER CRITERIA
5.5 Influence on the part of the user
Users (primarily patients) air the rooms very often regardless the current weather conditions (Summer = moist-warm climate, Winter = cold)

MEASURES TO ENHANCE THE SUSTAINABILITY
- Replacement of leak windows
- Installation and use of a regulated air ventilation system
- Removal of existing split units and closure of gaps that might have resulted therefrom


Pict.9 Connection of split units


Pict.10 Sliding window

EVALUATION CRITERIA 2. BUILDING

SHEET 14

2.4 MOISTURE PROTECTION

DEFINITION / DESCRIPTION
In principle, we distinguish between constructive and climate-induced moisture protection. The former deals with construction waterproofing to protect against precipitation events, stagnating groundwater or the like. The climate-induced protection against moisture investigates condensation and mold formation as well as material corrosion in or on components. Non-compliance of humidity protection can lead to massive damage, deterioration of indoor air quality, reduced heat protection or infestation by insects or fungi.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●	●●	●●	●●	●●	●●

EVALUATION & EVALUATION STANDARD

Constructive moisture protection:
construction waterproofing according to DIN 18195, ISO 13788
- soil moisture DIN 18195-4,
- non-pressing water DIN 18195-5,
- Externally pressing water DIN 18195-6,
- internally pressing water DIN 18195-7,

climate-induced moisture protection:
- formation of condensation according to DIN 4108-3, DIN EN ISO 13788,
- heat transfer resistances of external components according to DIN ISO 6946,
- airtight construction,
- air change according to room usage (moisture loads),
- Use of heat and humidity coupled dynamic simulations (WUFI, DELPHI), especially in interior insulation and complex existing structures

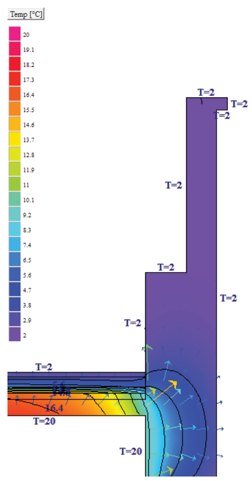
INTERACTION WITH OTHER CRITERIA
2.3, 2.5 – 2.7, 3.5 – 3.7, 3.9, 4.1, 4.2, 4.5

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Basically, no damaged spots detected
+ In winter season: improved air exchange rate due to wrongdoing on part of the user (perma nently open windows)
- Thermal bridges in the area of the balustrades and attics
- In summer season: The aspects concerning moisture protection are described under section 4.6 Humidification/Dehumidification)

CONFLICTING GOALS WITH OTHER CRITERIA
5.5 Influence on the part of the user
Users (primarily patients) air the rooms very often regardless the current weather conditions (Summer = moist-warm climate, Winter = cold
4.6 Humidification and dehumidification
3.6 Sanitation & quality of inside air

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation of thermal insulation system (check via simulation)
  In cold months, an exterior insulation of the component parts helps to prevent loss of condensation water in the building´s interior. In addition to this, an appropriate insulation would help prevent the generation of constructive and geometric thermal bridges
- In winter season: Preparation of a regulated air ventilation concept (see section 4.6 Humidification/Dehumidification)



Pict.11 Simulation thermal bridging (winter)

EVALUATION CRITERIA 2. BUILDING

2.5 OPAQUE COMPONENTS

DEFINITION / DESCRIPTION
Opaque components are made of opaque materials and form usually the largest surface area of the thermal building envelope. This includes exterior walls, roofs and floor slabs. In most cases, these components are made up of several layers.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●	●	●●	●●	●●	●●

EVALUATION & EVALUATION STANDARD
To evaluate the energetic quality of the surrounding surfaces, heat transferring the heat transfer coefficient U [W/(m²·K)] is used in accordance with DIN EN ISO 6946. To evaluate according to EnEV, the weighted average U-value U is considered. This is composed of all heat transfer coefficients of the opaque exterior components of the building, depending on the area fractions. The influence of the thermal properties of the ground contact components is weighted with 0.5.

Limit: Compliance with minimum thermal insulation **DIN 4108 – 2** (U ≤ 0,73 W/(m²·K)
Reference value*: $\bar{U}$ ≤ 0,35 W/(m²·K) (EnEV 2014)
Target value*: $\bar{U}$ ≤ 0,28 W/(m²·K) (EnEV 2016) * for rooms with target temperatures ≥ 19 °C

The reflective properties of the surface of opaque component parts and the associated thermal heat input play a rather minor role in Germany. Due to the high insulation quality of the thermal building envelope and the low average temperatures outside, the thermal heat inputs generated by means of opaque component parts are generally not recognized or recorded in the balance. In hot climatic regions, however, the impact of the solar radiation on opaque component parts may be considerably higher, which, again, calls for an appropriate solution with respect to the night cooling and the conflicting goals as the ultimate goal is the insulation of an opaque building envelope.

INTERACTION WITH OTHER CRITERIA
2.3, 2.4, 2.7, 3.5, 3.6, 3.9, 4.1, 4.2, 5.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Measured U-values of opaque component parts worse than required values according to the China Building Code
- Solidified masonry joints

U-values:

Thermal envelope component part	Requirement: U-value according to *China Building Code*[1] applying to zone HSCW (hot summer, cold winter) [W/(m²·K)]	U-value KH Ningbo [W/(m²·K)]*	
		New building	Old building
Roof	≤ 0,70	0,83	1,33 - 2,64
Exterior wall	≤ 1,00**	2,47	2,01 - 2,36
Flooring to soil	(R ≥ 1,2 (m²·K)/W)	1,94	-

[1] last revised 2008

*evaluated on the basis of as-completed drawings at hand

** includes impact of thermal bridges

- Measured U-value of opaque component parts worse than required values according to the *China Building Code*
- Insulation measures required → Reduction of heat consumption

Pict.12 Facade wards

Pict.13 Facade ambulance

EVALUATION CRITERIA 2. BUILDING

CONFLICTING GOALS WITH OTHER CRITERIA
2.3 Airtightness
4.4 Cooling of the building
4.6 Humidification/Dehumidification

MEASURES TO ENHANCE THE SUSTAINABILITY

- Insulation measures required --> Reduction of heat consumption
- with new planning projects (expansions, retrofitting), it should be seen to it that the material used for the mortar of the masonry is cement instead of plaster (prevention of crack formations).

EVALUATION CRITERIA 2. BUILDING

SHEET 17

2.6 TRANSPARENT COMPONENTS

DEFINITION / DESCRIPTION

Transparent components are translucent. These include, for example, windows and glass facades. While the insulation quality of these is generally worse than that of the opaque insulated components, energy in the form of solar radiation can pass into the building due to the transparency. This results in additional demands on the summer heat protection to avoid the overheating of rooms. In addition, the use of daylight is ensured in the building through transparent components. The quality of the stay and significantly the energy required for lighting depend on this.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●	●●	●●	●●	●●	●●

EVALUATION & EVALUATION STANDARD

To evaluate the transmission heat transfer through the transparent devices, the U-value [W / (m • K)] is used. In addition the total energy transmittance g, as a measure of the permeability of the transparent components for energy, the light transmittance value U is a measure for the radiation in the visible range that passes perpendicularly through the glazing. An important planning task is to optimize the physical properties of the transparent components for the winter and the summer. Through the use of automatic sun protection devices, the interaction between the parameters in summer and winter can be optimized.

U-value [W/(m²·K)]:

Limit: $U_f \leq 2,9$ (DIN 4108 – 2)

Reference value*: $U \leq 1,90$ (EnEV 2014)

Target value*: $U \leq 1,50$ (EnEV 2016)

*for rooms with target temperatures ≥ 19 °C

Solar transmission **value S**:

Reference value / limit: $S_{vorh} \leq S_{zul}$

Target value: $S_{vorh} \leq 0,8\ S_{zul}$

INTERACTION WITH OTHER CRITERIA

2.2 – 2.4, 2.7, 3.5, 3.6, 3.9, 4.1, 4.2, 4.4, 4.5, 4.7,5.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

- A_W/A_{AW} =0.395
- Old building: Single glazing

\+ New building: Double glazing – Isolation of frame moldings, Low-e-coating

U-values:

Thermal envelope component parts		Requirement according to *China Building Code* for zone HSCW (hot summer, cold winter) [W/(m²·K)]		U-value KH Ningbo [W/(m²·K)]*	
		U-value [W/(m²·K)]	Total transmittance degree of energy g [-]	U-value [W/(m²·K)]	Total transmittance degree of energy g [-]
Exterior windows and transparent curtain walls	$A_W/A_{AW} \leq 0,20$	≤ 4,70	-		
	$0,20 \leq A_W/A_{AW} \leq 0,30$	≤ 3,50	≤ 0,55/-		
	$0,30 \leq A_W/A_{AW} \leq 0,40$	**≤ 3,00**	**≤ 0,50/0,60**	**3,22 – 5,77****	**0,76**
	$0,40 \leq A_W/A_{AW} \leq 0,50$	≤ 2,80	≤ 0,45/0,55		
	$0,50 \leq A_W/A_{AW} \leq 0,70$	≤ 2,50	≤ 0,40/0,50		

*evaluated on the basis of as-completed drawings at hand

** in old buildings

Pict.14 Facade wards

Pict.15 Facade ambulance

EVALUATION CRITERIA 2. BUILDING

- A_W/A_{AW} = 0,395
- Replacement of windows of old building with at least double glazing (triple, if required) → Reduction of heating consumption
- Glazing with a low transmittance degree of energy g (sun-protection glass) required → Reduction of solar loads cooling load

CONFLICTING GOALS WITH OTHER CRITERIA
2.3 Thermal comfort
Solar load leads to an impairment of the thermal comfort and increase of the energy de mand, as the higher temperatures need to be balanced.
4.4 Patterns of use (closed windows)
4.6 Visual comfort

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation of a sun protection system
- Old building: Replacement of windows / Single glazing with at least double heat insulation (triple glazing, if required) to reduce heat consumption
- Glazing should exhibit a low transmittance degree of energy g (sun protection glass), in order to facilitate the reduction of the solar and cooling load.

EVALUATION CRITERIA 2. BUILDING

2.7 BUILDING MATERIAL & RECYCLING

DEFINITION / DESCRIPTION
The choice of materials has an influence on many characteristics of a building (optics, haptics, costs, interaction with environment, etc.). Depending on the configuration of certain components, corresponding materials are to be selected. Here, for example, structural, building physical or economic aspects can be decisive. In order to promote material cycles and reduce the burden on the environment, it is desirable to use recyclable materials.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	● ●	● ●	● ●	●	○

EVALUATION & EVALUATION STANDARD
For the evaluation of a building material, the following criteria are to be considered, regardless of its functional requirements:

- Energy and resource consumption in manufacturing and disposal (EPD),
- Potential risk for the environment and the user (GISCODE, EMICODE, Blauer Engel, AgBB),
- Environmental and human toxicity (heavy metals, CFCs, HCFCs, car-cinogenicity, etc.),
- Durability and economy,
- Behavior in case of fire,
- Recyclability and the effort required for this (energy, time, cost, etc.)

In order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

INTERACTION WITH OTHER CRITERIA
2.3 – 2.6, 3.1, 3.3, 3.4, 3.6, 3.9, 4.1, 4.11, 5.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Assessment of surfaces used/ surface treatment not possible due to missing safety data sheets
- Used material, see annex 7

CONFLICTING GOALS WITH OTHER CRITERIA
Availability of highly-qualitative construction material (import) and extra charges associated with it.

MEASURES TO ENHANCE THE SUSTAINABILITY
- Check for feasible construction standard (determined budget) and appropriateness of the technologies applied for possible improvement (material, rules of engineering)
- with new planning projects (expansions, retrofitting), it should be seen to it that the selec tion of the construction material is made on the basis of the specifications set out in the safety data sheets and under consideration of the cost-effectiveness, economic-, and ener getic aspects
- Inspection of the material to be used (Introduction of documentation)


Pict.16 Flooring wards (new building)


Pict.17 Flooring wards (old building)


Pict.18 Reconstruction patientroom

EVALUATION CRITERIA 3. INTERIOR

3.1 FIRE PROTECTION

DEFINITION / DESCRIPTION
Fire incidents threaten people, cause damages to the building and may produce hazardous emissions. The minimum requirements are in the respective building regulations, the specifically created fire pro-tection plan of a building or the special building codes, such as the high-rise building policy. Through structural and technical measures, fire protection can be planned, that goes beyond the minimum requirements.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	●	● ●	○	● ●	● ●	● ●	●

EVALUATION & EVALUATION STANDARD
Compliance with legal provisions/ conditions relating to fire protection of the building permit (including deviation requests and approvals in each individual case).

Structural fire protection:
- Training of fire and smoke compartments,
- Undercutting the max. permissible escape route lengths by 20%,
- Exceeding the in the building regulations required escape route width by at least 25%,
- Prevention of fire gas risks (PVC in building materials),

Plant fire protection:
- Installation of extensive fire alarm system,
- Installation of security lighting,
- Installation of air vents for automatic smoke exhaust system,
- Installation of a BOS-building radio system for the fire department,
- Marking of safety equipment (fire extinguishers, fire hydrants, etc.),
- Prevention of fire gas risks (halogen-free cables/ lights)

INTERACTION WITH OTHER CRITERIA
2.3, 2.7, 3.2, 3.8, 3.9, 4.2 – 4.7, 5.1 – 5.3, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
Construction-related fire protection
+ area/site-covering sprinkler system
+ Extinguishing water storage available in basement
- missing smoke sections
- Status: Fire-related risks with existing PVC-windows


Pict.19 Ceiling Patientroom (new construction)

CONFLICTING GOALS WITH OTHER CRITERIA
4.7 Lighting (Artificial lighting)
Use of a specific illuminant in order to prevent electrical shorts
2.7 Construction material & Recycling
Check for feasible construction standard (counters, hand rail made of PVC)

MEASURE TO ENHANCE THE SUSTAINABILITY
- Prevention of risks related to combustion gases through replacement of the PVC-windows in place, etc.

EVALUATION CRITERIA 3. INTERIOR

3.2 SOUNDPROOFING

DEFINITION / DESCRIPTION
For a hospital, the insurance of a minimum audible quality is an indispensable prerequisite to the creation of the necessary peace and the protection of legitimate expectations for patients. A high sound insulation technical quality is an essential part of the comfort and satisfaction of the users. The set minimum requirements by the building regulation must be met.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	●	● ●	●	● ●	● ●	○

EVALUATION & EVALUATION STANDARD
Compliance with legal provisions/ requirements according to the generally recognized rules of technology.

- DIN 4109 „hospitals, sanatoriums" (minimum requirement),
- Sound insulation requirements against external noise,
- Noises from domestic installations,
- Formation of a higher sound insulation (compliance with minimum requirement) in accordance with Bblt. 2 to DIN 4109

Evaluation variables:
- Air damping characteristics:
- Sound level from domestic installations

INTERACTION WITH OTHER CRITERIA
2.3, 3.1, 3.9, 4.2 – 4.6, 5.2, 6.3, 6.4

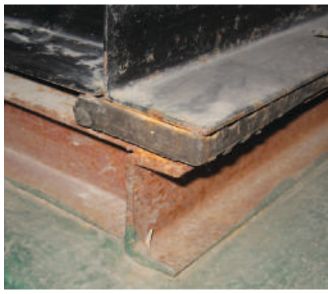
STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
The engineering of the buildings in place comply with the national standard´s (China Building Code) requirement of 75 dB impact noise.

+ Isolation of all service plants
- high noise level due to surrounding exterior facilities
- no provision for impact noise protection in floor construction
- no increased acoustic protection in place
- Acoustic noise transmission into all rooms and facilities due to integrated safety barrier

CONFLICTING GOALS WITH OTHER CRITERIA
None (material cost)

MEASURES TO ENHANCE THE SUSTAINABILITY
- With new planning projects (expansions, retrofitting) or redevelopment plans, it should be provided for a higher degree of the impact noise protection (reference to German standards)
- Isolation of all noise protection units and devices in all rooms and facilities (prevention of spatially overlapping component parts)



Pict.20 Decoupling technical equipement

Pict.21 Handrail patientrooms ward (new construction)

EVALUATION CRITERIA 3. INTERIOR

3.3 ACOUSTIC COMFORT

DEFINITION / DESCRIPTION
The room acoustic properties of a hospital have a major impact on the comfort of users. Firstly, the performance of the hospital staff will be affected and on the other hand the room acoustic quality affects the well-being and recovery of patients. In particular, the speech intelligibility in working and meeting rooms and the background noise level can be used as an assessment parameter. The acoustic comfort interacts with the noise reduction measures in kitchens, dining rooms, laundries and noise-sensitive communal areas.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	● ●	● ●	●	● ●	●	○

EVALUATION & EVALUATION STANDARD

In order to evaluate the acoustic comfort, the reverberation time T of the unfurnished space in the frequency range of 125 - 4000 Hz is determined:

small rooms ($A_{netto} \leq 50 m^2$)
eg. treatment rooms
T ≤ 0,8 s (good room acoustics)
T ≤ 0,5 s (comfortable room acoustics)

bigger rooms ($A_{netto} > 50 m^2$)
eg. operating theaters
T ≤ 1,0 s (good room acoustics)
T ≤ 0,5 s (comfortable room acoustics)

For larger rooms, such as dining rooms and living areas the ceiling reflection prevails.
Here, the **A_R/V_R-ratio**
(effective absorbing room surface $A_R = \sum_{i=1}^{n} \alpha \cdot S_i$) of a room according to DIN 18041 (for office areas VDI 2569) and DIN EN 12354-6 is being determined. Whereas A_R is the overall equivalent sound absorption area in a room and V_R its volume.

$A_R / V_R \geq 0,23 m^{-1}$ (good room acoustics)
$A_R / V_R \geq 0,28 m^{-1}$ (comfortable room acoustics)

INTERACTION WITH OTHER CRITERIA
2.7, 3.9

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
\+ Acoustic ceilings (mineral fiber ceiling tiles) installed in most of the rooms

CONFLICTING GOALS WITH OTHER CRITERIA
2.7 Construction material & Recycling
3.6 Sanitation & quality of inside air
Deposits of pollution, dirt, and mold due to poor workmanship and leaks in service plants
5.2 Maintenance & servicing

MEASURES TO ENHANCE THE SUSTAINABILITY
- An enhancement with respect of the acoustic comfort is not possible, as most of the rooms are fitted with acoustic-efficient ceiling material.
- Reduction of acoustical surfaces – Replacement with smooth surfaces in order to provide for improved sanitation and cleanability / servicing


Pict.22 Acoustic ceiling patientroom


Pict.23 Acoustic ceiling ambulanz

EVALUATION CRITERIA 3. INTERIOR

3.4 VISUAL COMFORT

DEFINITION / DESCRIPTION
Like the acoustic comfort, visual comfort massively influences the quality of the indoor climate. The working conditions of hospital employees are to be addressed, just like patient satisfaction. In the visual comfort both natural lighting and artificial lighting is considered. The aim is to provide high quality lighting with low energy use.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	●	● ●	●	● ●	○	○

EVALUATION & EVALUATION STANDARD

- Daylight availability evaluation through daylight factor D,
- Light level
  room specific, according to use, e.g.:
  Corridors, bed rooms: eye level 500 lx, ground 200 – 300 lx
  Examination and treatment rooms: 1000 lx, ground 200 – 1000 lx,
- Visual contact to the outside,
- Light distribution of artificial light by means of combined direct / indirect lighting,
- Absence of glare
  glare protection for daylight
  for artificial light UGR_L = 19,
- Color rendering (for artificial light color rendering index R_a 80 – 90 %)

INTERACTION WITH OTHER CRITERIA
2.2, 2.7, 3.8, 3.9, 4.1, 4.4, 4.7, 5.5

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
There is no national standard in China (e.g. guideline for workplaces) that specifies the requirements (natural lighting, min. level of lighting at the shop board) with respect to the lighting at a workplace.

+ Very good daylight illumination in rooms with exterior room covering (windows)
- Lack of natural lighting in some permanent workplaces (new building nursery area, archive)
- Very poor lighting in hallways (cost-cutting, no natural and insufficient artificial lighting)

CONFLICTING GOALS WITH OTHER CRITERIA
3.5 Thermal comforts
  Deterioration of thermal comfort and increase in energy consumption due to solar load, resulting in problems with respect to the temperature compensation
4.1 Energy consumption
  Higher levels of solar load improve the service life of ventilation and cooling systems)

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation of glare- and sight protection systems
- Opening of domed roof light, glass roof, e.g. sun protection system with greenery.
- With new planning projects (expansions, retrofitting) it should be provided for better lighting conditions using natural illumination, i.e. elaboration of a more efficient ground plan

Pict.24 Nursestation (new construction)

Pict.25 Refurbished restaurant (staff)

EVALUATION CRITERIA 3. INTERIOR

SHEET 24

3.5 THERMAL COMFORT

DEFINITION / DESCRIPTION

The thermal comfort takes into account the ambient air temperature, the air humidity, drafts and radiation asymmetries occurring through different surface temperatures (ISO EN DIN 7730). Only an optimal range of all components mentioned ensures the thermal comfort of the users. In this case, it acts both on the job situation of the employees as well as on the well-being or the quality of patient recovery. Additional requirements on thermal comfort may result from therapeutic or diagnostic targets.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●●	●	●●	○	●

EVALUATION & EVALUATION STANDARD

Operational temperature:
- Thermal room or building simulation
- Measurement
- heating load calculation according to DIN EN 12831 (winter case)
- Cooling load calculation according to VDI 2078 (summer case)

Draft:
- indoor air flow simulation

Radiation asymmetries:
- Surface temperatures according to VDI 3804

Relative humidity:
- In case of mechanical ventilation air humidity requirements according to DIN EN 15251

Under certain circumstances, additional requirements for thermal comfort may result from therapeutic or diagnostic targets.

INTERACTION WITH OTHER CRITERIA

2.2 – 2.6, 3.9, 4.1 – 4.10, 5.1, 5.6

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Overheating in summer (solar load, opened windows, vestibules and single glazing (old building)
- Radiation asymmetry found in the area of thermal bridges (in winter season)
- Draft due to permanently opened windows and leaks in the building envelope

CONFLICTING GOALS WITH OTHER CRITERIA

3.4 Visual comfort

Larger window cases contribute to an overheating of the building in the summer season

5.5 Influence on the part of the user

Users (primarily patients) air the rooms very often regardless the current weather conditions (Summer = moist-warm climate, Winter = cold)

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation of sun-protection system
- Improvement of cooling system (see section 4.4 Cooling of building)

Pict.26 Facade wards

Pict.27 Covered light dome

EVALUATION CRITERIA 3. INTERIOR

3.6 HYGIENE & INDOOR AIR QUALITY

DEFINITION / DESCRIPTION

A high indoor air quality is to ensure that the well-being and health of the users are not affected. Especially in permanent employment and living spaces hygiene is to be ensured. Concentrations of harmful substances and olfactory perceptions that are perceived as unpleasant must be avoided. By the appropriate design of a neces-sary ventilation rate using openable windows or a ventilation system, a high-quality indoor air is sought. Fur-thermore, additional odors and emissions can be avoided through a targeted building product selection.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	● ●	●	● ●	●	●

EVALUATION & EVALUATION STANDARD

Volatile organic connections (VOC):

- Use of low-emission declared building products („Blue Angel“, EmiCode, admission test of the „Committee for health-related evaluation of building products“ (AgBB),
- Measurement after completion of the building,

Ventilation rate:

- DIN EN 15251 – Determining the ventilation rate in dependency of the function,
- DIN EN 13779 (CO_2 - concentration outdoor air 400 ppm),
- Up to 800 ppm = high indoor air quality / 800-1000 ppm = medium indoor air quality

INTERACTION WITH OTHER CRITERIA

2.2 – 2.7, 3.9, 4.1 – 4.6, 4.9, 5.1 – 5.4, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

- there haven´t been specified any statutory/building regulations concerning the site require ments, yet
- Assessment of the building products not possible due to missing safety data sheets
- Selection of poor/low-quality material (not suitable when considering density of people)
- missing protective measures regarding existing surfaces
- Air exchange rate too low

Pict.28 Ceiling patientrooms wards

Pict.29 Lavatory bathroom patientrooms (old construction)

CONFLICTING GOALS WITH OTHER CRITERIA

4.1 Energy consumption

Increase in air exchange rates provides for quality improvement of the inside air

MEASURES TO ENHANCE THE SUSTAINABILITY

- Check for feasible construction standard (determined budget) and appropriateness of the technologies applied for possible improvement (material, rules of engineering)
- Increase in air exchange rate
- Use of high-quality building products
- Use of wipeable material (wall coating) / fender, etc.

EVALUATION CRITERIA 3. INTERIOR

SHEET 26

3.7 ACCESSIBILITY

DEFINITION / DESCRIPTION
For the pioneering and sustainable use of a building, a maximum accessibility of the indoor area as well as the associated outdoor areas is of critical quality. The entire built environment with the variety of different situations should be accessible and usable for every human being without any difficulties and without any outside assistance. This especially applies for public usage areas, for the outer and inner development of a building and for the specifically usage designated areas. Through predictive solutions in the planning phase, costs for additional adjustments can be largely avoided. In comparison, hospitals are used by an above average number of people with physical limitations as also different user groups (patients, staff, visitors).

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	○	● ●	● ●	●	● ●	●	●

EVALUATION & EVALUATION STANDARD

- Compliance with the general accepted rules of technology in accordance with § 4 / § 8 para. 1BGG and the currently valid building model of all paragraphs and requirements concerning accessibility (minimum requirement),
- DIN 18040-1,
- DIN 18040-3 (Replacement DIN 18024-1:1998-1: „Accessible building - part 1: streets, plazas,
  paths, public transport, parks, playgrounds and planning basics.",
- Technical rules for workplaces (ASR) in accordance with § 3a paragraph 2 of the Labour Ordinance „barrier-free design of workplaces [cf. ArbStättV (2004)],
- Disabled/ handicapped-accessible design of the patient (care, examination & treatment, etc.), visitor (hallways, lounges, etc.) and personnel areas (workplaces, lounges, etc.),
- Barrier-free design of the exterior

INTERACTION WITH OTHER CRITERIA
1.1 – 1.3, 2.3, 2.4, 3.8, 3.9, 4.3, 4.5, 4.7, 5.1, 5.2, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Accessibility is being provided for throughout the entire hospital by means of ramps and elevators, this goes especially in the ambulance area
- Bathrooms in patient rooms are not adapted to the needs of handicapped or disabled persons (narrow-spaced)
- Bathrooms in patient rooms are not adapted to the needs of handicapped or disabled per sons (door sills, restrooms)
- tactile guide-system is missing


Pict.30 Patientrooms: Bathroom


Pict.31 Threshold Toilet Patientrooms

CONFLICTING GOALS WITH OTHER CRITERIA
6.4 Space utilization

MEASURES TO ENHANCE THE SUSTAINABILITY
- With new planning projects (expansions, retrofitting), it must be seen to it that the space requirements of the patient bathrooms are adapted to the needs of handicapped or disabled persons
- Integration of a simple, clear guidance system to be applied to the entire hospital facilities
- Retrofitting to a tactile guide-system

EVALUATION CRITERIA 3. INTERIOR

3.8 SECURITY

DEFINITION / DESCRIPTION
A high sense of security fundamentally contributes to human comfort. Measures that increase the sense of security are usually also suitable for the reduction of risk of attacks by other people. The aim is to avoid dangerous situations and to reduce the impact of a non-preventable damage caused by force majeure as much as possible.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	● ●	● ●	○	● ●	● ●	●

EVALUATION & EVALUATION STANDARD

Protection against attacks / Improved sense of security:
- Clear routing (visibility, signalization),
- Illuminate the paths to public outdoor spaces and corridors in the building,
- Paths to security-enhanced parking/ bicycle parking spaces (short distances, lighting),
- Technical safety installations (video equipment, emergency telephones)
- Safety also outside of the normal working and opening times (gatekeeper, janitor)

Reducing the extent of damage in the event of loss event:
- Evacuation plans (event of damage outside the building e.g. bomb threat)
- Evention of the risk of fire gases due to various building materials (Halogen, PVC)
- Barrier-free escape ways (additional measures beyond legal requirements)
- Operating instructions for the ventilation and air-conditioning technology (HVAC-Systems) for the case of polluted air (in the event of fire)

INTERACTION WITH OTHER CRITERIA
1.1 – 1.3, 3.1, 3.4, 3.7, 3.9, 4.7, 5.1, 5.2, 6.1, 6.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Excellent technical safety devices (Monitoring of bicycle parking spaces, entrances, hallways, technical facilities
- consistent signposting system is missing
- insufficient illumination in hallways and at the elevator core
- evacuation plan is missing
- Risk of combustion gases due to use of PVC (windows, etc.)

CONFLICTING GOALS WITH OTHER CRITERIA
4.7 Lighting/Illumination (artificial light)
Sufficient illumination of hallways and escape routes in case of emergency
5.5 Influence on part of the user

MEASURES TO ENHANCE THE SUSTAINABILITY
- Elaboration of a consistent plan with respect to the signposting (signage / guide-system)
- Elaboration of a comprehensive evacuation plan

Pict.32 Observation camera

Pict.33 Security lighting

EVALUATION CRITERIA 3. INTERIOR

3.9 INTERIOR DESIGN

DEFINITION / DESCRIPTION

Especially in the health care system very specific demands are placed on the floor plan and interior design, as these have a significant impact on its functionality and flexibility in terms of different usages. Additionally, both of these factors significantly contribute to the spatial and aesthetic quality, acceptability and value stability of a building, which can promote the sustainability of a property in the long term. By planning as many transparent and visible areas as possible, additional spatial and functional features and a high quality of design of the functional areas can increase the well-being of each user group.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	● ●	● ●	○	● ●	●	●

EVALUATION & EVALUATION STANDARD

Mix of various usage possibilities:
- Additional potential uses (use of traffic and access area as lounge and communication zones,
- Community installations (seating, multi-purpose rooms),
- Additional services for users (cafeteria, gym, child care, etc.),

Quality of the usage area:
- Lounge and seating possibilities in the internal entrance and reception area,
- Natural lighting,
- Visual references, visibility in the interior and connection to the exterior spaces,
- Overall design/ ability of flexible furnishing,
- Storage and placing space,

INTERACTION WITH OTHER CRITERIA

1.1, 1.2, 2.1 – 2.7, 3.1 – 3.8, 4.2 – 4.7, 4.10, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

+ Seating areas in entrance area/lobby are available
- no additional options for use or community amenities
- poor daylight conditions in the entrance area/lobby and hallways
- no provision for a passage from interior to exterior facilities
- missing basic conception with respect to the overall design not (missing recreational areas for staff/visitors, no storage- and parking areas)

CONFLICTING GOALS WITH OTHER CRITERIA

6.5 Space utilization

The provision of additional public amenities requires additional space in the building

3.5 Thermal comfort

Deterioration of thermal comfort and increase in energy consumption due to solar load, resul ting in problems with respect to the temperature compensation

4.1 Energy consumption

MEASURES TO ENHANCE THE SUSTAINABILITY
- With new planning projects (expansions, retrofitting), various needs on the part of users need to be taken into account – check to be conducted using different conceptual approaches
- Improvement in terms of the daylight conditions

Pict.34 Nursestation (new construction)

Pict.35 Main entrance (old construction)

EVALUATION CRITERIA 4. ENERGY

4.1 ENERGY REQUIREMENTS - BUILDING

DEFINITION / DESCRIPTION

The energy demand of a building is determined by calculation and the energy consumption is being captured by measurement. It is composed of the energy demand for heating, ventilation, air conditioning, hot water and lighting. In addition, auxiliary energy sources are recognized, which are needed for energy supply. Not considered is the energy requirement for use-related systems or processes such as medical equipment in the building. For the distinction between final and primary energy requirements, the calculated final energy demand is multiplied by a primary energy factor for the respective power supply form, whereby amounts of energy from the upstream process chain (production, transformation and distribution) are being considered.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●●	●●	●	●	●●	○	○

EVALUATION & EVALUATION STANDARD

Final energy demand:
Calculation by reference building method according Energy Saving Ordinance and DIN V 18599 „Energy performance of buildings"

Primary energy demand:
The use of renewable or fossil energy is accounted for by the primary energy factor. Comparison with primary energy demand of the reference building according to Energy Saving Ordinance 2014: $\mathbf{Q_p \leq Q_{p,Ref}}$

In order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

INTERACTION WITH OTHER CRITERIA

2.1 – 2.7, 3.4, 3.6, 4.2 – 4.11, 5.1 – 5.3, 6.2 – 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

The data (see annex 6) gathered by Mr. Müller were compared by means of a thermal building simulation. A precise assessment is not possible, as we have no building assessment to refer to.

Consumption (Data acquisition: Company Erfassung Müller)		**Values gathered from building simulation**	
Heating	**Cooling**	**Heating**	**Cooling**
41,25 kWh/(m²·a)	51,35 kWh/(m²·a)	38,40 kWh/(m²·a)	55,80 kWh/(m²·a)
92,6 kWh/(m²·a)		**94,2 kWh/(m²·a)**	

CONFLICTING GOALS WITH OTHER CRITERIA

3.4 Visual comfort
    Larger window cases contribute to an overheating of the building in the summer season

3.6 Sanitation and quality of inside air

5.5 Influence on the part of the user
    Users (primarily patients) air the rooms very often regardless the current weather conditions (Summer = moist-warm climate, Winter = cold)

EVALUATION CRITERIA 4. ENERGY

4.3 Hot water

Increase of storage temperature in order to prevent the risk of legionella, increase in availabi lity of hot water in order to enhance the satisfaction level on the part of the user.

MEASURES TO ENHANCE THE SUSTAINABILITY

- Installation of sun-protection system
- Installation of thermal insulation system

EVALUATION CRITERIA 4. ENERGY

4.2 HEATING

DEFINITION / DESCRIPTION
Heat generation systems, including distribution and storage have a great influence on the energetic quality of the building. The dimensioning of the heating generation systems is based on the transmission heat losses (through the thermal envelope including thermal bridges) and the ventilation heat losses (through infiltration and the use-related air exchange). The design temperatures of the heat generation have a direct influence on the thermal comfort in winter.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●	●	●●	●	●●

EVALUATION & EVALUATION STANDARD

- **Producer:**

Fossil: Constant temperature boilers, condensing boilers *, low temperature boilers,
combined boiler
Regenerative: geothermal, solar thermal
* For improved condensing boilers with higher temperatures, exhaust gas heat exchanger help in increasing the efficiency.

- **Energy sources**:

Oil, natural gas, LPG, coal, wood / pellet, biogas, solar, electricity

- **Heating system / heating energy transfer:**

The following heating systems are possible: surface heating, free heating surfaces (radiators), thermally activated components, electric blankets, heating and air through the HVAC
Position of the transfer (radiators): in front of inner walls / external walls

- **Heating times:**

The heating times are calculated for particular rooms depending on utilization and as a function of degree days, which result from the outside temperatures. A night and weekend setback in certain zones reduces the energy consumption.

- **Heating distribution:**

One / two-pipe system,
Before-and return temperature,
Pipe length and cross-section,
circulation pump,
Hydraulic balancing
Non-insulated pipes U ≤ 1,00 W/(m·K) (distribution / sections / connection)
insulated pipes U ≤ 0,200 W/(m·K) (distribution)
U ≤ 0,255 W/(m·K) (sections / connection)

- **Control:**

Inertia of the heating medium (example underfloor heating),
Zones / room-side control,
Intermittent heating mode / room-by-room reduction

INTERACTION WITH OTHER CRITERIA
2.1 – 2.6, 3.1, 3.2, 3.5, 3.6, 3.9, 4.1, 4.5, 4.8 – 4.11, 5.1 – 5.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
Previous inspections of the technical facilities in order to provide for an enhancement of the current situation have been addressed and partly implemented, already. Basically, it can be said that

EVALUATION CRITERIA 4. ENERGY

the heating- and water circulation system are going to be implemented within a single system.

+ Boilers (gas)
+ 2nd boiler supposed to be retrofitted
+ heating pump (air-water)
+ Thermal heat transmittance via ventilation system

- No CHP
- unregulated pumps
- no hydraulic compensator system
- Both the heating- and cooling circuits are integrated in a single system, which may lead to problems during transitional months due to missing control system

CONFLICTING GOALS WITH OTHER CRITERIA
3.5 Thermal comfort

MEASURES TO ENHANCE THE SUSTAINABILITY
- Hydraulic compensation
- Integration of measurement- and control systems (pumps, valves, etc.)
- Replacement of circulation system

Pict.36 Heating system - solid fuel boiler (new technical supply)

EVALUATION CRITERIA 4. ENERGY

SHEET 33

4.3 HOT WATER

DEFINITION / DESCRIPTION
In hospitals, high demands are being made on domestic hot water systems and their quality. Due to the use, large hot water distribution systems with central domestic hot water production are often installed in the buildings. Large storages ensure the hot water supply in compliance with the security of supply and seasonal demand at any time. The design temperatures of the production and distribution result from hygienic requirements for the absence of Legionella. By appropriate insulation of the wires and insulated reservoirs, heat loss must be avoided and the energy requirements reduced. An energy efficient support of the production of hot water is possible through the use of solar thermal systems.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	● ●	●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- **Production:**

Outlet temperature at the domestic hot water generator: ≥ 60 ° C (DVGW W 551)
Centralized and decentralized

- **Distribution:**

Hot water temperature in circulation systems: ≥ 55°C (DVGW -work sheet W 551)
Temperature reduction max. 8h/24h (DVGW -work sheet W 551)
Implementation of a hydraulic balancing to avoid pressure and distribution losses

Length and cross-section of the piping

Non-insulated pipes	U ≤ 1,00 W/(m·K) (distribution / sections / connection)
insulated pipes	U ≤ 0,200 W/(m·K) (distribution)
	U ≤ 0,255 W/(m·K) (sections / connection)

- **Energy sources:**

Oil, natural gas, LPG, coal, wood / pellet, biogas, solar

- **Circulation pump:**

Regulated, unregulated, demand-driven, over-sized, electric power, pump expenditure figures

INTERACTION WITH OTHER CRITERIA
3.1, 3.2, 3.5 – 3.7, 3.9, 4.1, 4.8 – 4.11, 5.1 – 5.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
The generation of hot water takes place by means of a condensing boiler with an integrated storage charging system. The installation of another condensing boiler system is in the planning phase (replacement of current generators).

+ Potable water reservoir in basement (resources sufficient for 1 day)
+ additional hot water generation for potable water supposed to take place via continuous flow water heater
- Hot water feed and –temperature at 20-55°C
- Availability hot water from 5:00 a.m. - 8:00 p.m.
- Storage temperature too low – legionella prophylaxis not fulfilled


Pict.37 Hot water storage tank

CONFLICTING GOALS WITH OTHER CRITERIA
4.1 Energy consumption

MEASURES TO ENHANCE THE SUSTAINABILITY

- Check and assessment of legionella risk – Increase of storage temperature (legionella prevention)
- Replacement of pumps (Effectiveness)

EVALUATION CRITERIA 4. ENERGY

4.4 BUILDING COOLING

DEFINITION / DESCRIPTION
With increasing internal heat loads caused by medical devices, etc., and increased requirements for the reduction of transmission heat losses of the building envelope, energy-efficient building cooling is gaining on significant importance. For new, increasingly complex buildings in the health sector, the factor ‚cold' is already more important than heating. The conventional technical building services via compression chillers or the combination of cogeneration with absorption chillers are available energy efficient alternatives based on evaporation processes. Passive cooling of buildings on roof and facade greening complement the technical systems. Another option is the greening of facades with climbing plants that are deciduating in autumn. In the summer they offer shading, with the shading proportion being determined by how the climbing ropes are placed. Furthermore, evaporative cooling is generated by the plant.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	● ●	●	●	● ●	●	●

EVALUATION & EVALUATION STANDARD

- Adiabatic cooling in air conditioning systems,
- Construction of an energy efficient cooling network via hybrid cooler for year-round free cooling,
- Decentralized waste heat management for process energy and medical equipment,
- Building greening, high vegetation proportion in the building environment

DIN V 18599 „Energy performance of buildings", EEWärmeG, EnEV

When it comes to the choice of the refrigerant, the check of the environmental compatibility of the coolant is indispensable. This goes in particular for the global warming potential (GWP) and the ozone depletion potential (ODP). The use of CFC-, HFC-, PFC-, HFC-containing coolants has already been pro-hibited in Germany, resp. allowed to a limited extent. Alternative coolants come in the form of propane, propylene, ethane, and isobutene.

INTERACTION WITH OTHER CRITERIA
1.1, 2.1 – 2.3, 2.6, 3.1, 3.2, 3.4 – 3.6, 3.9, 4.1, 4.5, 4.6, 4.8 – 4.11, 5.1 – 5.3, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
The generation of the cooling requirements takes place via the combination of compression refrigeration systems (screw compressor) and split system cooling units with an integrated device to optimize the efficiency by means of humidification.

- Intrusion of waste heat from split system cooling units into open windows of the building
- missing calibration resp. inappropriate adjustment of circulator pumps
- missing alignment of hydraulics

Pict.38 Screw compressors (new technical supply

Pict.39 Split units with humidification

CONFLICTING GOALS WITH OTHER CRITERIA
4.1 Energy requirements

MEASURES TO IMPROVE THE SUSTAINABILITY
- Integration of alternative cooling and air-conditioning systems of buildings (adiabatic air cooling)
- Integration of hybrid cooling system to provide for a full free cooling
- Implementation of greening works around the building – Generation of evaporation-based cooling and shading
- Replacement of circulator pumps (adjusted and calibrated)

EVALUATION CRITERIA 4. ENERGY

4.5 VENTILATION

DEFINITION / DESCRIPTION
Basically, ventilation can be divided into free window ventilation and mechanical ventilation through room ventilation equipment. Air conditioning systems are being planned for certain areas in hospitals, as there are special requirements for indoor air quality. This is especially true in operating rooms and intensive care units. Here germs, odors or other air pollution can be selectively discharged. In addition, the supply air can be conditioned with regard to heat, cold, or humidity.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	● ●	● ●	●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Energy demand air transportation,
- Dependent on flow rate, time-and use-dependent, depending on cooling load (if applicable),
- Daily operating hours,
- Energy demand air conditioning,
- Draft risk,
- Room Conditioning:
  heating,
  cooling,
  humidification & dehumidification,
- recovery system
  heat recovery (≥ 75 %),
  moisture recovery

INTERACTION WITH OTHER CRITERIA
2.3, 2.4, 2.6, 3.1, 3.2, 3.5 – 3.7, 3.9, 4.1, 4.2, 4.4, 4.6, 4.9 – 4.11, 5.1, 5.2

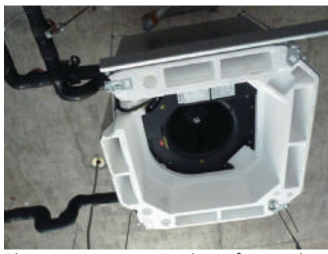
STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
Both the heating and cooling demands incurred on the part of the hospital are effected by means of a mechanical ventilation system. In the new building, the supply- and exhaust air is regulated; however, this takes place without any heat recovery or energy-efficient dehumidification. There´s no mechanic ventilation (restrooms are situated on the balcony).

- Exhaust air of split devices intrudes into the building through open windows
- no efficient cooling devices applied

CONFLICTING GOALS WITH OTHER CRITERIA
4.1 Energy consumption

MEASURES TO ENHANCE THE SUSTAINABILTY
- Retrofitting of humidification and dehumidification units by means of a cross-type heat exchanger (economizer) to provide for dehumidification and energy saving
- Integration of a hybrid cooling system to provide for an entirely free cooling system
- Implementation of building greening – Generation of adiabatic cooling and shading



Pict.40 New construction of an recirculating air-cooling equipment

Pict.41 Moisture damages due to condensation from cooled supply air (new construction)

EVALUATION CRITERIA 4. ENERGY

4.6 DE- & HUMIDIFICATION

DEFINITION / DESCRIPTION
The conditioning of the air in hospitals can lead to a considerable energy demand. This is in particular due to the high demand for humidification and dehumidification in combination with high air change rates. In humidification and dehumidification, the phase change of water, between liquid and gaseous state, is overcome with 700 kWh/m³. The humidification via steam is exergetically expensive. At a direct high-pressure humidification, a heat demand is created for post-heating. The dehumidification of the supply air via the summer chillers should also be avoided. As an energy-efficient alternative, sorption processes on silica gel (rotary heat exchangers) or liquid salt solutions can be considered.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	○	●●	●	●●	●●

EVALUATION & EVALUATION STANDARD

The air exchange rates are to be limited to the hygienic minimum and to be steered presence-dependent e.g. by CO_2 measurements. Wherever possible humidification and dehumidification should be avoided in most functional departments. Wherever necessary, the humidification should be oriented on the humidity of the air. The latent heat recovery in winter through sorption with indirect transmission of exhaust air humidity with simultaneous heat recovery is aiming at. Additionally to so far widespread sorption wheels, liquid and at the same time sanitizing salt solutions for complete separation of supply and exhaust air is preferable. In summer, the salt solutions of energy-efficient dehumidification can deliver the potential of regeneration of the brine solution, ambient heat or waste heat utilization.

INTERACTION WITH OTHER CRITERIA
3.1, 3.2, 3.5, 3.6, 3.9, 4.1, 4.4, 4.5, 4.9 – 4.11, 5.1 – 5.3, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
In the summer season, high temperatures and a high level of fresh air humidity may result in the formation of condensation water in the building´s interior facilities. Besides a controlled ventilation system, i.e. air supply system, the installation of an additional dehumidification system is inevitable.

- Dehumidification system considered to be insufficient
- Full climate control with integrated air circulation and dehumidification system in surgery department
- Exhaust heat of split devices intrudes into building through open windows
- no efficient cooling devices applied

CONFLICTING GOALS WITH OTHER CRITERIA
4.1 Energy consumption

MEASURES TO ENHANCE THE SUSTAINABILITY
- Integration of an energy-efficient dehumidification system based on sorption technologies

EVALUATION CRITERIA 4. ENERGY

SHEET 37

4.7 LIGHTING (ARTIFICIAL LIGHT)

DEFINITION / DESCRIPTION
The illumination by artificial light ensures the coverage of areas with little or no natural light. Typical of hospitals are the long periods of use. It is being used here also during nights and weekends. The energy demand for artificial light is highly dependent on the individual components of the illumination. The more efficient they are, the higher the energy savings.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●	●●	●●	●●	●●	●	●

EVALUATION & EVALUATION STANDARD
- **Required illuminance (at the height of the utilization level)**

Specific room according to use, for example,
Corridors: 100 lx,
Bed room (general / simple bedside examinations): 100/300 lx,
Examination and treatment rooms (general / examination place): 500/1000 lx

- **Illuminants:**

halogen spotlight:	ca. 95 % heat / 5 % light
Fluorescent lamp:	ca. 60 % heat / 40 % light
Energy saving lamps:	ca. 75 % heat / 25 % light
LEDs:	ca. 10 % heat / 90 % light

LEDs are characterized not only by their efficiency and low energy consumption but also by their long service life and mechanical insensitivity.

- **Presence detector:**

Due to their high detection quality, these are well suited for indoor areas and register even the smallest change in the thermal image within the room.

- **Constant light control:**

The adjustment of the lighting level can be made via dimmable actuators using light sensors.

- **Daylight-supplied areas**

Operating time:
Use of daylight hours
Use to daylight hours

- **Ballasts:**

Electronic ballasts (EB) should be preferable to low-loss devices (LLB) & conventional devices (CB).

INTERACTION WITH OTHER CRITERIA
2.2, 2.6, 3.1, 3.4, 3.5, 3.7 – 3.9, 4.1, 4.9 – 4.11, 5.1, 5.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ current illuminants in use: Fluorescent lamps, energy saving lamps, LED
+ partly use of electr. control gears
- insufficient lighting in hallways/workplaces
- no presence detector or constant light control

CONFLICTING GOALS WITH OTHER CRITERIA
4.1 Energy consumption

MEASURES TO ENHANCE THE SUSTAINABILITY
- Adaption of illumination level in accordance with usage


Pict.42 Lightning floors

EVALUATION CRITERIA 4. ENERGY

4.8 STORAGE

DEFINITION / DESCRIPTION
The storage of heat and hot water is for large buildings such as hospitals of high relevance. This guar-antees a daytime independent provision of hot water or heating. Especially with the use of renewable energies, the storage of heating in buffer storage is important because the heat demand is not time-coincident with the production in some cases. Likewise, in the operation of CHP modules, the storage allows a time-varying current production taking account load peaks in the National power grid. Furthermore, the storage of electricity both in the use of PV as well as to ensure security of supply during power outages is possible as a combination with UPS.
As a relatively new method, the storage of latent heat via sorption systems is possible.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	○	● ●	●	●	●

EVALUATION & EVALUATION STANDARD

- Standby heat loss,
- Insulation / self-discharge,
- Storage temperature and storage content,
- Location (in or outside the thermal envelope),
- Energy density

INTERACTION WITH OTHER CRITERIA
3.5, 4.1 – 4.4, 4.9 – 4.11, 5.1 – 5.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ Storages or reservoirs available or partially in use as buffer tanks, only
- no other storage facilities

CONFLICTING GOALS WITH OTHER CRITERIA
None

MEASURES TO ENHANCE THE SUSTAINABILITY
- Use of buffer tanks along with the use of regenerative energies or combined heat and power units.

EVALUATION CRITERIA 4. ENERGY

4.9 PROCESS ENERGY

DEFINITION / DESCRIPTION
With process energy, the energy requirement for the building services is captured here and the energy requirement, which is relevant for the use, such as for medical devices. The Technical facility-related energy requirements include the provision of energy for lighting, air conveying and auxiliary energy, which for example is required for the operation of pumps or the like. For the user-side process energy, a high energy demand occurs in the cooling of medical devices, such as MRI and CT scanners. Depending on the device type, a large energy requirements also results from the base load of the equipment (MRI, CT).

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	●	● ●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

Technical facility:
- Demand-based ventilation by flaps or flow compensators,
- Prevention of oversized ventilation systems,
- Design of compact duct networks, channel lengths as short as possible,
- Usage -oriented arrangement of the air handling units reduces pressure losses,
- Use of process energy through heat recovery systems,
- Implementation of hydraulic balancing in water-bearing pipe networks,
- Proportion use of renewable energy,

Usage:
- Use of efficient equipment components such as power supplies and cooling for medical devices.
- Reduction of standby time of the equipment (MRI, CT) by high capacity utilization.
- Better coordination of the radiation intensity of CT images,
  --> The lower the radiation dose, the lower the energy requirements.
- Use of energy-efficient cooling systems for the storage of medicines, blood bags etc..
- Use of IT technologies corresponding to the state of art (consideration in tenders).

Uninterrupted power supply:
- To supply the facilities which are relevant to safety according to building regulations (security lighting, smoke extraction) and areas with increased security of supply (operating rooms, intensive care units, etc.), an emergency power system should be used (fossil driven motor with a coupled generator). This switches on upon failure of the general energy supply within 15 seconds automatically, thus ensuring the correctly continued operation of the facility.
- Uninterruptible power supplies (UPS) are being used for uninterrupted power supplies for critical computing and medical technology (intensive care unit, operating room, fire alarm systems).

INTERACTION WITH OTHER CRITERIA
3.5, 3.6, 4.1 – 4.11, 5.1 – 5.3

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Local supply with electricity and gas
+ existing water storage tanks for potable water supply, only
- no storage facilities

TGA:
- RLT constant, no demand-responsive control

EVALUATION CRITERIA 4. ENERGY

- no hydraulic calibration of the hydrophilic pipe conduits performed as to yet, planning in progress
- no heat recovery

Usage:
+ state-of-art devices in surgery area Picture?

Emergency power supply system:
- No automatic emergency power supply system in case of a failure of the local power grid ("emergency power-truck, only – however, at least15 min. travel time to be considered)

Trade-offs:
none

Measures to be taken:
- Installation of heat recovery systems
- Installation of an emergency power supply system (e.g. diesel generator set or battery set)
- Upgrading of monitoring- and meters and fuse boxes, especially with respect to gas supply

- hydraulic reconciliation of hydrophilic pipe-system hasn´t taken place yet, in process of planning
- no utilization of waste heat
+ state-of-art devices in surgical area

Emergency power supply system
- No automatic emergency power supply system in case of a failure of the local power grid (emergency power-truck, only – however, at least15 min. travel time to be considered)

CONFLICTING GOALS WITH OTHER CRITERIA
none

MEASURES TO ENHANCE THE SUSTAINABILITY
- Use of thermal storage tanks along with the use of regenerative energies or combined heat- and power units (CHPs)
- Installation of heat recovery systems
- Installation of an emergency power supply system (e.g. diesel aggregate or battery set)
- Upgrading of monitoring- and meters and fuse boxes, especially with respect to gas supply

Pict.43 Technical infrastructure

Pict.44 Operationroom (new construction)

EVALUATION CRITERIA 4. ENERGY

SHEET 41

4.10 INTERNAL LOADS

DEFINITION / DESCRIPTION
Internal loads are incurred by waste heat of technical equipment, people, lighting and poorly insulated heating or domestic hot water pipes. In hospitals are incurred particularly high internal loads at certain times. This occurs for example by medical equipment (MRI, CT), which are relevant for its use.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	●	● ●	●	● ●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Use of efficient equipment (medical, IT),
- Adequate insulation of water pipes and storage,
- Coupling of arising waste heat in low temperature heating systems,
- Energy efficient transfer of heat through evaporation processes,
- Use of LED lighting

Compensation of the internal loads can be carried out on the one hand by **active ventilation** of the Air conditioning systems. On the other hand **thermal storage materials** can use their thermal storage capability to dampen the temperature fluctuations. An energy efficient form of transfer of internal loads is the direct cooling as a year-round free cooling via hybrid cooler.

INTERACTION WITH OTHER CRITERIA
3.5, 3.9, 4.1 – 4.9, 4.11, 5.1, 5.2

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ illumination systems with low heat loss
- Insulation of hydrophilic pipes only partially in place
- no utilization of waste heat

CONFLICTING GOALS WITH OTHER CRITERIA
None

MEASURES TO ENHANCE THE SUSTAINABILITY
- Pipeline insulation
- Installation of a system to enable the utilization of waste heat or replacement with more efficient devices (minimization of waste heat)


Pict.45 Operationroom (new construction)


Pict.46 Operationroom (new construction)

EVALUATION CRITERIA 4. ENERGY

4.11 RENEWABLE ENERGY

DEFINITION / DESCRIPTION
The use of renewable energies such as solar and wind energy reduces dependence on external sources providing finite resources. They can contribute to increasing the security of supply and the economic security by reducing the dependence from price increases and from the availability of finite resources. The use of biomass has to be weighed depending on local availability and concurrent applications. Energy-efficient building cooling by the evaporation of water is considered to be renewable energy, as are the use of waste heat from heat recovery systems and CHPs.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
● ●	● ●	● ●	●	● ●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD

The evaluation is done on primary energy factors of the individual energies. Required auxiliary energy must be added. The not always permanently available sources of renewable energy, especially wind energy and solar energy, imply storage technologies which can be combined to form a synergy with the existing building (see 3.4.8 „retention“).

DIN V 18599 „Energy performance of buildings“, EEWärmeG, EnEV

In order to provide for an adequate assessment of possible environmental impacts (emissions, consumption of energy and resources), the environmental life cycle assessment may be taken into account as a factor with respect to the assessment.

Evaluated are:
- solar thermal energy
- photovoltaics
- energie of wind
- evaporative cooling
- utilization of waste heat

INTERACTION WITH OTHER CRITERIA
2.1, 2.7, 4. – 4.10, 5.1, 5.2, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- no use of technologies to enable utilization of renewable energies, yet partially use of waste heat

CONFLICTING GOALS WITH OTHER CRITERIA
None

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation and use of photovoltaic plants, solar heat units, CHPs, adiabatic refrigeration system

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.1 REGULATION & CONTROL

DEFINITION / DESCRIPTION

With the help of a building automation system, which includes the monitoring, control and regulation technology, functional processes can be automated and optimized. Through automated or demand-based control systems, an increase in efficiency of the overall system and large economic savings can be achieved. The equipment of the respective trades with modern sensor technology (metrology) and accurate actuators (adjusting elements) is the basis for it.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●●	●●	●●	●	●●	●●	●●	●●

EVALUATION & EVALUATION STANDARD

- **Control heating system:**

The control accuracy has a high impact on the energy efficiency. The more precise the control is, the lower the heating energy demand, and the lower the temperature fluctuations in the room, which has a positive effect on the comfort. The lowest accuracy and efficiency thus has a centralized supply and return temperature control. An increase in the efficiency occurs with a proportional control (2 - 1 K accuracy) to a PI (proportional-integral) control with room-by-room control.

- **Control ventilation:**

Variable air volume control with reference variable (e.g. CO_2),
Constant volume flow control with set point adjustment (on - off)

- **Lighting control:**

Daylight-and presence-dependent control through the use of presence detectors.

The controller should have low intrinsic energy consumption in order to keep the process energy re-quirements as low as possible. The use of e.g. Piezo elements is recommended.

With regard to an optimal operating management, a cross-disciplinary building automation makes sense (DIN V 18599-11). Here, all information will be merged into information points (cabinets). The individual information areas are brought together via a bus system. Via a central computer, all information of the building services can be read and necessary adjustments can be made.

INTERACTION WITH OTHER CRITERIA

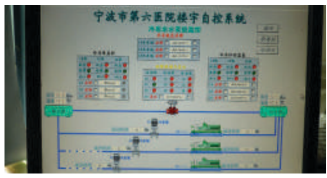
3.1, 3.5 – 3.8, 4.1 – 4.11, 5.2, 5.5, 6.1 – 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

+ retrofitted factory master control system RS 485
+ 380 retrofitted power meters for the measurement of power consumption
+ Data transmission to local energy monitoring center
- Only 1 main meter for measurement of gas consumption, no sub meters
- central heat control
- constant flow rate control

Pict.47 Upgraded power meters



Pict.48 Central building control system - technical supply

CONFLICTING GOALS WITH OTHER CRITERIA

None

MEASURES TO ENHANCE THE SUSTAINABILITY

- more precise measurement of consumption values regarding the medium gas;
- more precise measurement of the flow rates by means of flow sensors, as these may be helpful with respect to the planned hydr. reconciliation

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.2 CLEANING & MAINTENANCE

DEFINITION / DESCRIPTION
The question of how a building can be cleaned and maintained has a large effect on the cost and environmental impact of a building during its use. Building components that can be maintained at an optimum have a longer service life. Surfaces that can be cleaned easily require less detergent and cause lower cleaning costs. The aim must therefore be to keep the operating expenses for cleaning and maintenance as low as possible and at the same time to ensure a long service life of the materials used.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	●	●	● ●	● ●	● ●

EVALUATION & EVALUATION STANDARD

- Maintenance of relevant parts of the supporting structure,
- Maintenance of relevant parts of non-supporting exterior structure (service lifts and und cleaning catwalks for facades),
- Maintenance of relevant parts of non-supporting interior structure (uniform, joint-free surfaces and disinfectant-resistant materials , Formation of plinth and impact protection),
- Dirt trap zone for main and side entrances,
- Barrier free floor plans (Installation of heaters (min. distance of 15 cm from the floor, wall mounted toilet and sink, etc.),
- Ensuring accessibility of maintenance relevant parts

INTERACTION WITH OTHER CRITERIA
2.5 – 2.7, 3.1, 3.2, 3.6 – 3.8, 4.1 – 4.9, 4.11, 5.1, 5.3 – 5.5, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Cleaning is performed by external company
- no check or inspection of the works performed by the external company
- no or inadequate cleaning schedules/guidelines
- high efforts with respect to commissioning – in-patient wards subject to restoration every 2 years
- significant discrepancies with respect to sanitary standards between new and old building

CONFLICTING GOALS WITH OTHER CRITERIA
5.5 Influence on part of the user

MEASURES TO ENHANCE THE SUSTAINABILITY
- Elaboration of a cleaning schedule
- Use of wipeable wall coating, fully covering wall protection panels, high-quality material for surfaces, which are subject to increased wear (floorings)
- Supervision and training of staff provided by the external company

Pict.49 Wall Patientroom
(new construction)

Pict.50 Protection wall floors
(new construction)

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.3 WATER SUPPLY & WASTE WATER DISPOSAL

DEFINITION / DESCRIPTION
Hospitals have a high demand for drinking water, but also a need for industrial water with lower quality standards for different uses. At the same time, hospitals make a significant point source of endocrine substances/ drugs that do not or hardly degrade in municipal wastewater treatment plants. The different requirements for cleaning, hygiene, toilet flushing, cooling buildings, irrigation of outdoor installations, etc. are to be connected with the locally available resources and in particular the use of cascades through recycling. For this purpose it is necessary to separate different waste streams at their sources and feed them into the recycling to minimize wastewater and the resource consumption of water. Using rain water for evaporation purposes such as cooling of buildings is one of many options. Separate collection and recycling of yellow/ black/ gray water are further measures.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	● ●	● ●	●	● ●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD
- Separate collection and recycling of black/ grey/ yellow and rain water,
- Reduction of waste water, decentralized rain water management,
- Evaporation of the highest possible proportion of the resulting water resources for the closure of the natural water circuit,
- Installation of water-saving taps,
- Visualization of water resources

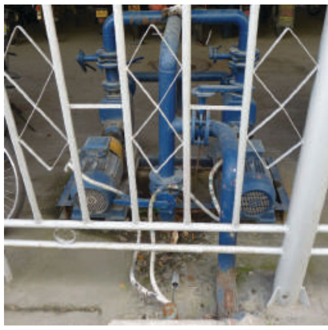
DIN 1986, DIN 1989, ATV-DVWK 138

INTERACTION WITH OTHER CRITERIA
3.1, 3.6, 4.1 – 4.4, 4.6, 4.8, 4.9, 5.2, 5.5, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Water supply is provided entirely by the local grid
+ Intermediate storage to provide for a bridging in the event of supply disruption
+ Waste water disposal system is supposed to be equipped with a pre-treatment unit consisting of a sediment pool + E. coli bacteria and sodium hypochlorite, which provide for the defecation of drug residues in the waste water (magnitude up for clarification)
+ Separate disposal of sludge obtained from the treatment (location of storage up for clarification)
+ The local pre-treatment is an improvement when compared to the conventional disposal
- Rainwater is disposed separately from waste water and is directly fed into the adjacent surface water
- No local rainwater management measures, no recycling of waste water


Pict.51 Pump station water supply


Pict.52 Pump station water supply

CONFLICTING GOALS WITH OTHER CRITERIA
3.6 Sanitation and quality of inside air
When installing water-saving fittings, it must be provided for the avoidance of legionella bacteria, as i.e. flow limitation switches lead to the nebulization of water, which in turn makes it more respirable.

MEASURES TO ENHANCE THE SUSTAINABILITY
- Installation of water-saving fittings
- Utilization of rainwater, integration into adjacent river (integration of rainwater management)
- With new planning projects (restoration projects): Isolation of waste water flows, separate routing of pipelines in order to improve the quality of waste water, potable water, and process water, which in turn facilitates the implementation of water recycling and utilization of rainwater.

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

SHEET 46

5.4 WASTE MANAGEMENT

DEFINITION / DESCRIPTION
Hospitals have a variety of different wastes that need to be separated carefully during collection and distribution. In particular infectious and radioactive waste shall be collected strictly separate to avoid additional strain of unencumbered waste volumes and the high expenses of disposal. Waste prevention is the first priority, recycling is the second priority.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
○	● ●	● ●	●	●	● ●	●	● ●

EVALUATION & EVALUATION STANDARD

- Prevention of quantities of waste by multiple usages,
- Separate collection and recycling of preferably unmixed waste,
- Strict control and separate disposal of infectious and/ or radioactive waste

INTERACTION WITH OTHER CRITERIA
3.6, 5.2, 5.5, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- New building: Appropriate waste separation (triple separation system), appropriate signage to provide for correct handling
- Old building: Waste is partly scattered across the floor

CONFLICTING GOALS WITH OTHER CRITERIA
3.6 Sanitation and quality of inside air

MEASURES TO ENHANCE THE SUSTAINABILITY
- Avoidance of waste, integration of a multiple use- and recycling system

Pict.53 Separating and recycling waste

Pict.54 separating and recycling waste - workspace nurse

Pict.55 separating and recycling waste - supply yard

EVALUATION CRITERIA 5. FACILITY MANAGEMENT

5.5 INFLUENCE OF THE USER

DEFINITION / DESCRIPTION

Patients and workers sojourn in the hospital for a long time. The user satisfaction/ the well-being, among other things, depends on the possibility of the individuals to influence the building's technology. The individual override of the sun protection is desirable, for example, though it does not lead to a higher energy-efficiency. Other criteria include being able to manually open the window and have an influence on presence-dependent artificial lighting.

RELEVANCE

ENERGY EFFICIENCY	ECOLOGICALLY	ECONOMICALLY	SOCIO CULTURALLY	TECHNICALLY	IN PLANNING	IN EXECUTION	QUALITY ASSURANCE
●	○	●	● ●	●	● ●	○	○

EVALUATION & EVALUATION STANDARD

- Manual override of automatic sun protection,
- Possibility of window ventilation,
- Influence on presence-dependent artificial lighting

INTERACTION WITH OTHER CRITERIA

3.4, 3.5, 5.1 – 5.4, 6.3, 6.4

STRUCTURAL SURVEY

DESCRIPTION OF THE ACTUAL STATUS

- openable windows
- Users are a significant hindrance/problem regarding the saving of energy (Windows are always open, dealing with the hospital, internal resources, and building)

Pict.56 Open windows ward building (new construction)

CONFLICTING GOALS WITH OTHER CRITERIA

- ENERGY-EFFICIENCY

MEASURES TO ENHANCE THE SUSTAINABILITY

- Integration of training for the entire staff (techn. + med.)
- Promotion campaign / posters, etc. for visitors / patients

EVALUATION CRITERIA 6. REFERENCE POINTS

6.1 QUALITY OF PLANNING AND DEVELOPMENT MEASURES

Quality with respect to design and town planning
The development of new buildings is usually related to the architectural design of adjacent buildings, which contributes to the characterization of the overall appearance of a town and represents a significant part of our social life. In order to meet the highest possible standards, the planning phase for the implementation of every new building requires the highest level of accuracy under consideration of the respective context. The implementation of planning competitions contributes to the development of ideal approaches regarding the interior and exterior design, the technical building equipment, as well as the infrastructural connections, and the surrounding outdoor facilities. Under consideration of ecological, quality-optimized, and economic aspect, the demonstration of different design drafts enables and facilitates a reasonable project selection.

Quality of the planning process
The early evaluation of demands and requirements (determination of framework conditions, needs of the individual user groups, goals) along with a detailed specification concerning the requirements and the concrete project goals at an early stage of planning may help to avoid re-scheduling or re-organization measures and high costs owing to optimized planning results. The early evaluation of demands and requirements (evidence-based design method) requires an interdisciplinary planning team that, together with the user and building contractor, carries out both the assessment and development of various holistic concepts (waste-, energy-, water-, lighting concept) in order to realize a sustainable overall strategy to be applied to the respective project. It is recommended to stick to this approach throughout the entire planning and implementation phase so as to achieve the best-possible results. When it comes to complex building projects such as hospitals, the BIM (Building Information Modeling) offers a new approach to facilitate the implementation of transparent planning- and decision-making processes.

Functional quality
The functional design of a building plays a decisive role when it comes to its functionality and flexibility required for the various fields of application, and hence contributes to the design quality, comfort, and recognition on the part of the different user groups, and last but not least to an increase in the value retention. The provision of optimized daylight spaces and views under consideration of the specified requirements along with the efficient utilization of individual areas with respect to their functionality and energy consumption, view, and passages to the exterior facilities, room for furnishing, storage and parking areas, and the comfort quality of utilized areas – thus an optimized elaborated building design increases the recognition in our society.

Art in architecture
Art in architecture constitutes a direct correlation between the public, building, and utilization. It is supposed to serve the purpose of enhancing the individual sense of identification with a building and, in doing so, promote and allow for its intrinsic value. There are many ways to express art in architecture in the context of its direct surroundings, such as paintings, sculptures, installations in the interior and exterior facilities, video-art, etc.

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
- Difficult to be assessed for lack of insight into planning processes
- Sometimes the planning was carried out without considering the needs of the users (no natural lighting) and the requirements concerning the building (no disassembly of sun-protection due to lack of typhoon-proofness
- Considering the requirements and demands of a clear/simple guide-system, the design of the buildings (except for the in-patient wards) was not implemented in a structured way. This becomes obvious at the entrance already, since the foyer is way too small and contorted given the density of people arriving each day.

CONFLICTING GOALS WITH OTHER CRITERIA
6.4 Area utilization

MEASURES TO ENHANCE THE SUSTAINABILITY
- With new planning projects (expansions, retrofitting), the above-mentioned aspects should be taken into account
- Improvement of the current guide-system

EVALUATION CRITERIA 6. REFERENCE POINTS

6.2 CONSTRUCTION PHASE AND COMMISSIONING

The continuous feedback during the construction from the professional planners and architects and good building site documentation are essential for a smooth construction process.

Highly complex buildings such as hospitals require particular transparent decision-making processes and immediate feedback of problems in construction. As an integrated design and construction supervision and project documentation, BIM (Building Integrated Manufacturing) is a promising approach to create transparency in highly complex planning and decision-making processes.

An extensive number of sensors, such as an energy meter, are already provided for commissioning as well as the optimization of an energy-efficient operation in the planning and construction phases. Furthermore, malfunctions of the TGA can be detected and corrected as well as planning assumptions can also be reviewed and corrected.

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

- Difficult to be assessed for lack of insight into planning processes

CONFLICTING GOALS WITH OTHER CRITERIA

None

MEASURES TO ENHANCE THE SUSTAINABILITY

• With new planning projects (expansions, retrofitting), the above-mentioned aspects should be taken into account

EVALUATION CRITERIA 6. REFERENCE POINTS

6.3 LOCATION / SITE

For the choice of location, various environmental influences (floods, storms, earthquakes), which are partly predetermined by the geographical constellations, have to be considered in the decision process and the subsequent planning. Since environmental conditions are not always predictable and rarely influenceable, structural measures can possibly help to minimize or improve the effects on the health and well-being of users.

Before deciding on a location/ inventory/ existing building a comprehensive site and market analysis should be prepared by an appraiser to determine the general social acceptance and perception, existing synergies or potential conflicts, as well as the care and conservation status, as these points are an important indicator for the later acceptance of the building in any particular location.

Therefore existing infrastructure, such as a well-developed road network, existing open spaces, as well as intact local amenities (restaurants, supermarkets, public facilities, etc.) contribute to the improvement of the acceptance.

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS
+ central location
+ good transport connections (public transit, Metro)
+ Connection to the river - microclimate
- Downtown premises not suitable for expansion of the hospital facilities

CONFLICTING GOALS WITH OTHER CRITERIA
3.2 Acoustic protection

MEASURES TO ENHANCE THE SUSTAINABILITY
- unable to be influenced with existing buildings
- with new planning projects (expansions, retrofitting), the above-mentioned aspects should be taken into account

Pict.57 Overview hospital area - site plan

EVALUATION CRITERIA 6. REFERENCE POINTS

6.4 AREA UTILIZATION

Alongside the location, the criterion of area occupation plays an important role for the determination of where to establish the building or which existing property to consider for usage. The goal is to be as efficient as possible and take advantage of already developed land, so that no additional transport and residential areas, which would increase the degree of sealing of the surface, must be formed.

If, due to a variety of reasons, an extension of the building surface or infrastructure cannot be abstained from, appropriate compensatory measures (e.g. formation green roof etc.) should be aimed for. Furthermore, it should be examined whether the property is afflicted with various inherited wastes (pollution of ground with harmful substances, etc.), as this is an exclusion criterion for the construction of a hospital.

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

The building is located in the town center, exhibits a high degree of compactness, and is used efficiently in comparison. Yet, this does not apply to the car parking spaces provided on the premises - an optimization and improvement with respect to the comfort quality for patients and staff is required.

CONFLICTING GOALS WITH OTHER CRITERIA

- none

MEASURES TO ENHANCE THE SUSTAINABILITY

- The existing parking space areas should be arranged in a more compact way and greened (car park). In order to allow for a dual use of the existing area, the installation of green roofs (extensive or intensive greening to allow for the usage as open space) should be taken into account with new planning projects (expansions, retrofitting).
- Existing roof areas may be greened and partly expanded as recreation areas

EVALUATION CRITERIA 6. REFERENCE POINTS

6.5 MEDICAL -TECHNICAL DEVICES

Apart from the building envelope and building services engineering, the medical-technical units and devices are to be considered in particular when it comes to the design and development of a sustainable hospital solution, which is due to the considerably high cost-efficiency potential in terms of both the operational- and the investment costs. Therefore, the focus is on the utilization of state-of-the-art and highly efficient medical-technical systems that facilitates an eco-friendly operation. So as to cut the energy consumption, the use of overhauled systems provides a reasonable opportunity to bring forward the efficient use of available resources with respect to cutting costs of investments and high operational costs incurred due to obsolete devices.

The actual energy consumption with respect to the medical engineering can´t be derived from the connected value. In order to record the actual energy consumption incurred by the medical devices and engineering stuff, one essential point of the research project "Krankenhaus plus" (Hospital plus) includes to provide hospitals with a multitude of power meters The actual power consumption depends on the operating hours, the partial load consumption, etc.

However, due to a lack of practical experience from scientific accompanying research, which is required for the determination of the actual energy consumption in the fields of medical engineering, the studies carried out for e.g. the design and engineering of refrigerating machines for the ventilation of buildings in summer, are most often based on the connected values read with respect to the medical devices and engineering. This comes along with a significant over-dimensioning of the installation engineering, so that the refrigerating machines are always being run in partial load operation mode, which in turn results in poor results when it comes to the annual performance (COPs).

In general, the power consumption of hospitals can be compared to those of others buildings and is, apart from the medical-technical devices, characterized by the multitude of small consumers. The optimization of each device, which might be done by the use of efficient technology and automated stand-by control would, when compared with conventional systems, not only result in an overall reduction of the consumption rate, but also in a minimization of the energy consumption when it comes to the refrigeration of the building. The varying equipment, utilization rate, and configuration options of the devices may lead to deviations when it comes to the actual values provided in the specifications of the devices used in the hospitals.

It is especially unusual to specify the dimensions of large devices, as the space required for those turn out to be much larger in most cases. Yet, this is necessary, in order to provide for the appropriate installation of the system and the generation of an adequate air stream flow. In addition to this, the dimensions depend significantly on the device´s configuration and will, hence, change when the device is being moved or displaced. It´s hardly possible to specify or determine the energy consumption of devices, as the maximum output is usually only required for short exposure times, i.e. less than a second.

The same goes for the thermal discharge, which is, like the energy consumption dependent on the actual usage. The only exception is made for MRTs, which require constant refrigeration and which allows for a reliable value. Usually, our data base is fed with the maximum values, so that it´s not possible to state average values in the charts. The specifications and values were elaborated in collaboration with Philips GmbH Resort Healthcare. Any warrantee with respect to correctness or completeness is not assumed. This applies especially for large devices.

STRUCTURAL SURVEY

DESCRIPTION OF ACTUAL STATUS

- Surgical areas are equipped with new devices and, no info concerning other areas

CONFLICTING GOALS WITH OTHER CRITERIA

4.1 Energy consumption due to the functionality of devices

MEASURES TO ENHANCE THE SUSTAINABILITY

- Use of devices, which allow for the utilization of waste heat or enable an efficient discharge using local refrigeration/cooling system.
- Optimization of control system and briefing of staff in the guidelines of an energy-efficient stand-by operation

MEASURES TO ENHANCE THE SUSTAINABILITY

The following tables can be considered as the bottom line of the assessment of the chinese hospital located in South, which was carried out during phase II of this study. For this purpose, all elaborated measures were summarized and, in accordance with their effects on the enhancement of the sustainability, put into categories.

This categorization is made by means of measures, which are considered to improve the energy-efficiency, as well as to improve the ecological quality with respect to both the local environment and the global context, but also to facilitate the optimization of the socio-cultural conditions on the part of the users of the building (especially patients and staff).

In order to provide for a better assessment of the individual measures and to allow for their general assessment regarding their practicability in other projects or application fields, which are based on another level of technology, the respective measures were categorized under consideration of the required technical standard. The categorization differs according to: ‚low', ‚medium' and ‚high', with the latter requiring the highest level of technology and, hence involves the highest amount of investment.

1. ECOLOGY

No.	Measure	Quality improvement in terms of ecology		Standard
		general	local	(low/medium/high)
1	Extension of green areas in exterior facilities / and greening of facades and roof	-	Improvement of microclimate, counteraction against heat island effect, quality of exterior facilities and site image	medium
2	Consideration of recycling potential and production-related pre-processes with respect to material selection	Cut-down of energy- and resource consumption	-	medium
3	Material selection with respect to environmental and human toxicology, incl. inspection of installed material	-	Minimization of risk potential (toxics or the like) in favor of users and local environment	medium
4	Use of rainwater (watering exterior facilities)	Reduction of potable water consumption		
5	Provision of drainable exterior facilities	Facilitation of natural circulation systems, improvement of microclimate, counteraction against heat island effect		

Fig.4 Measures Ecology

MEASURES TO ENHANCE THE SUSTAINABILITY

2. ENERGY EFFICIENCY

No.	Measure	Improvement with respect to energy efficiency	Standard (low/medium/high)
1	Use of a controlled ventilation system	Reduction of auxiliary energy demand for air conveyance	high
2	Replacement of leaky windows	Reduction of heat loss due to ventilation	medium
3	Installation of double- or triple glazing	Reduction of transmittance heat loss by means of transparent component parts	medium
4	Installation of external insulation systems	Reduction of transmittance heat loss by means of opaque component parts, protection against moisture	medium
5	Installation of a sun protection system, preferably at the exterior wall	Reduction of solar and cooling load	medium
6	Raising the staff´s and patients´ awareness concerning the importance of natural ventilation	Reduction of heat loss due to ventilation by means of permanently opened windows + improvement of the efficiency of the RLT-systems	low
7	Implementation of hydraulic calibration	Minimization of thermodynamic loss, improvement of efficiency of heat generators, pumps, etc.	high
8	Use of controlled circulating pumps	Reduction of auxiliary energy demand	high
9	Insulation of pipes and storage pipes	Reduction of transport- and storage heat loss	low - medium
10	Greening of buildings	Generation of latent heat + opacity, resulting in a reduction of the cooling demand	low
11	Use of alternative cooling systems (adiabatic, natural cooling)	Reduction of cooling energy demand, energy-efficient support of existing cooling by conventional means	medium
12	Installation of heat recovery systems	Reduction of heat energy demand and air dehumidification as the case may be, utilization of waste heat by means of RLT.	medium – high
13	Use of sorption-based system to provide for dehumidification	Energy-efficient dehumidification of supply air, prevention of climate-induced damages due to moisture by means RLT	medium – high
14	Use of regenerative energy generation systems and corresponding buffer storage systems	Significant increase in energy efficiency by means of using environmental energy	high
15	Precise data acquisition related to consumption using comprehensive monitoring system	Optimization of operation- and control processes → resulting in a reduction of the consumption related to the energy processes	high
16	Appropriate commissioning and functional check of plants and use-related devices	Optimization and improvement of efficiency due to calibration and readjustment	high
17	In case of new purchased plants: Use of state-of-the-art technology, only.	Cut-down of energy consumption owing to state-of-the-art technology and high efficiency	high

Fig.5 Measures Energy efficiency

MEASURES TO ENHANCE THE SUSTAINABILITY

3. INFLUENCE OF USER

No.	Measure	Quality improvement in terms of socio-culture		Standard
		For the patient	For hospital staff	(low/medium/high)
1	Concept to improve exterior facilities	Facilitation of recovery process	Quality improvement of work place	medium
2	Installation of "Info Health Box"	Fast help or information for patients	-	low
3	Abandonment of component parts containing halogens and PVC	Prevention of fire gas risks in case of fire		medium
4	Isolation of all rooms in order to provide for acoustic protection	Reduction of undesired acoustic transmission and quality improvement of acoustic protection		medium
5	Removal of redundant open-pored surfaces (acoustic ceilings)	Reduction of pollution, bacteria, etc.		low
6	Provision of most possible daylight usage	Facilitation of recovery process	Quality improvement of work place	low - medium
7	Enhancement of ventilation under consideration of the comfort criteria	Provision of sanitary-related indoor air		high
8	Use of low-emission surfaces (low in VOC)	Provision of sanitary-related indoor air		medium
9	Use of durable and sanitary surfaces/ fender	Quality improvement of sanitary facilities and persistence of materials		low - medium
10	Draft of cleaning and monitoring concept plus training of external staff	Quality improvement of sanitary facilities		low - medium
11	Provision for accessibility (obstacle-free zones with resp. to clearance widths)	Quality improvement with respect to the stay of handicapped or disabled patients & staff, as the case may be		low - medium
12	Clearly elaborated signposting system/ signal technics	Improvement with respect to the overall orientation	-	low
13	Elaboration of an evacuation plan	Improvement of safety in the event of emergencies and cases of average for patients and staff		medium
14	Provision of sufficient storage temperature of hot water	Prevention of legionella in hot water system and corresponding diseases or infections		medium
15	Implementation of trainings for staff, promotion campaigns for patients and visitors	Raising awareness for usage concerning several sustainability aspects		

Fig.6 Influence of user - comfort

ASSESSMENT OF MEASURES REGARDING THEIR ECONOMIC VIABILITY

The described measures to improve the energy efficiency (package of measures to improve the energy efficiency) reflect the feasible measures of existing hospitals with similar conditions.

The measures chosen for the implemented thermal building simulations comply with the requirements of the sample hospital in a demonstrable way concerning the dimensions and calculations. The other measures require a more detailed planning and/or more information concerning the parameters of the existing technical plants (e.g. facts concerning the hydraulic alignment, controlled/regulated ventilation, etc.).

Apart from that, the scenario outcomes of the thermal building simulations can be regarded as a means to demonstrate the condition of hospitals, which were built in the 90ies and in climate regions such as Shanghai (tough winters/ hot summers, increased relative humidity outdoors.

1. ECONOMICAL EVALUATION OF ENERGY EFFICIENCY MEASURES

The economical evaluation is based on thermal building simulation (Energy Demand) of the chinese Hospital (total Area of the Building = 61.825 m²)

ENERGY DEMAND (actual baseline, simulated values) :

- Total Final Energy Demand = 9.731.255 kWh/a / 157,4 kWh/(m².a)
  The calculations incl. Cooling, Heating, Lighting, Equipment and DHW
- Cooling energy demand = 3.449.835 kWh/a / 55,8 kWh/(m².a)
- Heating energy demand = 2.374.080 kWh/a / 38,4 kWh/(m².a)

ENERGY PRICE:

- The Electricity price = 0,88 CNY/ kWh
- The Gas price = 0,385 CNY/ kWh

COST NOTES:

- The Amortization calculated with 6% Interest rate for investment / Energy price increase by 6% p. a.
- The external Shading area is equivalent to window area.

SOURCE:

- Energy Price: Analysis and concept for a pilot project as part of the overall project
Energy Efficiency in Public Buildings, HMT Hygiene Medizin- & Krankenhaus-Technik GmbH, 01-06.08.2012
- Material Cost: Mr. Shecan Zhang - GIZ China

EXCHANGE RATE:

- Calculation Exchange Rate 1 € (Euro) ≈ 8 CNY (Chinese Yuan)

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

A. UPGRADING OF THE EXISTING MECHANICAL VENTILATION SYSTEM WITH HEAT RECOVRY

Heat Recovery Efficiency: ≥ 70 %
Energy Saving:

Heating = 921.192 kWh/a (38%)
Cooling = 160.745 kWh/a (4,6%)
Total = 1.081.937 kWh/a (11,1% of the total Energy demand)

Energy Cost Savings:

Heating = 921.192 kWh/a X 0,385 CNY/kWh = 354.658 CNY/a
Cooling = 160.745 kWh/a X 0,88 CNY/kWh = 141.455 CNY/a
Total = 496.113 CNY/a = 62.014 Euro/a

Investment Cost: 2.400.000 CNY = 300.000 Euro
Payback Period: 6 Years

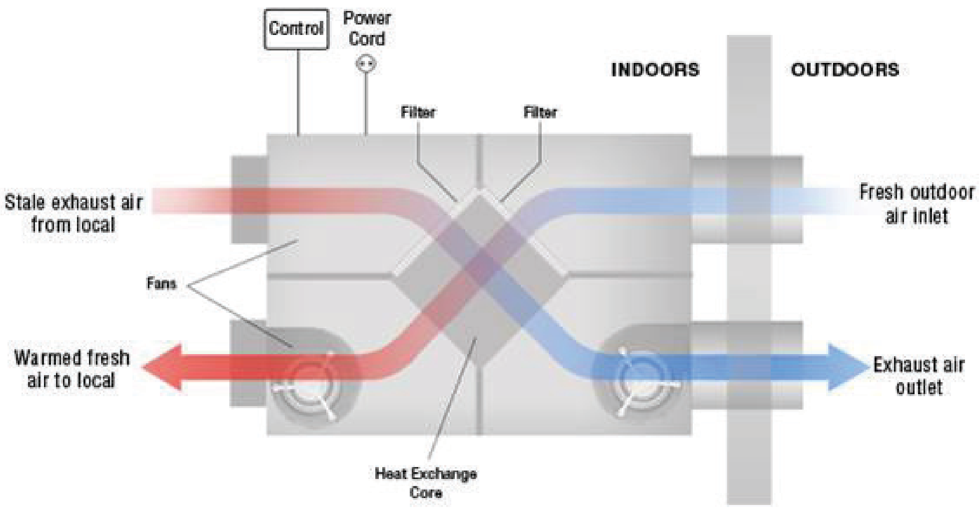


Fig. 58 Source: www.airtecnics.com

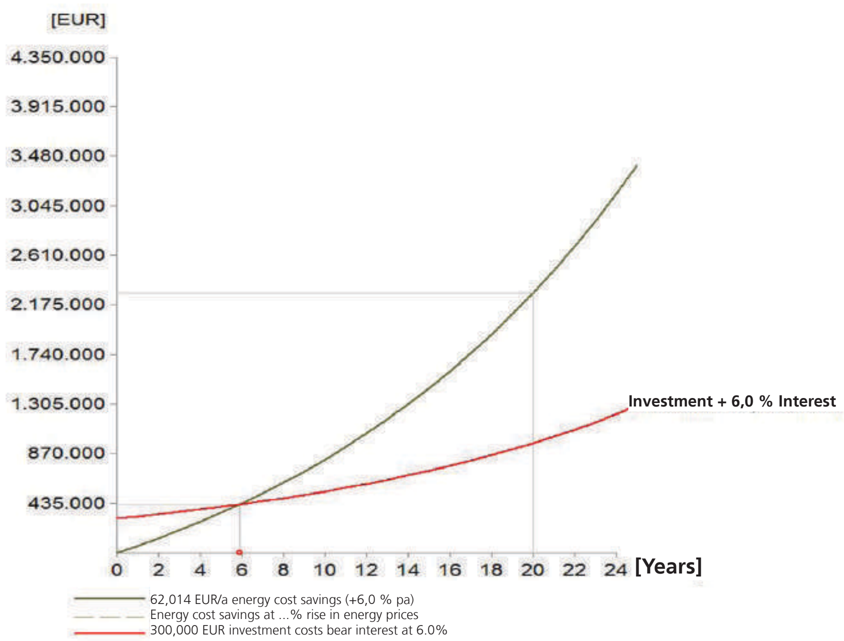


Fig.7 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

B. THERMAL INSULATION OF WALLS AND ROOFS

Thermal conductivity: = 0,040 [W/(m.K)]
Insulation Thickness: = 12 cm
Insulation Areas: = 11.733 m² (External Walls and Roofs)
Insulation Cost: = 200 CNY/ m2

Energy Saving:
Heating = 537.877 kWh/a (22,6 %) =(5,5 % of the total Energy demand)

Energy Cost Savings: = 537.877 kWh/a X 0,385 CNY/ kWh= 207.082 CNY/a = 25.885 Euro/a

Investment Cost: = 2.346.600 CNY = 293.325 Euro
Payback Period: = 20 Years

Fig. 59 Source: http://perfectpacking.in

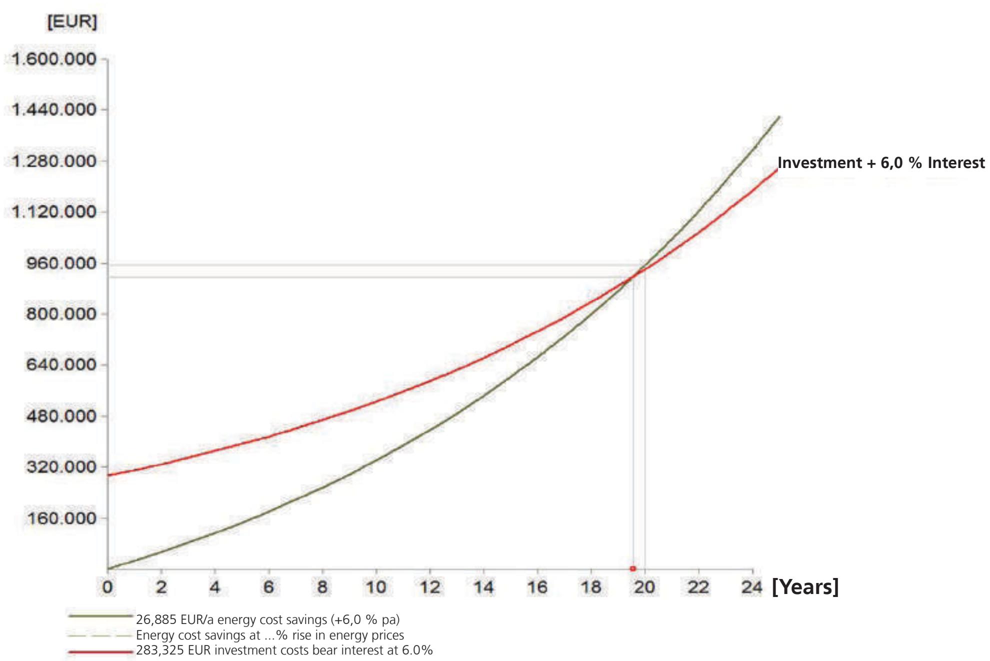


Fig.8 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

C. INSTALLATION OF AN EXTERNAL SHADING SYSTEM

Thermal conductivity: = 0,040 [W/(m.K)]
Shading Type: = Blind with medium reflectivity slats for all orientations
Shading Area: = 6255 m² (Window Area)
Shading Cost: = 925 CNY/ m²
Energy Saving:
Cooling = 476.052 kWh/a (13,7%) = (4,8 % of the total Energy demand)

Energy Cost Savings: = 476.052 kWh/a X 0,88 CNY kWh= 418.925 CNY/a = 52.365 Euro/a

Investment Cost: = 5.785.875 CNY = 723.234 Euro
Payback Period: = 31 Years

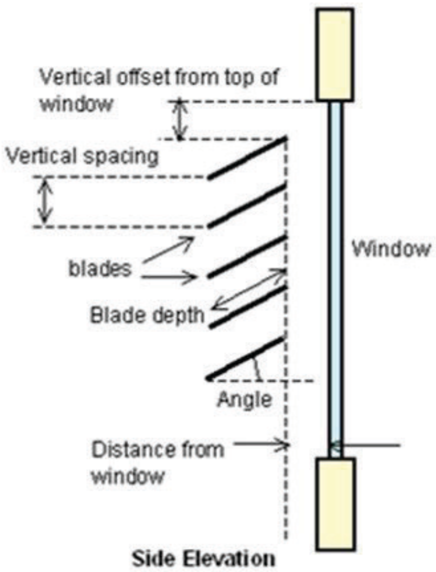


Fig. 60 Source: DesignBuilder manual

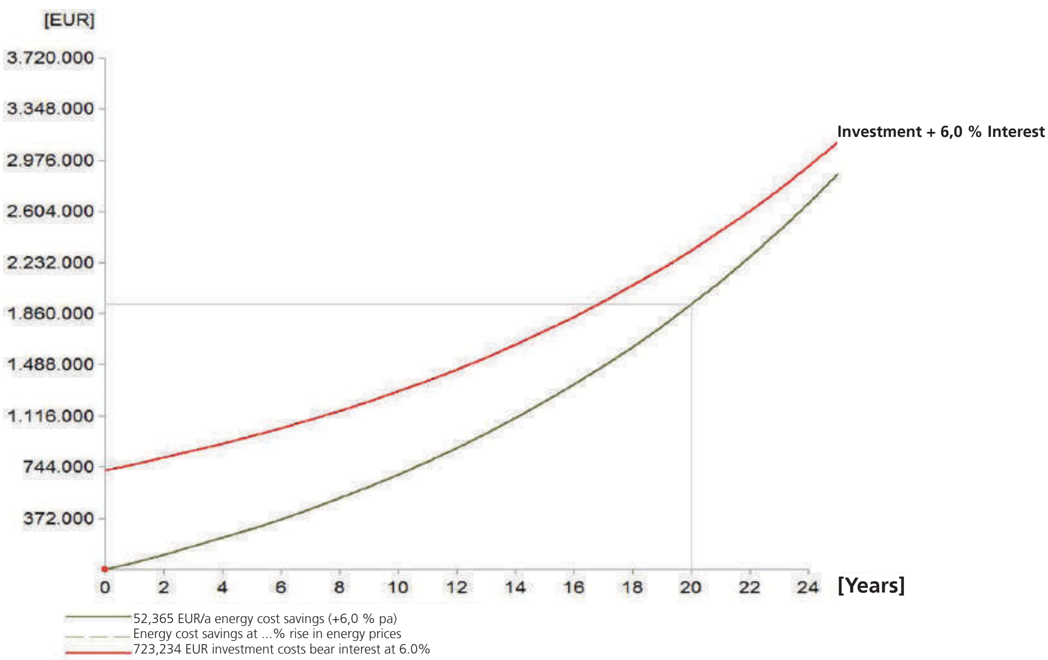


Fig.9 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

D. INSTALLATION OF NEW AIRTIGHT WINDOWS

The whole Window will be changed with frame, Air tightness will be improved.

Glass Type:		= Double glazing Ug = 1,32 W/m²K, Uf = 1,80 W/m²K, SHGC = 0,40
Window Area:		= 6.255 m2
Window Cost:		= 1.350 CNY/ m²
Energy Saving:		
	Heating	= 766.630 kWh/a (32,2%)
	Cooling	= 352.402 kWh/a (10,2 %)
	Total	= 1.119.032 kWh/a (11,4 % of the total Energy demand)
Energy Cost Savings:		
	Heating	= 766.630 kWh/a X 0,385 CNY/ kWh = 295.152 CNY/a
	Cooling	= 352.402 kWh/a X 0,88 CNY kWh = 310.113 CNY/a
	Total	= 605.265 CNY/a = 75.658 Euro/a
Investment Cost:		= 8.444.250 CNY (Window) = 1.055.531 Euro
Payback Period:		= 32 Years

Fig. 61 Source: http://www.milgard.com

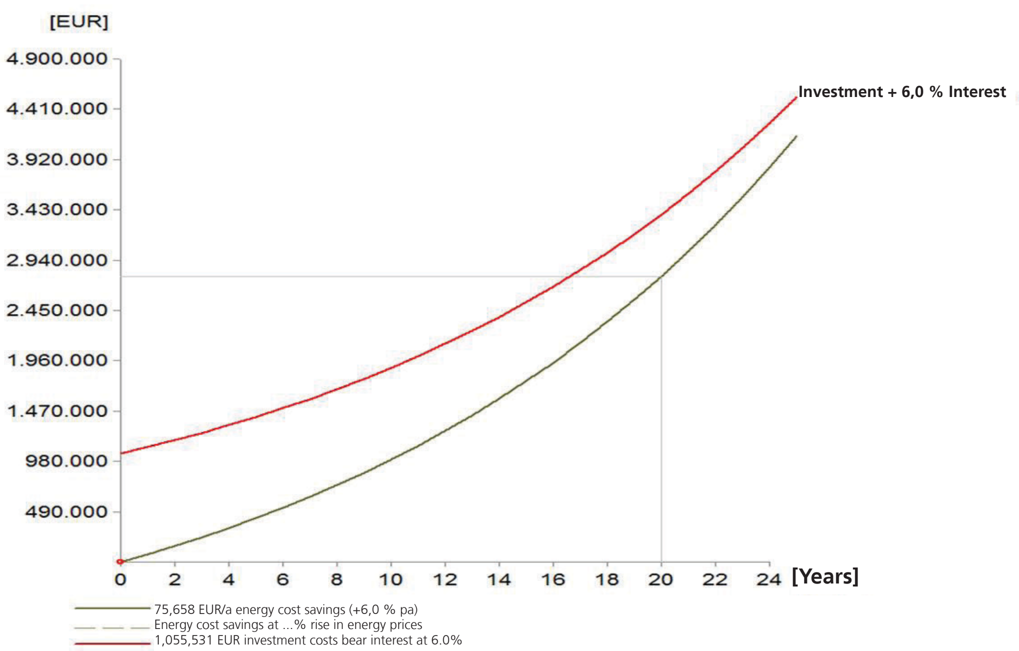


Fig.10 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

E. SENSITIZING STAFF AND PATIENTS IN TERMS OF NATURAL VENTILATION

Energy saving can be achieved by improved the awareness of the staff and patient to avoid constant opening the window during active Cooling and Heating:

Energy Saving:
Cooling = 760.447 kWh/a (22%) = (7,8 % of the total Energy demand)

Energy Cost Savings :
Cooling = 760.447 kWh/a X 0,88 CNY kWh = 669.193 CNY/a = 83.649 Euro/a

Investment Cost: = 0 Euro
Payback Period: = 0 Years

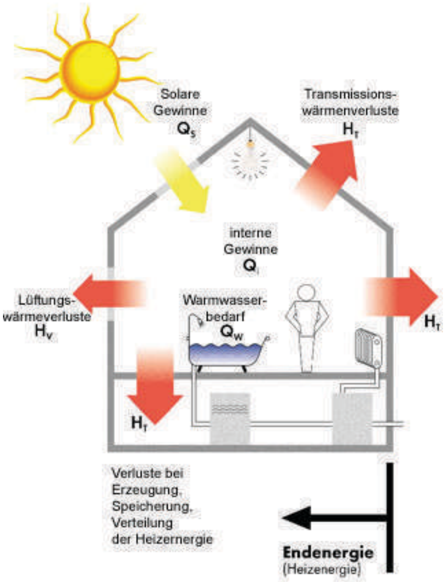


Fig. 62 Source: http://www.energiebereatung.warendorf.com

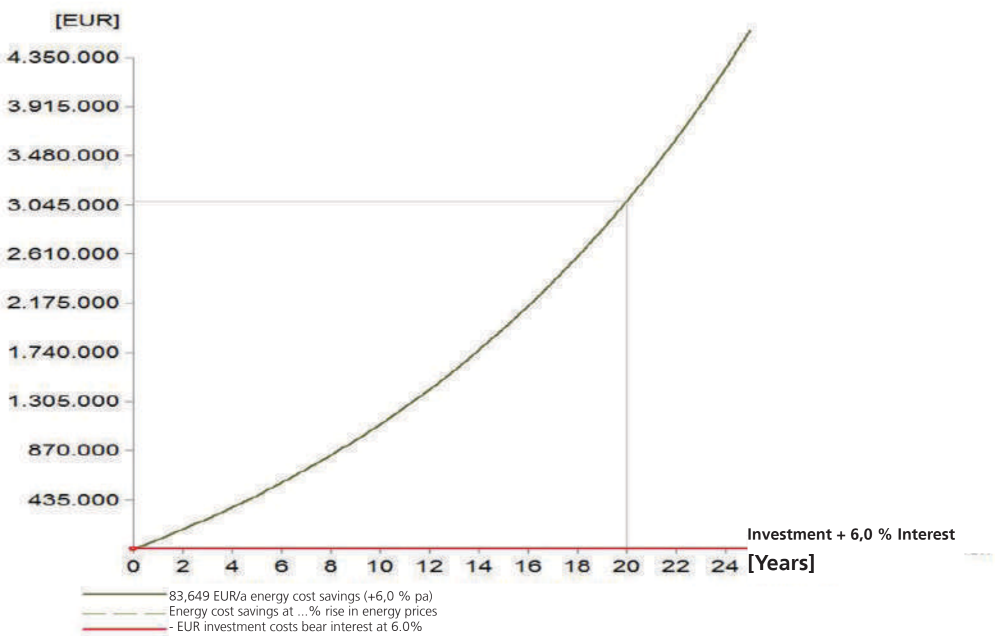


Fig.11 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

SHEET 62

2. MEASURES

F. NIGHTVENTILATION FOR COOLING DOWN IN THE SUMMER

Window Opening: = Night Ventilation during (22-06) h with Natural vent. Set point 20 °C

Energy Saving:
Cooling = 1.051.025 kWh/a* (10,8 % of the total Energy demand)

Energy Cost Savings: = 956.432 CNY/a = 119.554 Euro/a

Investment Cost: = 0 Euro
Payback Period: = 0 Years

* Humidity not considered

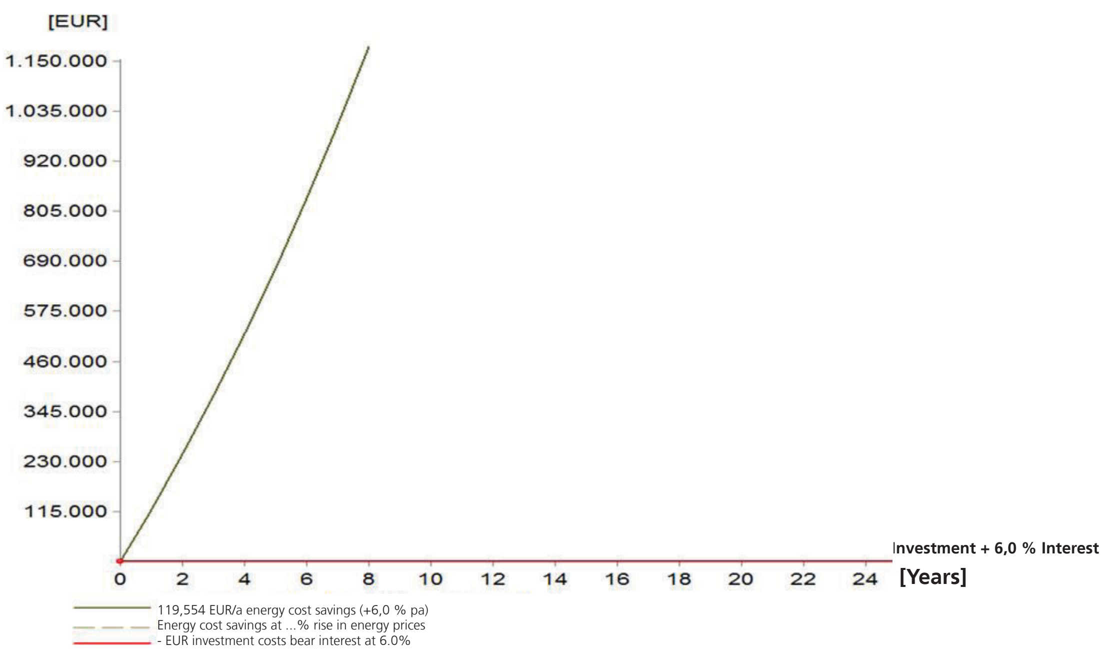


Fig.12 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

G. IMPROVING THE AIRTIGHTNESS WITH NEW WINDOW SEALS

Window perimeter:	= 10.500 m
Sealing Cost:	= 40 CNY/ m Window Perimeter
Energy Saving:	
Heating	= 630.615 kWh/a (26% heating) = (6,4 % of the total Energy demand)
Energy Cost savings:	
Heating	= 791.360 kWh/a X 0,385 CNY/ kWh = 304.673 CNY/a
Cooling (Increase)	= -160.745 kWh/a X 0,88 CNY kWh = - 141.455 CNY/a
Total	= 163.218 CNY/a = 20.402 Euro/a
Investment Cost:	= 420.000 CNY = 52.500 Euro
Payback Period:	= 3 Years

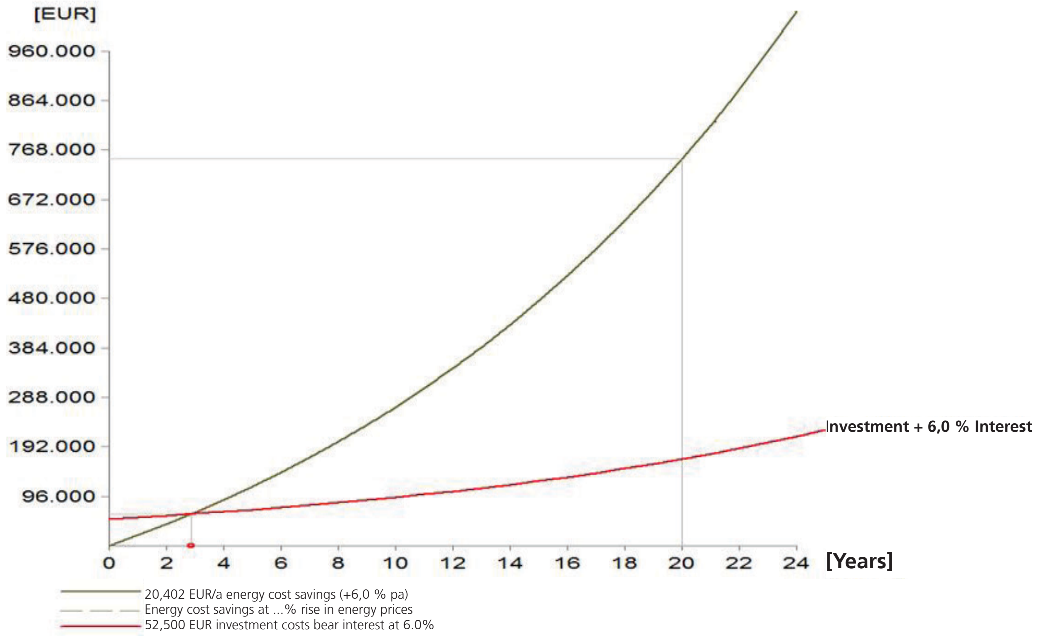


Fig.13 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

H. REDUCTION OF SOLAR HEAT GAINS BY USING A WINDOW SHADING FILM (on existing windows)

Window:	U	= 3,20 W/m²K ,
	SHGC	= 0,30 (totalSHGC, shading film x SHGC of existing Window)
Window Area:		= 6.255 m²
Window Film Cost:		= 90 CNY/ m²
Energy Saving:		
	Cooling	= 9,4 kWh/(m².a) x 61.825 m² = 581.155 kWh/a (16,8% Cooling)
	Heating (Increase)	= - 4,9 kWh/(m².a) x 61.825 m² = - 302.942 kWh/a
	Total	= 278.213 kWh/a (2,8% of the total Energy demand)
Energy Cost Savings:		
	Cooling	= 581.155 kWh/a X 0,88 CNY/ kWh = 511.416 CNY/a = 63.927 Euro/a
	Heating	= -302.942 kWh/a X 0,385 CNY/ kWh = -116.632 CNY/a = - 14.579 Euro/a
	Total	= 394.784 CNY/a = 49.348 Euro/a
Investment Cost:		= 6.255 m2 x 90 CNY/ m2= 562.950 CNY = 70.368 Euro
Payback Period:		= 2 Years

Fig. 63 Source: http://www.milgard.com

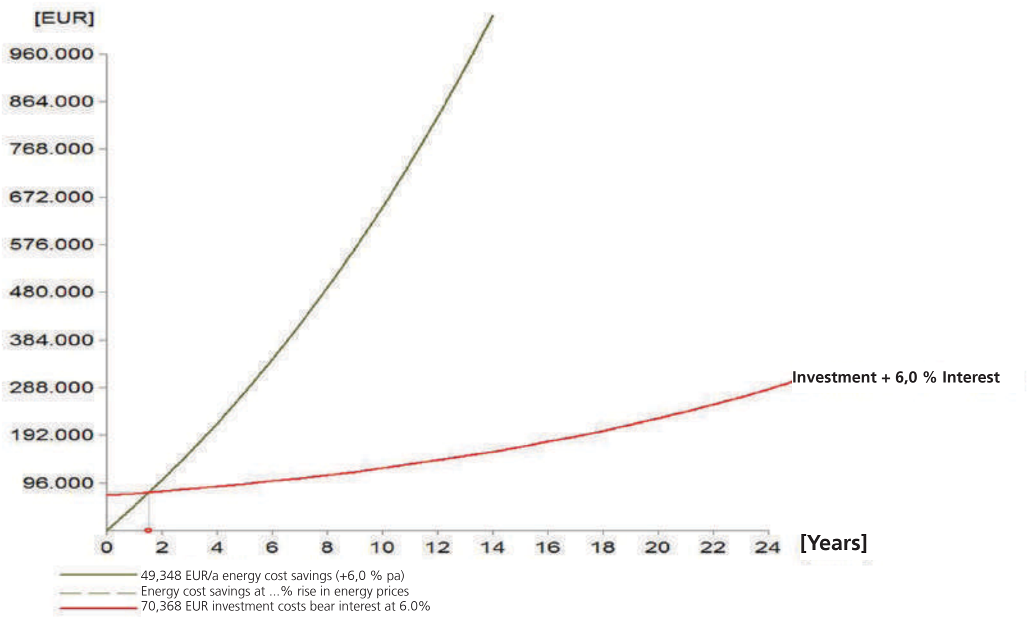


Fig.14 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

2. MEASURES

I. CHANGING THE WINDOW GLAZING, USING THE EXISTING FRAMES, USING NEW WINDOW SEALS

The Window glass will be changed, the existing frame will be used, the air tightness will be improved with new window seals:

Glass Type:		= Double glazing, Ug = 1,32 W/m²K ,SHGC = 0,40
Window Area:		= 6.255 m2
Window Cost:		= 750 CNY/m2
Sealing Cost:		= 40 CNY/ m Window Perimeter
Energy Saving:		
	Heating	= 766.630 kWh/a (32,2%) ,
	Cooling	= 352.402 kWh/a (10,2 %)
	Total	= 1.119.032 kWh/a (11,4 % of the total Energy demand)
Energy Cost Savings:		
	Heating	= 766.630 kWh/a X 0,385 CNY/ kWh = 295.152 CNY/a
	Cooling	= 352.402 kWh/a X 0,88 CNY kWh = 310.113 CNY/a
	Total	= 605.265 CNY/a = 75.658 Euro/a
Investment Cost:		= 5.111.250 CNY = 638.906 Euro
Payback Period:		= 12 Years

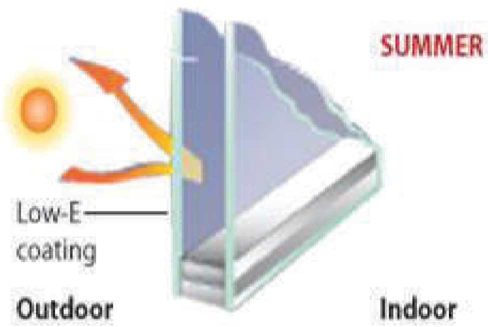


Fig. 64 Source: http://www.vinylwindowpro.ca

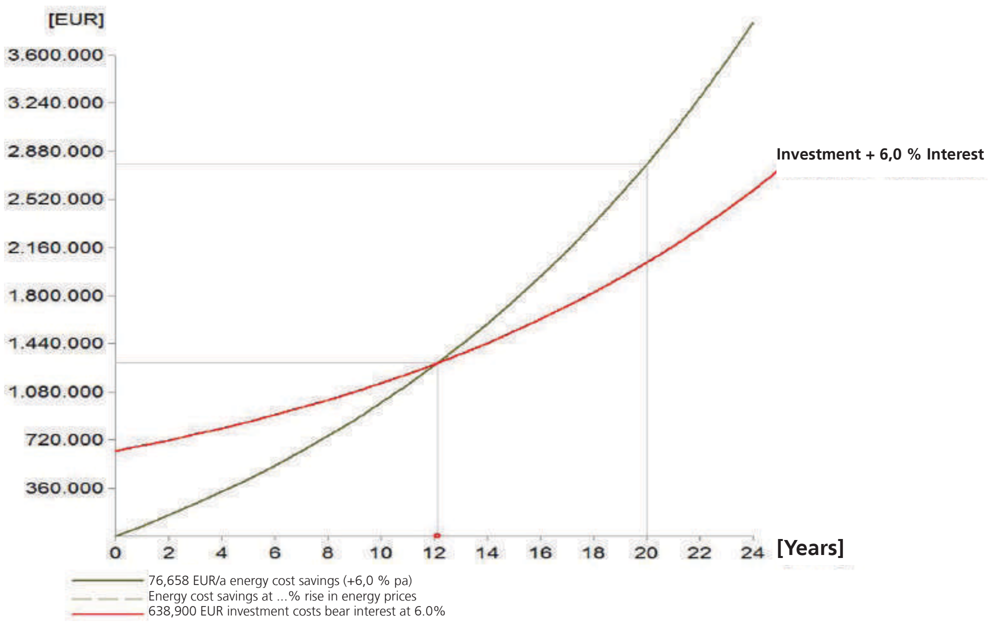


Fig.15 Source: Evaluation DesignBuilder

CONSIDERATION OF THE EFFICIENCY

3. SUMMARY

Nr.	Measurement	**Energy Saving** kWh/a	**Energy Cost Savings** Elek. kWh = 0,88 CNY Gas kWh = 0,385 CNY	**Investment Cost** CNY	**Energy Saving** % (of the total demand)	**Payback** Years
A	Heat recovery	1.081.937 kWh/a	496.113 CNY/a	2.400.000 CNY	11,1 %	6
B	Insulation of walls and roofs	537.877 kWh/a	207.082 CNY/a	2.346.600 CNY	5,5%	20
C	External shading	476.052 kWh/a	418.925 CNY/a	5.785.875 CNY	4,8%	31
D	Airtight windows	1.119.032 kWh/a	605.265 CNY/a	8.444.250 CNY	11,4%	32
E	Sensitizing staff and patients in terms of natural ventilation	760.447 kWh/a	669.2193 CNY/a	------------ CNY	7,8%	immediately
F	Night ventilation	1.051.025 KWh/a	956.432 CNY/a	------------ CNY	10,8%	immediately
G	Airttightness with new window seals	630.615 KWh/a	163.218 CNY/a	420.000 CNY	6,4%	3
H	Window shading film (on existing windows)	278.213 KWh/a	394.784 CNY/a	562.950 CNY	2,8%	2
I	Window glaszing using existing frame, using new window seals	1.119.032 KWh/a	605.265 CNY/a	5.111.250 CNY	11,4%	12

Fig.16 Measure parameter - summary

ECONOMIC VIABILITY OF MEASURES

In determining the economic viability of measures, investment costs must be offset against any economies made during the operational phase. Hospitals in particular require assessment of numerous non-monetary effects according to the criteria matrix. For instance, the impact of improved amenity values for patients and staff can not be expressed in term of figures. Furthermore, investments pertaining to the optimization of hospital hygiene cannot be monetarily assessed, or if so only indirectly. Conclusions concerning profitability cannot therefore be made in principle.

According to the criteria matrix in the study´s first phase, effects that cannot be assessed monetarily are by far in the majority. Monetary effects can generally only be demonstrated from a commercial point of view for measures relating to energy efficiency and water supply costs. Existing calculations models show considerable gaps concerning energy efficiency.

Simulation programs are, however, essential in portraying potential savings potential and calculating profitability of the suggested scenarios. Scientific research thus focuses on the improvement of calculation algorithms, which must be established for developing and newly industrializing countries as well. For this purpose, real operating costs in particular must be recorded in a differentiated way. In practice, there is a substantial lack of measuring systems, which differentiate individual energy consumption in different departments. As a rule, hospitals have only few energy meters and these are read only sporadically for the yearly billing period. As a result, a differentiation of operating costs for individual consumers regarding heating/cooling/ warm water/ steam/ electricity is generally not possible.

When implementing calculation programs, the problem remains that these have so far provided highly unreliable forecasts for complex buildings such as hospitals. Dynamic building simulation models such as Energy plus have finally paved the way for more reliable forecasts. The simulation performed in the present case, will, however, rather remain the exception in planning processes since dynamic simulations are usually scientifically oriented and very time-consuming.

Unreliable forecasts regarding energy consumption of separate media and departments only permit limited forecasts on the profitability of individual measures concerning energy-efficient renovation. Before carrying out any energy-efficient renovation, the actual energy consumption should be determined within the scope of a comprehensive analysis by installing energy meters. Software used to reconcile the calculation of requirements with the actual consumption can forecast the energy required in various scenarios. Dynamic simulations are preferential to static software programs.

Below, the dynamic model „Energy plus was implemented for an energetic simulation. The described measures to improve the energy efficiency reflect the feasible measures of existing hospitals with similar conditions. The measures chosen for the implemented thermal building simulations supply demonstrable dimensions and calculations. The other measures require a more detailed planning and/or more information concerning the parameters of the existing buildings (e.g. facts concerning the hydraulic alignment, controlled/regulated ventilation, etc.).

The scenario outcomes of the thermal building simulations can further be regarded as a means to demonstrate the condition of hospitals, which were built in the nineties and in climate regions such as Shanghai (cold winters/ hot summers, increased relative humidity outdoors.)

ECONOMIC VIABILITY OF MEASURES

RESULTS

Measures whose economic viability is considered to not exceed 5 years are usually to be recommended. On the other hand, it has turned out that it is extremely difficult to demonstrate economic viability calculations with pay-off periods of more than 20 years towards the property owners/stakeholders.

From experience, it can be said that the owners´/stakeholders´ acceptance with respect to the realization of energy-efficient improvements declines, if the pay-off period of cost-intensive measures takes up between 10 and 15 years. Yet, the investments can be made more comprehensible, if the measures to be taken are bound to necessity (such as windows that need to be replaced due to their functionality or appearance or a renovation of the roof and/or front facades).

The economic viability of various measures to improve energy efficiency is most often subject to a number of complex parameters. The outcome of the sample hospital with its “pay-off period of more than 30 years after the replacement of the windows” is considered too long, which is in turn ascribable to the fact that most of the existing windows come with insulation glazing and thermally separated profiles. Proportionally, the number of existing, single-glazed windows is relatively small, as they are merely found in the older buildings. Hence, single-glazed windows have almost no impact on the overall outcome with respect to the thermal building simulation.

In many respects, replacing single-glazed windows with insulated glazing is nonetheless highly recommended (reducing energy demand, increasing thermal comfort, improving sound insulation in the concerned area etc.), which applies particularly to existing buildings which have not been subjected to any improvement measures yet or newly constructed buildings.

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SHEET 69

COMPARATIVE MATRIX - DEGREE OF PERFORMANCE

COMPARISON - GERMAN PROJECTS WITH A PROJECT IN CHINA

Topic	Criterias	Indicator / valuation	Valuation parameters											
			energy efficiency	economically	ecologically	socio culturally	technically	in planning	in execution	quality assurance	General provider	university medical centre	rehabilitation Clinic	Ningbo No.6
Exterior	Exterior design		●	●●	●	●●	○	●●	●●	●	100%	13%	50%	25%
	Public accessibility		○	○	●	●●	○	●●	○	○	100%	40%	80%	20%
	Transport connection		○	●●	●	●●	○	●	○	○	100%	100%	100%	80%
Building	Cubature	*SA/vol ratio*	●	●	●	○	○	●	○	○	100%	100%	50%	100%
	Natural lighting		●●	●	●	●●	●	●●	○	○	88%	75%	75%	63%
	Airtightness	*Ventilation*	●●	●●	●	●	●●	●●	●●	●●	100%	100%	100%	60%
	Moisture protection	*Constructive/climate-induced shading coefficient*	●●	●	●	●●	●●	●●	●●	●●	89%	100%	89%	67%
	Opaque components	*U-value*	●●	●	●	●	●●	●●	●●	●●	50%	100%	100%	50%
	transparent components	*U-value, τ-value, g-value*	●●	●	●	●●	●●	●●	●●	●●	67%	100%	100%	67%
	Building materials & recycling		●	●●	●●	●●	●●	●●	●	○	83%	67%	67%	50%
Interior	Fire protection		○	●	●●	○	●●	●●	●●	●	100%	90%	80%	45%
	Soundproofing		○	○	●	●●	●	●●	●●	●	83%	100%	83%	17%
	Acoustic comfort		○	○	●●	●●	●	●●	●	○	100%	100%	80%	100%
	Visual comfort		●	○	●	●●	●	●●	○	○	100%	100%	83%	83%
	Thermal comfort		●●	●	●●	●●	●	●●	○	●	86%	100%	86%	57%
	Hygiene & indoor air quality	*VOC concentration*	●●	●	●●	●●	●	●●	●	●	50%	75%	75%	25%
	accessibility		○	○	●●	●●	●	●●	●	●	100%	100%	100%	50%
	security		●	○	●●	●●	○	●●	●●	●	67%	67%	67%	67%
	interior design		●	○	●●	●●	○	●●	●	●	100%	88%	100%	13%
Energy	Energy requirements - building	*Final and primary energy requirement*	●●	●●	●●	○	●	●●	○	○	25%	100%	25%	25%
	Heating	*Generation, distribution, delivery*	●●	●	●●	●	●	●●	●	●	83%	100%	83%	50%
	Hot water	*Generation, distribution, delivery*	●●	●	●●	●●	●	●●	●	●	33%	100%	67%	33%
	Building cooling		●●	●●	●●	●	●	●●	●	●	20%	40%	20%	20%
	Ventilation	*Generation, distribution, delivery*	●	○	●●	●●	●	●●	●●	●	20%	60%	40%	20%
	De- & humidification		●●	●	●●	○	●●	●	●●	●●	0%	0%	0%	0%
	Lighting	*Interior / outdoor lighting*	●●	●	●●	●	●●	●●	●	●	25%	80%	25%	25%
	Storage		●●	●	●●	○	●●	●	●	●	33%	0%	33%	0%
	Process energy		●●	●	●●	●	●●	●●	●	●●	43%	71%	71%	64%
	Internal Loads	*Usage profile & process*	●●	●	●	●	●●	●●	●	●●	40%	60%	40%	60%
	renewable energy		●●	●●	●●	●	●●	●●	●●	●●	20%	20%	40%	0%
Facility Management	regulation & control		●●	●	●●	●	●●	●●	●●	●●	63%	75%	50%	38%
	cleaning & maintenance		●	●●	●●	●	●	●●	●●	●●	83%	100%	75%	33%
	Watersupply & water waste disposal		●	●●	●●	●	●●	●●	●	●●	33%	8%	33%	17%
	Waste management		○	●●	●●	●	●	●●	●	●●	67%	67%	67%	67%
	Influence of the user		●	○	●	●●	●	●●	○	○	33%	33%	33%	33%
Reference points	Quality of planning													
	Construction phase & Commissioning													
	Location													
	Area occupation													
	Medical devices													

Fig.17 Comparision matrix - german projects with a project in China

COMPARATIVE MATRIX - DEGREE OF PERFORMANCE

ASSESSMENT AND COMPARISON OF DEGREE OF FULFILLMENT

The quality-relevant assessment criteria were applied to 4 hospitals, evaluated on a semi-quantitative basis, and compared with each other. This results in a degree of fulfillment with respect to the individual criteria, which constitute the basis for the optimization potential and allow for a comparison of the buildings.

The criteria are not related to each other. An emphasis would be conceivable in the event of a further expansion of the Green Hospital study, yet, the different priorities might raise some issues. According to the analysis of the local requirements, the definition of priorities would be an appropriate method to address the demands and needs of emerging and newly industrialized countries and to set priorities with respect to the quality criteria. The comparison of the three evaluated hospitals in Germany among each other and against the chinese hospital shows significant differences in various categories.

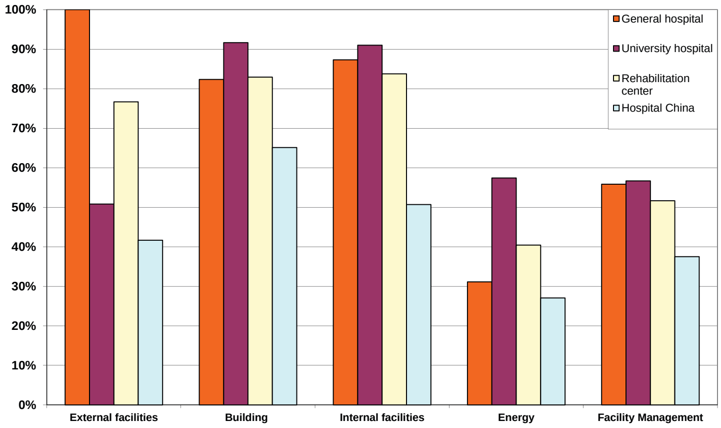

Fig. 19 Comparison of internal projects – Project implemented in China related to determined subject areas

For this purpose, the evaluation criteria from the matrix was set in relation to the maximum possible targets. Compliance with three of eight criteria, for example, results in 0.375 or 37.5 percent. Partial compliance with individual criteria is possible as well. Linear targets were introduced as targets for the A/V ratio and for energy consumption in relation to the universally valid sample building. In grouping all evaluation criteria together, we achieve an overall degree of fulfillment for thematic fields „residential environment/ building/ interior, etc." (Illustration 19).

By calculating targets for these evaluation parameters through correlation of „high impact" at 100% and „low Impact" at 50%, we are able to illustrate the relevance of subject areas for the evaluation parameters „energetic/ ecological/economical" etc. (Illustration 20). This allows for a comprehensive picture, comparing the hospitals with each other by means of a semi-automated procedure using an Excel-Matrix.

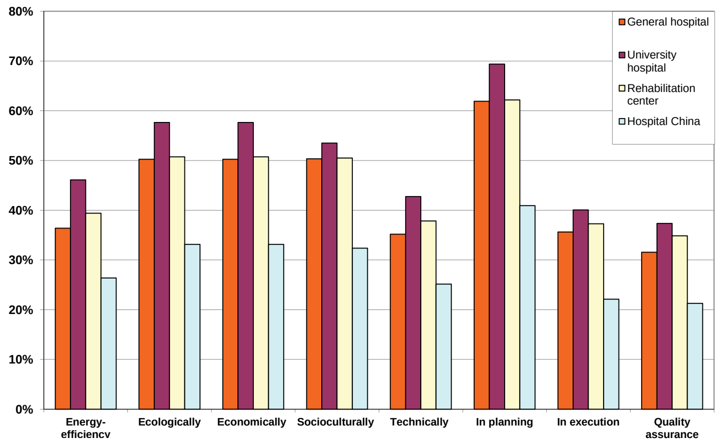

Fig. 20 Comparison of internal projects – Project implemented in China related to determined assessment parameters

COMPARATIVE MATRIX - DEGREE OF PERFORMANCE

Whereas the general hospital KH1 was developed and realized under consideration of the highest demands regarding energy and ecological aspects back in the late 90ies, the most significant issue of the planned modernization of the university hospital KH2 is reflected in the aspect of energy efficiency.

Owing to highly ambitious goals, the degree of fulfillment for almost all criteria turns out to be comparatively high in case of the university hospital, yet the achievement of 100% is far from being reached. Due to its central location, the criterion "Exterior facilities" is, similar to the assessment of the chinese hospital, was rather poorly assessed when compared to the two other buildings in Germany. In order to make the degree of fulfillment charts contained in the Excel data sheet suitable for third parties, it would be necessary to carry out another plausibility check of the individual criteria along with corresponding explanations. The purpose of the charts was based on the attempt to summarize the stated criteria by way of a quality assessment, despite the fact that the extent of requirements would be subject to consideration in the translation of the LEED and DGNB criteria to hospitals located in emerging- and newly industrialized countries.

The comprehensive assessment of each of the four buildings has, however, shown that the results not only reflect the priorities of the buildings regarding their history of origins, but also point out potential measures to be taken so as to facilitate their sustainable development. The evaluation performed on the basis of the elaborated criteria would require another plausibility check and adapted to the requirements and suitability for the use of third parties, if required.

Assessment category	No.	Criteria	Transferability of the parameters		
			unre-stricted	Anpassungsaufwand	
				low	hight
Exterior design	1.1	Quality of external facilities	x		
	1.2	Public accessibility		x	
	1.3	Transport connection		x	
Building	2.1	Cubature	x		
	2.2	Natural lighting/illumination	x		
	2.3	Airtightness		x	
	2.4	Moisture proofing			x
	2.5	Opaque component parts			x
	2.6	Transparent component parts			x
	2.7	Construction material & recycling		x	
Interior design	3.1	Fire protection			x
	3.2	Acoustic protection			x
	3.3	Acoustic comfort		x	
	3.4	Visual comfort		x	
	3.5	Thermal comfort			x
	3.6	Quality of sanitary and room facilities		x	
	3.7	Accessibility		x	
	3.8	Safety			x
	3.9	Quality of interior facilities		x	
Energy	4.1	Energy consumption			x
	4.2	Heating			x
	4.3	Hot water		x	
	4.4	Cooling			x
	4.5	Ventilation			x
	4.6	Humidification & Dehumidification			x
	4.7	Lighting/Illumination		x	
	4.8	Storage			x
	4.9	Process energy			x
	4.10	Internal impacts			x
	4.11	Renewable energy		x	
Facility Management	5.1	Control & operation			x
	5.2	Cleaning & maintenance		x	
	5.3	Disposal of water and sewage			x
	5.4	Waste management			x
	5.5	Influence factor on part of the user			x
General information	6.1	Quality concerning planning	x		
	6.2	Design process & commissioning		x	
	6.3	Site			x
	6.4	Space required	x		
	6.5	Medical-technical devices		x	

Fig. 18 Comparison - Applicability of the Matrix to emerging countries

GREEN HOSPITAL STUDY CONCLUSION

The Green Hospital study allows for a general overview of the parameters to be considered when planning/ building sustainable hospitals.

The sample hospital in the newly industrializing country China demonstrates deficits in existing hospitals pertaining to high-energy consumption but also concerning general aspects of hospital planning such as natural lighting, ventilation, hygiene etc. Numerous individual criteria further illustrates the potential for optimization.

It was found that all parameters must be known in detail before determining any precise economic forecasts for individual improvement measures and that a greater planning effort is required by means of simulations, technical assessments, calculations etc. in order to ensure the measure´s usefulness.

Evidence and on-site experience suggest that particularly newly constructed buildings have a high potential of being built in a sustainable way as all sustainability criteria can be defined from the outset in the planning process by all those involved. The potential of future occupants and their responsible use of the building should be established, respectively expanded in industializing countries in order to save natural resources, limit operational costs and ensure functional reliability even against the backdrop of difficult framework conditions.

The sustainability criteria derived from common building certification systems can be applied to new building without restrictions. In order to differentiate between the highly diverse local situations in industrializing and developing countries, specified critieria should be weighted according to the security of supply and local resource costs.

This study has not weighted any criteria, respectively, evaluated the comparative matrix on a one to one basis in order to achieve universal and applicable evaluation criteria as compared to existing building certification criteria. Applicability of an unweighted evaluation matrix appeared plausible to our mind in order to compare German hospitals to the sample hospital in China.

To further apply this study, more buildings in a wide range of countries in addition to the sample hospital in China would need to be included in the evaluation. It must be examined in particular whether further sustainability criteria in addition to local conditions concerning security of supply, flexibility, hygiene and access must be included in the criteria matrix when planning hospital construction and operations.

We hope to have presented a comprehensive picture of the universally crucial and important field of health care in this study and contributed to future planning and development processes in a positive way.

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GHP MEMBER COMPANIES GREEN HOSPITAL AUTHORITY ATTRIBUTES ACCORDING TO EVALUATION PARAMETERS

SHEET 73

Topic area	Criteria	Development Cooperation & Financing		Healthcare Consulting				Healthcare Architects, Engineers & Constructors			Laboratory Analyses & Pharmaceuticals			Turnkey Project Providers & Packagers			Medical Equipment Providers										Hospital Operators		Health Insurance Providers
		GIZ	KFW	EPOS Health Management	GFA Consulting Group	GITEC Consult GmbH	SANIPLAN	NICKL & PARTNER Architekten AG	HWP	IPROPLAN Planungsgesellschaft mbH	BAYER	BIOSCIENTIA	BOEHRINGER INGELHEIM	FERROSTAAL	HOSPITALIA INTERNATIONAL	SIMED INTERNATIONAL	BRAUN	BODYTEL	DRÄGER	MEYTEC	MMM GROUP	PARTEC	PHILIPS	SIEMENS	KARL STORZ	TELEKOM	ASKLEPIOS	KRANKENHAUS NORDWEST	MUNICH HEALTH
Exterior space	Quality of exterior space					x		x		x													x						
	Public accessibility					x	x	x		x																			
	Transport connection					x		x		x																			
Building	Spatial profile					x		x							x														
	Natural lighting			x		x		x		x																			
	Airtightness					x		x		x																			
	Moisture protection					x				x																			
	Opaque building components					x		x		x																			
	Transparent building components					x		x		x																			
	Building materials and recycling					x		x		x																			
Interior	Fire protection					x		x		x									x										
	Acoustic protection					x				x																			
	Acoustic comfort			x		x		x		x									x		x								
	Visual comfort			x		x		x													x		x						
	Thermal comfort			x		x		x		x									x		x								
	Hygiene & room air quality			x		x	x	x		x					x				x		x								
	Barrier-free accessibility			x		x		x		x											x								
	Safety and security					x		x		x									x		x								
	Internal space quality			x		x		x		x									x		x		x						
Energy	Energy requirement			x		x				x							x		x (gases)		x		x						
	Heating			x		x				x																			
	Hot water			x		x				x																			
	Cooling			x		x				x											x								
	Ventilation			x		x				x											x								
	humidification and dehumidification			x		x				x																			
	Lighting					x				x									x		x		x						
	Storage			x		x				x																			
	Process energy			x		x				x							x				x								
	Internal loads			x		x				x					x														
	Renewable energy			x		x				x											x								
Facility management	Control systems			x		x				x									x		x		x						
	Cleaning & Maintenance			x		x	x	x		x									x		x								
	Water supply & wastewater disposal			x		x	x			x											x								
	Waste management					x	x	x		x							x												
	User interference			x		x	x	x		x											x								
Points of notice	Quality of planning			x		x	x	x		x							x				x								
	Construction process & commissioning			x		x	x	x		x					x						x								
	Location			x		x	x	x		x											x								
	Space utilisation			x		x	x	x		x					x				x (work-place design)		x								
	Medical devices			x		x	x	x		x					x		x		x		x	x	x		x				
Other	Hematology, urine analysis, hemostasis																					x							
	Immunochemistry, clinical chemistry																					x							
	Molecular and cellular diagnostics & analytics																					x							
	Immune status diagnostics (HIV/AIDS, leukemia, lymphoma)																					x							
	Tuberculosis and malaria diagnostics, diagnostics for NTDs																					x							
	Awareness & IEC						x																						
	Logistics							x							x														
	Maintenance														x														
	Turnkey																								x				
	Healthcare Consulting							x																	x				
	Healthcare Architects							x																	x				
	Engineers & Constructors																								x				
	Purchasing process			x																									
	Concept, preliminary planning					x		x																					
	Strategy formation					x																							
	Performance management					x																							
	Hospital management					x																							
	Quality management & risk management					x																							
	Hospital surveillance (clinical data, epidemiology, statistics, indicators)					x																							
	Procurement process & tender management					x																							
	Training and development					x																							
	Medical training					x																							
	Paramedical training					x																							
	User training					x																							
	Management of medication					x																							

Fig.21 Comparision - german projects with a project in China

GHP MEMBER COMPANIES GREEN HOSPITAL AUTHORITY ADDITIONAL CONTRIBUTIONS

EPOS Health Management GmbH

EPOS Health Management GmbH brings together experts with the capacity and expertise to implement green hospital strategies in its projects on various levels. In construction projects these considerations are far reaching and may touch on multiple aspects of a hospital construction or refurbishment project, such as at the initial planning stages, in determining site location, re-use of existing structures, efficient building footprint and standardization of room sizes to allow flexibility of use. Throughout the various stages of execution in recognizing and promoting the need for integrating environmentally sustainable and responsible approaches, in the form of application of renewable energy technologies (solar and wind power) to provide electricity, pump water and maintain cold chains, and application of energy efficient technologies for lighting as well as air cooling or heating, use of natural ventilation, rainwater harvesting, and other technologies.
In addition, other aspects affecting the sustainability of health facilities are considered, such as the functionality and effectiveness of healthcare waste systems, environmental cleaning services and building and equipment maintenance services. All these are important issues in a hospital or health facility which contribute to its ability to provide service.
The idea of a 'green' hospital is perfectly aligned with our mission to make health systems more efficient, since it encompasses environmental and economic factors of health facility construction and operation.

GITEC Consult GmbH

With more than 180 staff, GITEC Consult GmbH is one of the largest German consulting firms working on the international market. GITEC has experience of four decades in consulting services, looking back on some 800 assignments in 130 countries in Europe, the Middle East, Africa, Asia and the Pacific, and Central and South America. The company is currently involved in 34 countries. GITEC has an extensive roster of international specialists available for project activities in the health infrastructure sector. The firm maintains partner relations with well-placed local agencies and organizations. Integrated Services is the unique approach of GITEC involving all relevant areas for an efficient completion of hospital projects to the benefit of the Consultant's clients. Current projects in the health and infrastructure sectors include:

- Sri Lanka: Construction and equipping of a new Maternity Hospital in Galle
- Republic of Uzbekistan: Rehabilitation of the Regional Medical Center Surkhandaria/ Modernization of Regional Medical Multi-Profile Centers in four Regions
- Lao Republic: Health facility assessment, design of construction/renovation of a provincia hospital
- Kyrgyz Republic: Installation and equipment of a BSL3 laboratory

Nickl & Partner Architekten AG

Our office that works on an international scale devotes itself to the planning and construction of buildings in the health care, research, social housing sectors and town planning for the private and public sectors. Our goal is to create modern buildings which positively boost working and living spaces. For us architecture means understanding and ordering things whilst focusing upon people. The designs of Nickl & Partner are based to a large extent upon the actions and needs of people who work, live and receive health care there. Their wellbeing in addition to the perfection, functional interplay of flexible spatial designs and exciting materials is our key concern when performing our work.

We rank among the leading architect's offices in Germany in the fields of medical facilities, clinics and research institutes. Our specialist expertise in the fields of technology and building materials is very extensive and our innovative concepts have proved themselves over a period of more than 3 decades.The team has been increased to number more than 80 architects since the foundation of Nickl & Partner in 1979. Clients from health care, research and urban planning fields have entrusted us with the production of plans and construction work in several different countries. In Germany, Austria, Switzerland, Italy, France, Russia, in the United Arab Emirates and in the People's Republic of China.

GHP MEMBER COMPANIES GREEN HOSPITAL AUTHORITY ADDITIONAL CONTRIBUTIONS

Our range of service is general planning and architect services of LPH-9 (service phases 1 to 9) of the following business areas:

- University clinics and hospitals
- Buildings for research and training
- Residential, administration & trade buildings
- Buildings for social services and nursing care
- Urban planning

Iproplan Planungsgesellschaft

iproplan® Planungsgesellschaft mbH is an independent firm of consulting engineers and architects with considerable experience in the design and construction management of a wide range of building and civil engineering projects in both the private and the public sector. The company was founded in 1950 and offers his professional consulting services worldwide. Presently, the firm has a multi-disciplinary workforce of 260 architects and engineers in the company group involved providing consultancy in project management, construction management & supervision and design of projects in the transport sector / infrastructure and building services. All projects are carried out according to Quality Management System (DIN EN ISO 9001:2008). iproplan® 's head office is situated in Chemnitz with branches in Berlin, Bochum, Brunswick, Dresden, Erfurt, Gera, Leipzig, Magdeburg, Munich, Nordhausen and Stuttgart as well as abroad in many countries including Russia, Estonia, Albania, Czech Republic, Romania, Syria, Qatar, Cambodia, China and Vietnam.

- Road construction / road improvement and road up-grading
- Bridges (pre-stressed, steel structure, composite structure) for highways, roads, railways, pe destrians etc.
- Tunnels (open cut construction method) for highways, railways
- Public transport systems for bus / tramway including stations, terminals, depots, roads etc.
- Network & Utilities (water supply network, waste water / sanitation network, treatment facilities, drainage water network)
- Electrical power supply including supply network & sub stations as well as public illumination
- Social Infrastructure (building rehabilitation, reconstruction, new construction etc.)

B.BRAUN Aesculap

In hospital projects, surgical instruments typically represent a substantial seven-figure $ investment. Aesculap Consulting Services allow the reduction of the number of instruments to be sterilized per each surgical case, as well as the reduction of the total stock of instruments. Aesculap also inspects, maintains and repairs potentially available instruments from previous hospital locations so that they can be used in the new OR and investment cost can be lowered. To achieve sustainability, Fleet-Management Programs permanently maintain a high functional and hygienic level of the entire instrument stock at constant monthly payments. In addition, the use of Aesculap sterile containers can avoid large quantities of single-use wrapping materials. These activities lead to a significant reduction of the ‚Total Cost of Ownership' of the surgical instrument stock, as well as ‚Green Hospital' advantages in the form of lower material usage, energy and water consumption for sterilisation and by a significant reduction of waste.

Dräger Medical GmbH

"As a family owned and run company and medical device manufacturer, Dräger is dedicated to taking responsibility in a wide array of aspects: the quality of products, the environment, employees and the society. A dedicated environmental management department is managing major aspects of sustainability. An environmental management system is well established, headquarter in Lübeck is certified according to ISO 14001, the so called Dräger Substance Radar represents an early warning system to reduce or even eliminate hazardous substances in daily operations as well as in Dräger products. With this Dräger not only fulfills but also exceeds the regulatory requirements like RoHS and REACH. Furthermore Dräger has implemented an extensive waste

GHP MEMBER COMPANIES GREEN HOSPITAL AUTHORITY ADDITIONAL CONTRIBUTIONS

management to reduce effects on the environment. The environmental performance is being monitored with various tools, such as graphical visualization of the environmental load and the monitoring of CO2-emissions. Eco-conscious acting at work is facilitated in many aspects. Dräger takes responsibility for its products – from the product idea and production to transport and disposal. Close attention is paid to reducing the consumption of materials and energy to the greatest extent possible. The long device life expectancy and excellent serviceability contributes to protecting the environment. Environmentally friendly and material-saving packaging systems are used. Dräger medical devices can help the customer to realize savings of resources such as of anesthetic gases not only improving the hospitals ecologic footprint, but also lowering the total cost of ownership. The company constantly improves the products' need for energy, for example by using stand-by concepts help save energy during use. Recycling passports for products help to keep environmental load low when a product gets out of service."

Therefore Dräger actively facilitates the "greening of hospitals" in many aspects, from development and production of devices, along the supply chain and throughout the usage at the hospitals."

MMM Group

The just-in-time supply of sufficient sterile medical devices is of great economic importance for operating hospitals. A smooth and hygienically correct workflow within the CSSD (Central Sterile Supply Department) and a resource-saving operation of the re-processing machines is equally decisive. MMM makes sure that as early as during the planning phase the flow of materials is efficient and that ergometric aspects are taken into account. Capacity planning by MMM is designed to exactly meet the future demand and allows the optimal equipment of the machinery. Matching processes allow short and hygienically correct ways with a high potential for energy-saving. All machines from MMM are made of material that can be recycled, their consumption of water and energy is continuously minimized and used energy is recovered by the use of energy recovering systems. MMM contributes to the long-term and sustainable utilization of the equipment by means of individual maintenance concepts, trainings for technicians and users as well as by the individual support when implementing a quality management system in a CSSD.

Sysmex Partec GmbH

German medical diagnostics company Sysmex Partec, established in 1967, is a worldwide leading pioneer, developer and manufacturer of fluorescence-based flow cytometry systems, enabling the accurate analysis of more than 100,000 cells per minute for measurement of several biochemical and physical cell properties simultaneously for each single cell. The key technology flow cytometry, introduced and patented by the company's founder in 1968, has become the standard method for automated rapid analysis and sorting of cells, nanoparticles and micro-organisms and for precise, accurate cell and particle counting in a wide range of applications in healthcare and medical diagnostics (e.g. immunology, leukemia, lymphoma, HIV/AIDS), cell biology and microbiology. Sysmex Partec additionally offers innovative, uniquely designed high-performance solutions for gel electrophoresis, PCR, fluorescence and transmitted light microscopy, thus covering a wide spectrum in molecular and cellular diagnostics. Through its „Partec Essential Healthcare" division, the company furthermore has a strong focus on dedicated, cost-efficient, accurate and easy-to-use diagnostic solutions for developing and emerging countries in the fight against HIV/AIDS, TB and Malaria. With a range of ultracompact and robust devices as well as point-of-servcice&point-of-care devices with uniquely low energy consumption, Sysmex Partec is thus contributing to the required decentralization of diagnostic services, leading to significantly reduced logistic and administrative requirements as well as to a much quicker time-to-result availability close to where the patients are.

Philips

The german Philips GmbH owns sustainable "Green Hospital" core competencies in both sectors lighting and medical equipment. At lighting, Philips does not only offer newest and high efficient LED lighting solutions both in outdoor and indoor lighting with up to 80% energy saving

GHP MEMBER COMPANIES GREEN HOSPITAL AUTHORITY ADDITIONAL CONTRIBUTIONS

but is actively supporting patient therapy and healing by an adjustable adaptive energy saving illumination, which is supporting well-being and the reduction of stress and fear.
Philips is also approaching a similar target by the project "ambient experience", where the medical equipment is embedded in highly efficient audio-, video- and lighting-solutions. By this, the therapy success is supported and simplified in a sustainable way.
At medical equipment newest technology and own research results are base for a portfolio of high efficient medical systems, which offer best of class diagnostic and therapeutic quality. Newest dose reduction technology participates in energy saving as well as newest production technologies, to grant sustainability both in manufacturing as in use. Of course the european RoHS regulations (Restriction of (the use of certain) Hazardous Substances) are transferred to the worldwide production; to realize the Philips sustainability principles all around the world.

Krankenhaus Nordwest

Krankenhaus Nordwest (KHNW) is a German pioneer in offering its medical services abroad, via Telemedicine. Telemedicine increases access to care and substantially reduces greenhouse gas emissions, by reducing travel distances for medical treatments. KHNW is a leading modern clinic and an academic teaching hospital of Goethe University in Frankfurt, Germany, treating 50,000 patients p.a. It has ten medical specialties as well as four research and diagnostic institutes and offers medical and nursing care services at the highest professional level with scientific guidance. Especially its department of Neurology, one of the largest facilities of its kind in Germany, and the department of Oncology & Hematology, are considered of supra-regional importance and have gained high credibility globally. KHNW has successfully set up a world class Neuroscience-Rehabilitation center to treat the residents of the State of Brunei Darussalam for neurological disorder & related ailments. The telemedical facility allows KHNW neurologists to assess Bruneian patients with stroke and other neurological diseases.

GHP GREEN HOSPITAL STUDY

STAGE 2 - APPLICATION OF STAGE 1

APPENDIX

iproplan® Planungsgesellschaft mbH Beratende Ingenieure und Architekten | TU berlin | Nickl & Partner

APPENDIX 1 SHEET 1

General

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Object specifications	Object	Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
	Year of manufacture/Restoration	2013	2012	1998	Current status: in the works, Building completion: Fall 2016
	Floors	5	5	5	5
	GFA	14.497 m^2	8.204 m^2	46.200 m^2	49.400 m^2
	NFA	12.689 m^2	7.134 m^2	22.400 m^2 (NF)	37.200 m^2
	GV	39.102 m^3	24.785 m^3	182.500 m^3	222.900 m^3
	Construction method	massive (Ferroconcrete)	massive (Brick work)	massive (steel frame construction / brick work)	massive (steel frame construction)
	Number of beds	ca. 135	118	476	314
	Space efficiency factor	0.546	0.52	0.48	0.40

Building thermal envelope

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Structure	Insulation	Composite heat insulation system	Composite heat insulation system	heat-insulating panels,weather boarding	Vacuum insulation; Insulation by means of VIPs; opaque cladding/facade: WLG 040 -26cm
	Air tightness measurement	outstanding	outstanding	outstanding	-

Rehabilitation center

		Exterior wall	Roof	Floor to soil	Windows	Exterior doors
U-value	[W/(m^2·K)]	0,30	0,23	0,36	1,30	1,80
Cost gross	[€/m^2]	474,4	559,4	237,5	366,0	1165,5
Cost net	[€/m^2]	398,6	470,1	199,6	307,6	979,4
Building area	[m^2]	4147	4654	4491	1461	19
	[%]	28,1%	31,5%	30,4%	9,9%	0,1%
H_T	[W/K]	1277	1087	574	1901	35
	[%]	26,2%	22,3%	11,8%	39,0%	0,7%
H_T	[W/m^2·K]	0.37				
$H_{V,inf}$	[W/m^2·K]	0.23				
A/V		0.42				

Clinical center

		Exterior wall: Existing facilities								Exterior wall: New building	Roof: Existing facilities	Roof: New building	Floor to soil: Existing facilities	Floor to soil: New building	Windows, casement doors: Existing facilities	Windows, casement doors: New building
U-value	[W/(m^2·K)]	0,37	1,44	1,33	1,14	1,00	0,76	0,26	0,32		0,21	0,27	3,26	0,36	1,8	1,3
Cost gross	[€/m^2]	-									-		-		-	
Cost net	[€/m^2]															
Building area	[m^2]	220	428	264	1271	342	105	19	69	1426	932	1319	1558	960	580	900
	[%]	2,1%	4,1%	2,5%	12,2%	3,3%	1,0%	0,2%	0,7%	13,7%	9,0%	12,7%	15,0%	9,2%	5,6%	8,7%
H_T	[W/K]	81	617	349	1448	341	80	3	11	410	167	328	1777	86	1043	1169
	[%]	1,0%	7,8%	4,4%	18,3%	4,3%	1,0%	0,0%	0,1%	5,2%	2,1%	4,1%	22,5%	1,1%	13,2%	14,8%
H_T	[W/m^2·K]	0,84														
$H_{V,inf}$	[W/m^2·K]	0,2														
A/V		0.42														

General supplier with respect to hospital

		Exterior wall	Roof	Floor to soil	Windows, casement doors
U-value	[W/(m^2·K)]	0,42	0,35	0,39	2,77
Cost gross	[€/m^2]	-	-	864,0	-
Cost net	[€/m^2]	-	-	699,8	-
Building area	[m^2]			13915	
A/V		0,25			

University hospital

		Exterior wall / Exterior wall to soil	Roof	Floor to soil	Windows, casement doors	Curtain walls
U-value	[W/(m^2·K)]	0,16 / 0,23 / 0,24 (Roof center)	0,15 / 0,25 (Garden for in-patients)	0,27 / 1,62 (Garage)	0,9 | 1,8	1,0 (profiles) / 0,7 (triple glazing)
Cost gross	[€/m^2]	-	-	-	-	-
Cost net	[€/m^2]	-	-	-	-	-
A/V		0,22				

Orientation

		Rehab. N	S	O	W	Clinical N	S	O	W	Supplier N	S	O	W	University N	S	O	W
Exterior wall area	[m^2]	1319,10	983,20	921,00	1154,50	956,50	1120,30	1185,40	883,50	2590,00	2755,00	2846,00	2923,00	-	-	-	-
	[%]	30,13	22,46	21,04	26,37	23,07	27,02	28,59	21,31	23,30	24,79	25,61	26,30	-	-	-	-
Windows area	[m^2]	403,50	285,20	330,50	454,90	407,60	397,40	421,30	254,00	5310,00	5520,00	3931,00	3767,00	-	-	-	-
	[%]	27,37	19,35	22,42	30,86	27,54	26,85	28,46	17,16	28,66	29,79	21,22	20,33	-	-	-	-
	[%]	24				35.71				62,50							

Building´s interior area

			Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Room acoustics	Patient rooms	Reverberation time [s]	0.6	0,9	-	-
	Restaurant	Reverberation time [s]	1,09	-	-	-
Building material	Lateral surface of component areas	Flooring	Floors, patient rooms, offices: PVC-flooring, sanitary facilities: Tiles	Floors, patient rooms, offices: PVC-flooring; Examination rooms: Vinyl flooring; sanitary facilities: Floor tiles, Staircase: Concrete building block	Streets: Cut stone, p. floors, staircases, patient rooms, Restaurant: Parquet ,floors, U+B, office rooms: Linoleum; Sanitary areas: tiles	Streets, separate areas: Parquet; Staircases: Cut stone; Floors, U+B, office rooms: Linoleum; Special U+B: highly-compressed PCV-flooring, Sanitary areas: tiles
		Walls	Floors, patient rooms, etc.: Dispersion paint, sanitary facilities: Tiles	Floors, patient rooms: Fiber glass wallpaper; offices: Dispersion paint; Surgical areas and sanitary facilities: Wall tiles and anti-mold paint	Floors, patient rooms; office rooms, U+B: Shielding fleece + Latex paint; Surgical rooms: HPL-cladding; sanitary areas: Wall tiles	Floors,patient rooms; office rooms, U+B: Shielding fleece + Latex paint; Surgical rooms: HPL-cladding, Sanitary areas: Wall tiles
		Ceilings	Floors, patient rooms, sanitary facilities, etc.: Dispersion paint	Floors, patient rooms, sanitary facilities, etc.: RAL 9016 traffic-white	Floors, patient rooms, office rooms, U+B: Dispersion paint	Floors, patient rooms, office rooms, U+B: Dispersion paint
	Air pollution control measurement of interior building	TVOC, averaged	558 µg/m^3	-	-	-
		Formaldehyde, averaged	15,2 µg/m^3	-	-	-

Energy

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Energy	Threshold primary energy (based on EnEV-NW)	179,5 $kWh/(m^2 \cdot a)$	286 $kWh/(m^2 \cdot a)$	355,2 $kWh/(m^2 \cdot a)$	411 kWh/m^2a
	Primary energy	164,9 $kWh/(m^2 \cdot a)$	202,5 $kWh/(m^2 \cdot a)$	355 $kWh/(m^2 \cdot a)$	282,00 kWh/m^2a
	∑ End energy consumption (EE)	174,5 $kWh/(m^2 \cdot a)$	248,5 $kWh/(m^2 \cdot a)$	269,6 $kWh/(m^2 \cdot a)$	-
	EE - thermal heat	93,1 $kWh/(m^2 \cdot a)$	198,1 $kWh/(m^2 \cdot a)$	163,5 $kWh/(m^2 \cdot a)$	84,10 kWh/m^2a
	EE - hot water	43,6 $kWh/(m^2 \cdot a)$	33,0 $kWh/(m^2 \cdot a)$	163,5 $kWh/(m^2 \cdot a)$	-
	EE steam - air humidification	-	-	860MWh/a	35.979,9 kWh/m^2a (Total power consumption in 2011)
	EE - air conveyance	11,0 $kWh/(m^2 \cdot a)$	3,5 $kWh/(m^2 \cdot a)$	Air heating 729 MWh/a, End energy consumption: Ventilation system 1.273 MWh/a	
	EE - ambient cooling	9,1 $kWh/(m^2 \cdot a)$	0,0 $kWh/(m^2 \cdot a)$	272 MWh/a Absorption refrigerating system	
	EE- lighting	17,7 $kWh/(m^2 \cdot a)$	13,8 $kWh/(m^2 \cdot a)$	577 MWh/a End energy consumption	
	EE - auxiliary energy	1,2 $kWh/(m^2 \cdot a)$	1,6 $kWh/(m^2 \cdot a)$	-	Heat consumption for transmission: LEG: 1.090.340 kWh/a
	Reading of EnEV-calculation (02/07/09)	EnEV 2009	EnEV 2007	EnEV 2009	EnEV 2009 (30%-deviation)

Technical facilities

		Rehabilitation center	Clinical center	General supplier with respect to hospital	University hospital
Heat supply	Type of power generation	Local heat, Block heat and power plant- waste heat system	District heat (KWK)	Block heat and power plant- waste heat system	District heat from adjacent coal-fired power station
	Years of service	Year of manufacture 2013	unknown	15 years	-
	Energy source	fossile	fossile	fossile (gas)	fossile (primary energy factor: 0.54)
	Maintenance interval	each year	unknown	unknown	quarterly
	Heating system	Central heating system	central	central	central
	Thermal storage	Heat buffer storage tank (V = 6000 l)	no	no	no
	Storage tank temperature	45°C	-	-	-
	Heat recovery	no	no	yes (Waste heat recovery - block heat and power plant)	no
	Distributing system	Double-pipe system with internal wires	Double-pipe system with internal wires	Double-pipe system with internal wires	Double-pipe system with internal wires
	Line insulation	Heat transfer coefficient U_i: 0,200-0,255 W/(m·K)	Heat transfer coefficient: Ui: 0,200-0,255 W/(m ·K)	available	Heat transfer coefficient: Ui: 0,35 W/(m·K)
	Flow/Return [°C]	70°C / 50°C	70°C / 50°C	90/70°C / 60/40°C	Distribution areas: heating elements / heating register RLT 70/50°C; Wall heating system surgical rooms/ Activation of component parts in patient rooms 35/32°C
	Heat transfer	Open heating space, panel heating	Open heating space	Open heating spaces	Open heating spaces
	hydraul. compensation?	yes	yes	yes	yes
Hot water generation	Type of water generation	Local heat, Block heat and power plant- waste heat	District heat (KWK)	Block heat and power plant- waste heat system	Steam turbine for energy usage from district heat supply unit
	System	central hot water supply with circulation system	central hot water supply with circulation system	central hot water supply with circulation system	central hot water grid - Post-heating (district heat) of entire complex
	Storage	Hot water storage tank (V = 6000 l)	Hot water storage tank (V = 1000 l)	not available	-
	Storage temperature	60°C	60°C	-	-
	Solar thermal energy	no	no	no	-
	Line insulation	Heat transfer coefficent U_i: 0,200-0,255 W/(m·K)	Heat transfer coefficient Ui: 0,200-0,255 W/(m ·K)	available	Heat transfer coefficient: Ui: 0,200-0,255 W/(m ·K)
	Tapware	Control system: Single lever-mixer basin tap , p. non-contact operation	unknown	Standard	Standard
Refrigeration supply	Type of refrigeration	Direct heat exchanger, Refrigerating plant, cold water	not available	Absorption units (2)	Absorption refrigeration unit (9%), compression cooling unit (91%), screw compressor unit, adiabatic cooling
	Years of service	Year of manufacture 2013		1998	2012
	Refrigerant	R410A		LiBr	
	Operating temperature	6/12°C		6/12°C	Cooling loop at average temperature level 8/14°C ; Activation of component parts at average temperature level 16/19°C
	Maintenance interval	each year		each year	quarterly
	Heat recovery	no		no	yes (disconnection from the brine circuit of the WRG might be required in winter)
	Central control	yes		yes	Substitution of elect. refrigeration by means of central chilled water distribution grid
Power supply	Type of power generation	Block-heat and power-plant waste heat unit	Connected to local energy grids	Block heat and power plant - waste heat system (100%)	Steam turbine (as of 2011)
	Load peak (Time?)	with full-time operation to be anticipated in the winter months	unknown	unknown	Load peak: relatively equally distributed
	energy-intensive areas/devices	Intensive care unit, radiology		Radiology, Intensive care unit, cardiology (LHC), radiation therapy (2014)	Special U+B rooms ENT / eyes
	Substitute supplies (Emergency standby system, storage battery grid)	Storage battery grid system available	Storage battery grid system available	Storage battery grid system, i.e. substitute devices available	Storage battery grid system, i.e. substitute devices available
	energy-intensive areas/devices	CT X-Ray unit	CT-unit, Magnetic resonance imaging system, X-Ray unit	CT-unit, MRI-unit, X-Ray units, LHCs	CT-unit, MRI-unit, X-Ray units
	regen. power generation	Use of a block-heat and power-plant waste heat unit	nein	no	no
Ventilation system	Type of ventilation	mech. ventilation system with heat recovery (60%)	partially mech. ventilation system with heat recovery (45%)	partially mech. ventilation system with heat recovery (60%)	mech. ventilation system with heat recovery
	Areas supplied	all areas	Sanitary areas	Surgical rooms, intensive care units, U+B-rooms, LHCs, radiology	Surgical rooms, intensive care units
	Maintenance interval	In general once a year, fan wheels twice a year	unknown	jährlich	each year
	Supply air conditioning	partially pre-heating or cooling of supply air	Supply air heating system by means of a supply register	pre-heating or cooling of supply air	pre-heating or cooling of supply air
	Heat recovery	Heat recovery level: 60 %	Heat recovery level: 60 %	Circulating heat exchanger WRG-level: 60 %	yes (heat circulating system - heat recovery coefficient 75%)
	Adiabatic cooling	no	no	no	yes
	Steam	no	no	one fraction is supposed to be converted to raw steam (490kW) for sterilization purposes	Humidification: Sorptive
Lighting and daylight	Type of electronic control gears	Electronic control gears	Electronic control gears	elect. control gear units	energy-efficient ventilation system
	Type of lighting	rod-shaped fluorescent lamps	rod-shaped fluorescent lamps	rod-shaped fluorescent lamps	Floors | Offices: High-Efficiency lighting systems , meeting rooms | support points and restrooms on wards: LED downlights
	direct/indirect/combinated	combinated	direct	direct/indirect	direct/indirect
	Reverberators	available (integrated in lamps)	available (integrated in lamps)	available (integrated in lamps)	available (integrated in lamps)
	Regulation (depending on daylight, stepless)	no	no	partially depending on daylight, not steplessly variable	depending on daylight, steplessly variable
	Presence detector	in restrooms for disabled persons	in restrooms for disabled persons	in public restrooms	Control in office- U+B-, laboratory-, patient rooms depending on daylight and presence Control mechanism depending on presence with traffic areas restrooms and wet rooms, staff rooms, meeting rooms and ward kitchen
	Sun protection	external sun protection, visual sight unhindered with active sun protection unit	external sun protection, visual sight unhindered with active sun protection	external sun protection, visual sight with active sun protection unit not possible	external translucent sliding shutters
	Daylight factor DF	1% - 1,5%	unknown	unknown	0,90%
	Areas supplied with daylight	60%	57%	unknown	Requirement for natural illumination for compactness purposes
Building automation	Grid system (central/peripheral)	central grid of components by means of a building management system	central building management system	central building management system	central building management system
	Automation of control processes	to take place in the assembly sections: heating system, refrigeration, hot water, ventilation and air conditioning, medical gases	400 physical. Data points, Activation by means of BUS-system	400 physical. Data points, activation by means of BUS-system	400 physical. Data points, activation by means of BUS-system
Fire protection	technical fire protection measures	Fire detection plant (BMA), smoke-heat-outlet plants (RWA)	Fire detection plant (BMA), Smoke-heat-outlet plants (RWA)	Fire detection plant (BMA), smoke-heat-outlet plants (RWA), partially sprinkler units (streets)	Fire detection plant (BMA), smoke-heat-outlet plants (RWA), partially sprinkler units (streets)
	Maintenance interval	BMA: quarterly, RWA: yearly	unknown	each year	each year

Abbreviations:

A / V Proportion of therm. cladding area to the building volume
AW Exterior wall
EE End energy
H_T Heat loss due to transmission
$H_{V,inf}$ Loss of air infiltration heat
TVOC Total Volatile Organic Compounds

Fig. 1 Evaluation assessment internal projects

APPENDIX 2 SHEET 1

No.	Characteristics (*DGNB) Category	Citerias	LEED category	LEED criteria	BUND "Energy saving Hospital"	VDE "Blue Hospital"	EnergieAgentur.NRW "Energiy efficiency in hospitals"
1	energy efficiency	ultimate energy demand	Energy & Atmosphere	optimize energy performance, Demand response	continuous decrease of the energy demand, long-time optimally energy usage, execute energy management		accurate & current heat demand determination
2		primary energy demand					
3		transmission heat source					insulating wiring and taps, insulation AW
4		Airtightness					
5		moisture protection					
6		heating demand (transmission+ventilation+Solar+internal loads)					
7		power supply					power factor correction, optimisation elect. hardware, purchase energy-saving hardware
8		percentage renewable energy	Energy & Atmosphere	renewable energy production		use sustainable energy source	fitting heat recovery system
9		energy demand and De- & Humidification	Energy & Atmosphere	optimize energy performance, Demand response	long-time optimally energy usage, continuous decrease of the energy demand		
10		energy demand IT-Systems and medical - & laboratory devices		optimize energy performance, Demand response		efficient use of IT- systems	
11		Building cooling	Energy & Atmosphere	enhanced refrigerant Mgmt			zentral regulation, adiabatic cooling
12		daylight availability evaluation	Indoor Environmental Quality	daylight			
13	ecological quality*	ecobalance	Energy & Atmosphere	green power and carbon offsets	reduce CO_2-usage through corresponding sanction		
14			Material & Resources	building life cycle impact reduction			
15		risiks for the locale enviroment (ecological evaluation of installed building material on the basis of data- and safty data sheet, GISCODE, etc.)	Material & Resources	PBT source reduction - mercury			
16			Material & Resources	building product disclosure and optimization - environmental product declarations			
17			Material & Resources	building product disclosure and optimization - material ingredients			
18			Material & Resources	PBT source reduction - lead, cadmium and copper			
19			Indoor Environmental Quality	low emitting materials			
20		ecologically sensitive material extraction	Material & Resources	building product disclosure and optimization - sourcing of raw materials			
21		drinking water demand and waste water disposal	Water Efficiency	outdoor water use reduction			use water saving hardware minimize & self-closing brace
22				indoor water use reduction			
23				cooling tower water use			
24				water metering			
25			Sustainable Sites	rainwater Mgmt			
26			Sustainable Sites*	heat island reduction			
27			Sustainable Sites	light pollution reduction			

Fig. 2 Evaluation criterias energy efficiency and sustainability

	Characteristics (*DGNB)		LEED		BUND	VDE	EnergieAgentur.NRW
No.	Category	Citerias	category	criteria	"Energy saving Hospital"	"Blue Hospital"	"Energiy efficiency in hospitals"
28	economical quality*	area occupation	Location & Transportation	reduced parking footprint			
29				sensitive land protection			
30			Sustainable Sites	environmental site assessment			
31				site assessement			
32				site development			
33				open space			
34		life cycle costs					
35		third party usability					
36	sociocultural quality*	thermal comfort (winter)	Indoor Environmental Quality	thermal comfort			
37		thermal comfort (summer)	Indoor Environmental Quality	thermal comfort			
38		interior - hygiene	Indoor Environmental Quality	minimum IAQ performance			
39			Indoor Environmental Quality	environmental tobacco smoke control			
40			Indoor Environmental Quality	enhanced IAQ			
41			Indoor Environmental Quality	low emitting materials			
42			Indoor Environmental Quality	construction IAQ Mgmt plan			
43			Indoor Environmental Quality	IAQ assessement			
44		acoustique Comfort	Indoor Environmental Quality	acoustic performance			
45		visual Comfort	Indoor Environmental Quality	interior lighting			
46			Indoor Environmental Quality	daylight		application of presence detector and day light sensors für day light control	EVGs, use energy saving lamp and mirrored reflector, presence detector
47		influence of the user	indoor environmental quality	quality views, thermal comfort		intelligent monotoring	information and motivation the whole staff to a energysaving behaviour
48		exterior design					
49		security & source of irritation	sustainable sites	direct exterior acces			
50		Accessibility					
51		area efficiency					
52		conversion	material & resources	design for flexibility			
53		Fahrradkomfort	location & transportation	bicycle facilities			
54		urbanistic & artistic Design					
55		Art					
56	technical quality*	fire protection					
57		soundproofing	Indoor Environmental Quality	acoustic performance			
58		qualität building cover	Energy & Atmosphere	optimize energy performance			
59		cleaning & maintenance					
60		demolition, recycling, removal	Material & Resources	construction and demolition waste Mgmt			
61		*(technical facility)*				integrated uniform IT- infrastructur (building services management system, air conditioning, cross linking medical hardware, IT- application system, integrated data network) / "Smart Building"	automatically regulationsystems
62		qualität project preliminary					

Fig. 2 Evaluation criterias energy efficiency and sustainability

No.	Characteristics (*DGNB) Category	Citerias	LEED category	LEED criteria	BUND "Energy saving Hospital"	VDE "Blue Hospital"	EnergieAgentur.NRW "Energiy efficiency in hospitals"
63	quality of the process*	integral Planning	energy & atmosphere	optimize energy performance		cooperation of a multi disciplinary planning - team in all phases of the process	
64				integrated project planning and design, integrative process			
65		improvment approach in planning	sustainable sites	advanced energy metering	execute energy management	transparency and continuous monitoring of the usage (integrate energy - management - rig)	Regelmäßige Verbrauchskontrolle mittels Strom- und Wärmemengenzählern
66		protection sustainability issues for advertisement and allocation					
67		establishment requirements for a optimal use and management					
68		construction phase / commissioning	sustainable sites	construction activity pollution prevention			
69		quality assurance commissioning	energy & atmosphere	fundamental commissioning and verification			
70		regular commissioning	energy & atmosphere	enhanced commissioning,fFundamental commissioning and verification			
71	quality of the location*	micro location	location & transportation	LEED for neighborhood development location			
72		image and condition location		high priority site			
73		transport connection		surrounding density and diverse uses			
74		proximity to relevant objects and infrastructure		acces to quality transit			
75				green vehicles			
76	other	interior & utilisation	sustainable sites	places of respite (recreation area)			
77			material & resources	furniture and medical furnishings			
78						innovative medical technology	
79						reduction exposure dose for patients (depending on medical technology)	
80			appearance of waste (utilisation)				

Fig. 2 Evaluation criterias energy efficiency and sustainability

APPENDIX 3 SHEET 1

Topic	Criterias	Indicator / valuation	Valuation parameters							
			energy efficiency	economically	ecologically	socio culturally	technically	in planning	in execution	quality assurance
Exterior	Exterior design		●	●●	●	●●	○	●●	●●	●
	Public accessibility		○	○	●	●●	○	●●	○	○
	Transport connection		○	●●	●	●●	○	●	○	○
Building	Cubature	SA/vol ratio	●	●	●	○	○	●	○	○
	Natural lighting		●●	●	●	●●	●	●●	○	○
	Airtightness	Ventilation	●●	●●	●	●	●●	●●	●●	●●
	Moisture protection	Constructive/climate-induced shading coefficient	●●	●	●	●●	●●	●●	●●	●●
	Opaque components	U-value	●●	●	●	●	●●	●●	●●	●●
	transparent components	U-value, τ-value, g-value	●●	●	●	●●	●●	●●	●●	●●
	Building materials & recycling		●	●●	●●	●●	●●	●●	●	○
Interior	Fire protection		○	●	●●	○	●●	●●	●●	●
	Soundproofing		○	○	●	●●	●	●●	●●	●
	Acoustic comfort		○	○	●●	●●	●	●●	●	○
	Visual comfort		●	○	●	●●	●	●●	○	○
	Thermal comfort		●●	●	●●	●●	●	●●	○	●
	Hygiene & indoor air quality	VOC concentration	●●	●	●●	●●	●	●●	●	●
	accessibility		○	○	●●	●●	●	●●	●	●
	security		●	○	●●	●●	○	●●	●●	●
	interior design		●	○	●●	●●	○	●●	●	●
Energy	Energy requirements - building	Final and primary energy requirement	●●	●●	●●	○	●	●●	○	○
	Heating	Generation, distribution, delivery	●●	●	●●	●	●	●●	●	●
	Hot water	Generation, distribution, delivery	●●	●	●●	●●	●	●●	●	●
	Building cooling		●●	●●	●●	●	●	●●	●	●
	Ventilation	Generation, distribution, delivery	●	○	●●	●●	●	●●	●●	●
	De- & humidification		●●	●	●●	○	●●	●	●●	●●
	Lighting	Interior / outdoor lighting	●●	●	●●	●	●●	●●	●	●
	Storage		●●	●	●●	○	●●	●	●	●
	Process energy		●●	●	●●	●	●●	●●	●	●●
	Internal Loads	Usage profile & process	●●	●	●	●	●●	●●	●	●●
	renewable energy		●●	●●	●●	●	●●	●●	●●	●●
Facility Management	regulation & control		●●	●	●●	●	●●	●●	●●	●●
	cleaning & maintenance		●	●●	●●	●	●	●●	●●	●●
	Watersupply & water waste disposal		●	●●	●●	●	●●	●●	●	●●
	Waste management		○	●●	●●	●	●	●●	●	●●
	Influence of the user		●	○	●	●●	●	●●	○	○
Reference points	Quality of planning									
	Construction phase & Commissioning									
	Location									
	Area occupation									
	Medical devices									

Fig. 4 Evaluation matrix

APPENDIX 4 SHEET 1

Functional areas	Medical devices	Medical Equipment	Weight kg	Dimensions (LxBxH) in cm	Energy consumption	Waste heat	Costs Euro	Hospital 300-500 beds	Hospital Ningbo No. 6
X-RAY RADIOGRAPY									
	X-ray workstation (digital or conventional)	Digital X Ray machines control / examination room	700 (heavily dependent on configuration!)	Room size: min 600 x 430; machine:143 x 400 x 240	max 150 kVA during illumination, Standby 1 kVA	500 W	ca. 600 €	2 to 3	3
	Mammography device	Mammography	500	118 x 92 x 203	Illumination: 14 kW, Standby: 600 W		ca. 500 €	1 to 2	
	Fluoroscopy device	Fluoroscopy	1000	242 x 192 x 207	long-term: max.1250 W, short-term: 2500 W max.	Generator: 1400 W; Tube: max 350 W	ca. 800 €	1	1
	Lithotriptor	Lithotriptor						1	1
	Dental x-ray	Dental Radiography						1	
	Urological x-ray	Urography	1300	237 x 275 x 245	max 150 kVA at individual illumination (Radiography); max 6.6 kVA for Fluoroskopy	1700 W in U + B - Room, 3800-5000 W by generators and regulation	ca. 800 €	1	
INTERVENTIONAL									
X-RAY RADIOGRAPY									
	Card angiography unit (single plane)	Monoplane Angiography	2450	299 x 99 x 145	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	1
	Card angiography unit (biplane)	Biplane Angiography	2950	317 x 115 x 215	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	
	Left heart catheterisation laboratory	[left (LHC) or right] Catheterisation Laboratory	2950	317 x 115 x 215	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	
	Hybrid OR		2450	299 x 99 x 145	Off: 500 W, On: 3-6 kW	Standby: 1,8 kW; During operation: up to 5,3 kW	ca. 1,300 €	1	1
CT / Nuc Med									
	16-slice CT	CT 16 Slice	3450	Room size: 570 x 360; machine: 380 x 238 x 200	During operation: 35 kVA over 90 sec.; Standby: 3 kW	5,3 kW	3,000 € - 4,000 €	1	2
	128-slice CT	CT 128 Slice	3500	Room size: 590 x 350; machine: 381 x 274 x 198	During operation: max. 15 kVA; Standby 3 kVA	5,9 kW	3,000 € - 4,000 €	1	1
	PET-CT	PET CT			max. 15 kVA continuous	26000 BTU	ca. 4,000 - 5,000 €	0 to 1	
MR			4250	Room size: 27 m²; Height 2,5 m	Standby 5.5 kW, Average 17kW, Max. 34 kW		ca. 18,000 €		
	1.5T MRT	MRI 1,5 T	5700	Room size: 30 m²; Height 2,5 m	Standby 9kW; Average 19 kW, Max. 50 kW		ca. 20,000 €	1	1
	3T MRT	MRI 3 T							
Radiotherapy								1	
	Linac	Linear Particle Accelarator							
STERILISATION									
	Autoclaves	Autoclave						2	2
	Disinfectors	Disinfector						5	
	Trolley washer	cart washing facility						1	1
ENDOSCOPY									
	Digital fluoroscopy workstation for ERCP	Endoscopic Retrograde Cholangio - Pancreatography work						1	2

Notes:

The information given may differ from actual values in some hospitals. This is due to equipment variations among individual hospitals as well as to different usage rates and different configuration options of the devices used.

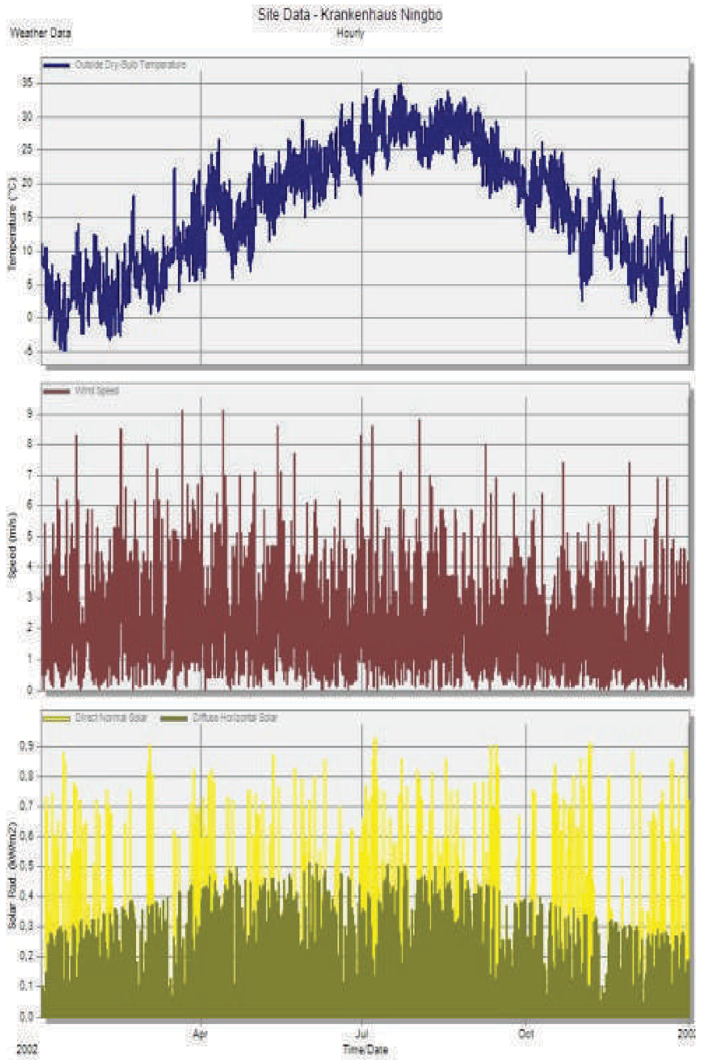
Especially for large devices it is uncommon to specify the size of the device. This is due to the fact that the required room size is also determined by the space required for installation and the space required for providing sufficient airflow. In addition, the size of the device depends on its configuration and changes when parts of the device are displaced.

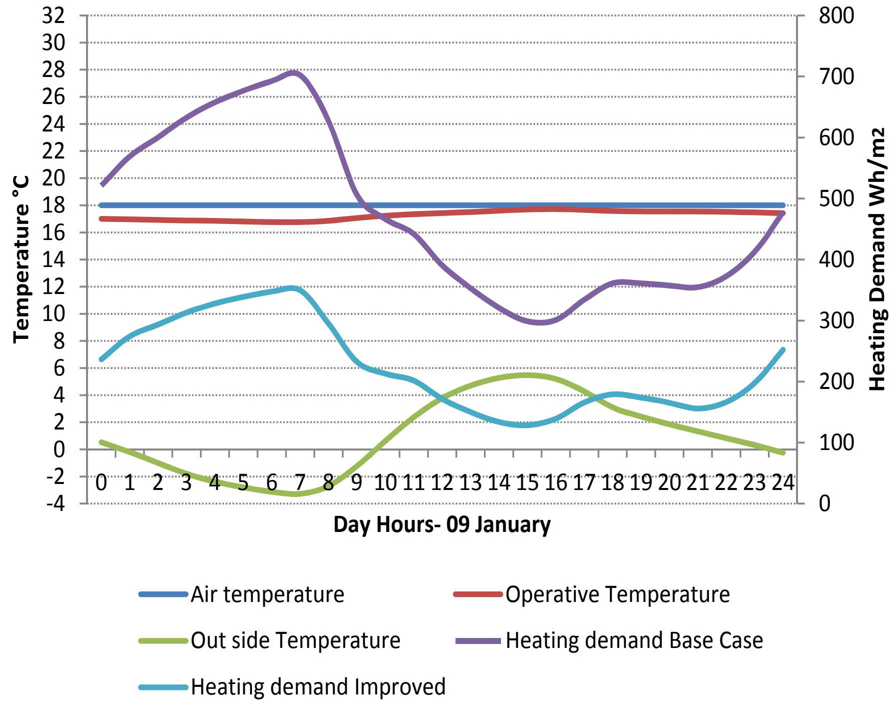
For many devices it is difficult to specify average energy consumption values since they typically work at maximum power only for short exposure times of less than one second.

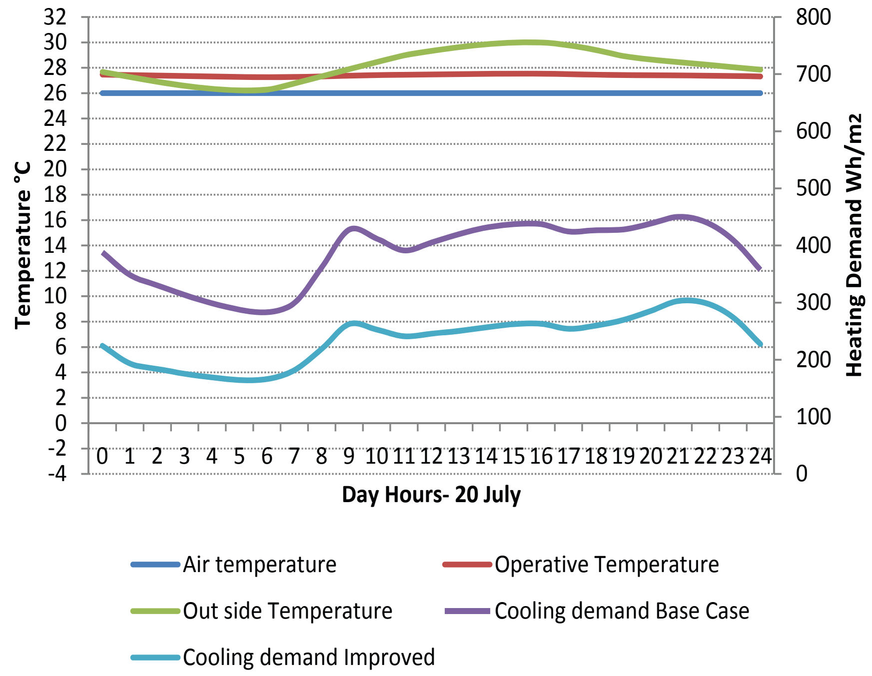
Like energy consumption, also exhaust heat is usage-dependent. Only for MRT devices, which must be continuously cooled, a reliable value can be assumed. Our datasets usually contain maximum values; we therefore cannot indicate average values.

All information has been compiled in collaboration with Philips Deutschland GmbH, BU Healthcare. We do not warrant its correctness or completeness.

Fig. 5 Evaluation medical equipement







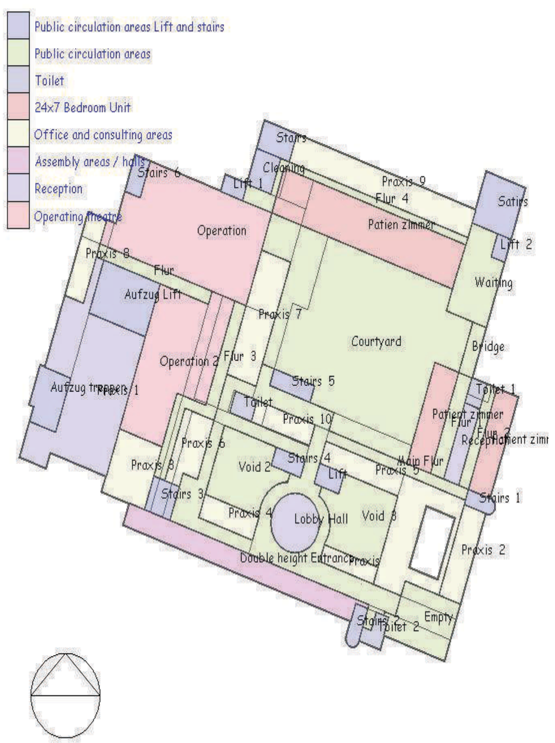


Fig. 6 Parameter of the Building - Hospital in China

Fig. 7 Weather data - year

Fig. 8 Weather data - 1 day

APPENDIX 5 SHEET 2

Building Envelope		Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
	Improvement	Base Case	Double Low E, Heat Recovery,Dehumidification, Lighting Control, Ex. Shading.	Triple Low E, Ex. Shading .	Triple Low E, Ex. Shading, Heat Recovery, Lighting Control, Elec. glass	Double Low E, Insulation, Heat Recovery, Lighting Control, Dehumidification	Double Low E, Insulation, Heat Recovery, Lighting Control, Dehumidification Elec. Glass.	Double Low E, Heat Recovery, Lighting Control, Dehumidification Elec. Glass, Ex. Shading.	Double Low E, Insulation, Heat Recovery, Lighting Control, Dehumidification Elec. Glass, Heat in corridors and stairs switch off at night.	Double Low E, Insulation, Heat Recovery, Lighting Control, Ex. Shading, night Ventilation.	Double Low E, Insulation, Heat Recovery, Lighting Control, Ex. Shading, night Ventilation, Infiltration 0,1 1/h.
Building (Typical floor)	External Wall U= W/m²K	2,47	2,47	2,47	2,47	0,29	0,29	2,47	0,29	0,29	0,29
	Floor U= W/m²K	1,33	1,33	1,33	1,33	0,26	0,26	1,33	0,26	0,26	0,26
	Triple Low E U= W/m²K - g Value	X	X	0,78 - 0,47	0,78 - 0,47	X	X	X	X	X	X
	Double Window U= W/m²K - g Value	3,22 - 0,76	1,32 – 0,42	X	X	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42
	Internal wall U= W/m²K	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02
	Ground Floor U= W/m²K	1,94	1,94	1,94	1,94	0,39	0,39	1,94	0,39	0,39	0,39
Building (stationary)	External Wall U= W/m²K	2,47	2,47	2,47	2,47	0,29	0,29	2,47	0,29	0,29	0,29
	Floor U= W/m²K	2,64	2,64	2,64	2,64	0,26	0,26	2,64	0,26	0,26	0,26
	Triple Low E U= W/m²K - g Value	X	X	0,78 - 0,47	0,78 - 0,47	X	X	X	X	X	X
	Double Low E U= W/m²K - g Value	3,22 - 0,76	1,32 – 0,42	X	X	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42
	Single Window U= W/m²K - g Value	5,77 - 0,81	X	X	X	X	X	X	X	X	X
	Internal wall U= W/m²K	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02
	Ground Floor U= W/m²K	1,94	1,94	1,94	1,94	0,39	0,39	1,94	0,39	0,39	0,39
Building (Ambulance)	External Wall U= W/m²K	2,47	2,47	2,47	2,47	0,29	0,29	2,47	0,29	0,29	0,29
	Floor U= W/m²K	0,83	0,83	0,83	0,83	0,26	0,26	0,83	0,26	0,26	0,26
	Triple Low E U= W/m²K - g Value	X	X	0,78 - 0,47	0,78 - 0,47	X	X	X	X	X	X
	Double Window U= W/m²K - g Value	3,22 - 0,76	1,32 – 0,42	X	X	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42	1,32 – 0,42
	Internal wall U= W/m²K	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02	2,02
	Ground Floor U= W/m²K	1,94	1,94	1,94	1,94	0,39	0,39	1,94	0,39	0,39	0,39
Heat Recovery	70 %	X	✓	X	✓	✓	✓	✓	✓	✓	✓
Dehumidification	50 %	X	✓	X	X	✓	✓	✓	✓	X	X
Lighting Control		X	✓	X	✓	✓	✓	✓	✓	✓	✓
External Shading		X	✓	✓	✓	X	X	✓	X	✓	✓
Electrochromic glass		X	X	X	✓	X	✓	✓	✓	X	X
Night Ventilation	3 1/h	X	X	X	X	X	X	X	X	✓	✓
Infiltration	1/h	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,1
Mech. Ventilation	1/h	1 1/h	1 1/h	1 1/h	1 1/h	1 1/h	2 1/h	1 1/h	2 1/h	1 1/h	1 1/h
Cooling	kWh/a	3.449.846	2.639.927	3.060.337	2.664.657	2.769.760	2.367.897	2.528.642	2.336.985	2.398.810	2.398.810
	kWh/m².a	55,8 (0%)	42,7 (- 23 %)	49,5(- 11 %)	43,1 (- 22 %)	44,8 (- 19 %)	38,3 (- 31 %)	40,9 (- 26 %)	37,8 (- 32 %)	38,8 (- 30 %)	38,8 (- 30 %)
Heating	kWh/a	2.374.087	1.533.260	2.306.072	1.496.165	778.995	1.514.712	1.570.355	1.588.902	840.820	222.570
	kWh/m².a	38,4 (0%)	24,8 (-35%)	37,3 (-2%)	24,2 (-36%)	12,6 (-67%)	24,5 (-36%)	25,4 (-33%)	25,7 (-33%)	13,6 (-35%)	3,6 (-90%)
DHW	kWh/a	364.767	364.767	364.767	364.767	364.767	364.767	364.767	364.767	364.767	364.767
	kWh/m².a	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)	5,9 (0%)
lighting	kWh/a	1.792.925	1.421.975	1.792.925	1.366.332,5	1.304.507,5	1.409.610	1.656.910	1.409.610	1.421.975	1.421.975
	kWh/m².a	29 (0%)	23 (-20%)	29 (0%)	22,1 (-23%)	21,1 (-27%)	22,8 (-21%)	26,8 (-7%)	22,8 (-21%)	23 (-20%)	23 (-20%)
Equipment	kWh/a	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647	1.749.647
	kWh/m².a	28,3 (0%)	28,3 (0%)	28,3 (0%)	28,3 (0%)	28,3(0%)	28,3 (0%)	28,3 (0%)	28,3 (0%)	28,3 (0%)	28,3 (0%)
Energy Saving (%)		(0%) - (0%)*	(20,7%) - (26,5,6%)*	(4%) - (6%)*	(21,4%) - (27,4%)*	(28,3%) - (36,2%)*	(23,5%) - (26,8%)*	(19,1%) - (24,4%)*	(23,4%) - (29,9%)*	(30,3%) - (38%)*	(36,7%) - (46,9%)*

*(%) Energy Saving without considering DHW and Equipment.

Fig. 5 Evaluation medical equipement

iproplan Planungsgesellschaft mbH · Nickl & Partner

APPENDIX 6 SHEET 1

Topic	Criterias	Indicator / valuation	Valuation parameters											
			energy efficiency	economically	ecologically	socio culturally	technically	in planning	in execution	quality assurance	General provider	university medical centre	rehabilitation Clinic	Ningbo No.6
Exterior	Exterior design		●	● ●	●	● ●	○	● ●	● ●	●	100%	13%	50%	25%
	Public accessibility		○	○	●	● ●	○	● ●	○	○	100%	40%	80%	20%
	Transport connection		○	● ●	●	● ●	○	●	○	○	100%	100%	100%	80%
Building	Cubature	*SA/vol ratio*	●	●	●	○	○	●	○	○	100%	100%	50%	100%
	Natural lighting		● ●	●	●	● ●	●	● ●	○	○	88%	75%	75%	63%
	Airtightness	*Ventilation*	● ●	● ●	●	●	● ●	● ●	● ●	● ●	100%	100%	100%	60%
	Moisture protection	*Constructive/climate-induced shading coefficient*	● ●	●	●	● ●	● ●	● ●	● ●	● ●	89%	100%	89%	67%
	Opaque components	*U-value*	● ●	●	●	●	● ●	● ●	● ●	● ●	50%	100%	100%	50%
	transparent components	*U-value, τ-value, g-value*	● ●	●	●	● ●	● ●	● ●	● ●	● ●	67%	100%	100%	67%
	Building materials & recycling		●	● ●	● ●	● ●	● ●	● ●	●	○	83%	67%	67%	50%
Interior	Fire protection		○	●	● ●	○	● ●	● ●	● ●	●	100%	90%	80%	45%
	Soundproofing		○	○	●	● ●	●	● ●	● ●	●	83%	100%	83%	17%
	Acoustic comfort		○	○	● ●	● ●	●	● ●	●	○	100%	100%	80%	100%
	Visual comfort		●	○	●	● ●	●	● ●	○	○	100%	100%	83%	83%
	Thermal comfort		● ●	●	● ●	● ●	●	● ●	○	●	86%	100%	86%	57%
	Hygiene & indoor air quality	*VOC concentration*	● ●	●	● ●	● ●	●	● ●	●	●	50%	75%	75%	25%
	accessibility		○	○	● ●	● ●	●	● ●	●	●	100%	100%	100%	50%
	security		●	○	● ●	● ●	○	● ●	● ●	●	67%	67%	67%	67%
	interior design		●	○	● ●	● ●	○	● ●	●	●	100%	88%	100%	13%
Energy	Energy requirements - building	*Final and primary energy requirement*	● ●	● ●	● ●	○	●	● ●	○	○	25%	100%	25%	25%
	Heating	*Generation, distribution, delivery*	● ●	●	● ●	●	●	● ●	●	●	83%	100%	83%	50%
	Hot water	*Generation, distribution, delivery*	● ●	●	● ●	● ●	●	● ●	●	●	33%	100%	67%	33%
	Building cooling		● ●	● ●	● ●	●	●	● ●	●	●	20%	40%	20%	20%
	Ventilation	*Generation, distribution, delivery*	●	○	● ●	● ●	●	● ●	● ●	●	20%	60%	40%	20%
	De- & humidification		● ●	●	● ●	○	● ●	●	● ●	● ●	0%	0%	0%	0%
	Lighting	*Interior / outdoor lighting*	● ●	●	● ●	●	● ●	● ●	●	●	25%	80%	25%	25%
	Storage		● ●	●	● ●	○	● ●	●	●	●	33%	0%	33%	0%
	Process energy		● ●	●	● ●	●	● ●	● ●	●	● ●	43%	71%	71%	64%
	Internal Loads	*Usage profile & process*	● ●	●	●	●	● ●	● ●	●	● ●	40%	60%	40%	60%
	renewable energy		● ●	● ●	● ●	●	● ●	● ●	● ●	● ●	20%	20%	40%	0%
Facility Management	regulation & control		● ●	●	● ●	●	● ●	● ●	● ●	● ●	63%	75%	50%	38%
	cleaning & maintenance		●	● ●	● ●	●	●	● ●	● ●	● ●	83%	100%	75%	33%
	Watersupply & water waste disposal		●	● ●	● ●	●	● ●	● ●	●	● ●	33%	8%	33%	17%
	Waste management		○	● ●	● ●	●	●	● ●	●	● ●	67%	67%	67%	67%
	Influence of the user		●	○	●	● ●	●	● ●	○	○	33%	33%	33%	33%
Reference points	Quality of planning													
	Construction phase & Commissioning													
	Location													
	Area occupation													
	Medical devices													

Fig. 5 Evaluation medical equipement