Criteria for Decisions in the Design Process

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Case Stories

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IEA SHC Task 23: "Optimization of Solar Energy Use in Large Buildings"
Subtask A: "Case Stories"

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Abstract

In the framework of the IEA SHC Programme, a task regarding optimization of energy use was initiated: “Task 23, Optimization of Solar Energy Use in Large Buildings”.

The Operating Agent of the Task is Professor Anne Grete Hestnes, Norway.

In a part of the Task, “Subtask A, Case Stories”, different low energy solar buildings were investigated and documented.

The objective of Subtask A was to provide the knowledge needed in the development of the guidelines, methods and tools to be developed in the other subtasks in the task. This was done by evaluating and documenting a set of buildings designed using the “whole building approach”. Both the particular processes used in the design of the buildings and the resulting building performance were evaluated.

Twenty-five different solar buildings, comprising both offices, schools and conference and research centres, have been documented. The buildings use a number of low energy and solar techniques, including daylighting, passive and active solar systems and photovoltaics. The criteria used in the decisions made during the design of the Case Story Buildings have been identified to give input for the other subtasks. This report documents these criteria.

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1. Introduction

The criteria used in the decisions made during the design of the Case Story Buildings have been identified to give input for the other subtasks. The criteria will give an indication of which criteria need to be included in the methods and tools to be developed in Subtask C and in which order they should be considered.

2. Overview of criteria case by case

In the following the identified decision criteria are listed for each of the Case Story Buildings. The criteria are identified using the IEA Task 23 Technical Report: *Description of Case Stories*, 1999. Because of lack of information not all of the descriptions of the criteria and of the organisations are complete.

Furthermore, the different ways of organising the design team are described, and in the appendix charts describing the design processes are included.

2.1. Primary School, Münchendorf, Austria

The architect led the design process and was responsible for the architectural concept and for the co-ordination of the design process and building process.

The choice of technologies and materials was done based on experience, and the criteria for decision-making were ecological performance and cost. In case of competing options it was first clarified which criterion was the most important one, then which criteria were met by one option only and at last which criteria were met by more than one option. But it was clear from the beginning, that wanting a ecological school, cost would be higher an usually and that was accepted.

The decisions were taken by comparing operational cost with investment cost. The investment cost was subsidised, and therefore the local authority, i.e. the client, was affected by the operational cost mainly.

2.2. Sparkasse, Bludenz, Austria

The members of the design team were contracted separately by the client. The architect proposed the engineers and was the co-ordinator of the team.

The bank set up a committee comprising two members of the management, a representative of the employees and two account managers. All solutions concerning specific design details were presented to this committee, whose questions were very critical. The advantage of this intense communication process - about 140 sessions were held - was that the client in the end really identified with the project. The client also informed the politicians and the public from time to time, which is very important for promoting an innovative building project in a small town.

For the different solutions cost-benefit analysis were carried out. E.g. the benefits of the daylighting system had to be quantified for the client. The decision in favour of the concept was taken because of the enthusiasm and the persistence of the architect, who convinced the client and the design team. During the optimisation phase of the design process the daylighting system was reduced to the extern necessary to meet the basic requirements.

During the optimisation phase cost effectiveness had to be proven by an analysis of the operation hours.

2.3. Crestwood 8, Richmond, Canada

The owner/developer led the process. The normal design team was revised to become more interdisciplinary. This involved including mechanical, electrical and lighting engineers in most meetings, from the beginning, and also involved adding an energy specialist and the C-2000 representative as part of the team.

The team prepared several exploratory concept designs and prepared draft performance target reports. The team developed one selected design, carried out several energy simulations and completed performance strategy reports.

After parametric energy simulations were completed, cost estimates decided which elements made it or not, but constrained by the need to reach the 50% energy performance improvement over existing good practise.

When the team was ready to begin contract documentation, the performance and cost of the design was compared to the conventional design. At this point, decisions were taken on what features had to be dropped to meet budget requirements.

The rest of the process followed conventional path except for commissioning (including building envelope) two-year monitoring process under separate contract.

2.4. Green on the Grand, Kitchener, Canada

The owner/developer led the process. A multi-disciplinary design team met regularly to design the building.

2.5. Danfoss HQ, Nordborg, Denmark

The organisation of the design team was structured as a shared responsibility contract, where architects and engineers share responsibility for quality, economy and durability. The engineering company responsible for the constructions led the design team, whereas the architect usually is leading the design team. The decision to have the design team led by an engineer was taken by the client of the building on the recommendation from all members of the design team including the architect due to the fact that the renovation was necessary because of moisture and carbonisation of all main facade parts of concrete.

Since the client has their own company architect and building engineering department all contact between the design team and the client was as discussions between the design team and the client's architect and engineer. This also means that the client is very professional in the decision process and discussions of architectural and technical aspects are based on a high aesthetic and technical level.

The overall and final decisions taken regarding the future of the building and the overall goal of the renovation of the building is on the other hand taken at the Board of Directors of Danfoss.

2.6. Brundtland Centre, Toftlund, Denmark

The organisation of the design team was structured as a shared responsibility contract, where architects and engineers share responsibility for quality, economy and durability. The engineering company responsible for the constructions led the design team, whereas the architect usually is leading the design team. The decision to have the design team led by an engineer was taken by the client of the building on the recommendation from all members of the design team including the architect due to the technical complexity of the building. The head of the group was shifted to an engineer with installations background when starting erecting the building, also on recommendation from the whole design team, since the co-ordination on site of the different enterprises primarily concerned building installations.

The decision process within the project was not different from other building projects. The design team was responsible to the client for keeping budgets and technical solutions due to the standard contract form. A set of technical solutions was defined at an early stage according to the funding received from the European Union and the Danish Energy Agency.

Generally the design process was very cross-disciplinary, because of the many constraints on the design regarding technical parameters, function of the facade and overall design goals using the building as energy system itself. Asking the participants in the design process it has been the general experience, that more time has been used compared to conventional designs – and if the process was to be repeated, a more close communication possibility, i.e. sharing a project office or similar would be recommended.

2.7. Arktikum, Rovaniemi, Finland

The owner/developer was responsible for the design process. The architect co-ordinated the design process and the designers had individual responsibilities. The main contractor co-ordinated construction and sub-contracts, and was responsibility of project schedule, budget, administration and guarantees.

The design criteria of the project were suitability for institutional and public use, well daylighted public areas and energy efficiency both for good indoor conditions and substantial decrease of running costs.

Rovaniemen Teollisuuskylä Oy is a building developer and real estate management company. The building is rented to the users. Rovaniemen Teollisuuskylä was a natural builder for the project due to their long experience in building in the north. The owner chose the design team according to certain quality rules including earlier design experience, design quality and costs. In this specific case, the designers had been working together in several other projects, which was very favourable for the design project. There was no hierarchy within the design team; rather the process was a continuous discussion within the group.

2.8. Maisema 2000, Karkkila, Finland

The client/owner contracted the architect and the project manager. The contractor was responsible for management, co-ordination, budget and 35 sub-contracts.

The design criteria of the project were interesting architecture for PR-value, the flexibility of the office spaces and construction costs. The first requirement by the building owner was a working environment that supports teamwork. The office needed to form an inspiring frame and to encourage the will to make progress, both among the clients and stuff. Technical solutions, materials and colours needed to be rational for fast construction, to make sure that the costs do not exceed the costs of a typical office building.

The design work continued throughout the project. When costs were about to exceed the budget new solutions were found in co-operation between the architect and the sub-contractors.

2.9. Gniebel HQ, Gniebel, Germany

The design team shared the responsibility. The architect was responsible for concept and co-ordination of the design process and building process. The meetings of design team were every two weeks including the client – a mechanical engineer by education.

The aim was a building without mechanical cooling to keep the investment costs as low as possible. Replacing the mechanical system or reducing it to it’s minimum was creating free room and money for other parts. The client was very fixed on a certain cost limit, but within this limit the planners were free. Therefore the savings in the mechanical system covers in addition an increased insulation level and better glazing above the regulations.

2.10. WAT, Karlsruhe, Germany

All engineers worked under the architect as sub-contractors. The architect was responsible for concept and co-ordination of the design process and building process.

The major goal was to achieve given functions (such as natural ventilation, no cooling) as cheap as possible. For the daylight system 4 alternatives were investigated, and the cheapest of them was chosen.

2.11. Tokyo Gas Kohoku, Yokohama, Japan

All members of the design team, the architects, the structural engineers, mechanical and electrical engineers were from the same design company. The general contractor was responsible for the construction of the whole building.

To decide a design change from the original one, computer simulations were carried out to confirm that the design change would not negatively influence on the energy saving effect. When selecting the most effective energy saving technology, life cycle energy and life cycle CO_2 were estimated and the results were used for evaluation.

2.12. Yamanashi Institute of Environmental Sciences, Yamanashi, Japan

All members of the design team the architects, structural, mechanical, electrical and civil engineers, landscape designers and construction supervisors all belonged to the same design firm. A total of 19 contractors joined the project.

Organisation of the building occupant was not officially established during the design and construction press. However, the building owner commissioned the “advisers for the Institute of Environmental Sciences” before starting the building design phase. Therefore, the building owner made the decisions based upon the advisers’ requirements.

The technical solutions were chosen to minimise impact upon local and global environment (CO_2 emissions etc.) and they should be easy to operate in the extremely cold climate. Furthermore, life cycle costs were a decision parameter.

2.13. Inzai General Welfare Centre, Inzai, Japan

All members of the design team the architects, structural, mechanical and electrical engineers were all from the same design firm. One general contractor was responsible for building construction and two sub contractors for mechanical and electrical equipment construction.

Whereas the one-storied building is disadvantageous in the aspect of the energy consumption because the roof area is big, the one-storied building is effective clearly with the rainwater utilisation and also if using top lights and light-shelves, it is effective with daylight use, too. Moreover, as for the one-storied building, all rooms are near the ground, that invented the use of the heat in the ground, i.e. the idea of the cool/heat tube. Disadvantages and advantages of a one-storied building were considered and it turned out that it was possible to achieve low energy use in this building.

2.14. KIER, Taejon, Korea

The decisions in each phase were made based on a regular expert meetings in each phase of the design process, the conceptual design phase, the detail design phase and the construction and operation phase.

2.15. Bellevue, Arnhem, Netherlands

The client and the architects carried out the project management. All members of the design team had separate contracts. The client was represented in the design team by a project manager, who contributed a great deal to the design process by his enthusiasm and stimulating participation. Thus the client played a major role throughout the design process. The fact that the engineers got involved at a very early stage resulted in the integrated design of several building parts

Some crucial design decisions were made in a very early stage, as they resulted from restrictions by the building site. Therefore not so many alternatives, concerning architectural concept and energy concept had to be considered.

From the point of view that the client is an energy distribution company the concept of electrical heating was considered, but was rejected soon as it appeared not to be energy efficient. All solutions considered were evaluated according to energy performance and costs. Some were left out due to the fact that energy savings did not set off investment costs.

2.16. Seterbråten School, Oslo, Norway

The design team shared the responsibility. The building owner used a design team and controlled the different contracts with the entrepreneurs.

Different ventilation strategies were investigated. The study showed very good environmental savings for the rotary heat exchanger, but it was not selected because the teachers were afraid of contamination from exhaust to inlet.

The solutions considered were all evaluated according to costs and benefits (energy performance etc.). Some solutions were left out due to expected high cost compared to benefit.

2.17. Centre for Marine Environment and Security, Horten, Norway

The contractor was responsible for the concept and for the co-ordination of the design process, the building site and building process.

The client provided a final space program, which included environmental goals. The project was divided into strictly separated phases. Each phase was evaluated, and decisions were founded on simulations for each environmental issue (where available) before the next phase started. Simulations and calculations were done both regarding technical and economical aspects of the different issues. Reports were issued after each phase, with decisions and simulation results.

The documents show that economy was the main reason for choosing or not choosing the different issues discussed. There did not seem to be an overall ecology-conscious structure in the design process, although almost all the building components were discussed from an environmental point of view, which shows the importance of clearing the "goals" and "background" for environmental buildings before design starts.

2.18. La Junta, Madrid, Spain

The owner contracted the architect, who was responsible for the design supported by system engineers, surveyor and structural engineer, doing the budget and finally, is the responsible for the construction of the building. The main contractor co-ordinated construction and subcontractors, each being responsible for the project schedule, budget, administration and guarantees.

The programme for the building was set up by the City Council. This contained a definition of the areas and an estimate on their use. With participation of experts and specialised companies on subjects as materials, technical loads, passive and active solar and noise the specific criteria and recommendation for the building was established.

Decisions were based on assessment of extra costs, savings and environmental advantages, carrying out comparative analyses.

2.19. Swiss Federal Office for Statistics, Neuchatel, Switzerland

The architect was in charge of the co-ordination of the engineers. The Swiss Federal Office for Building accompanied the project with its specialised technical team and SORANE was mandated for special related energy, comfort issues, and also for the controlling of the energy concept application.

The decision process was quite complex, as the design team and the technical advisors were not in the same office. Furthermore, they had sometime contradictory decision criteria. There was no direct link between the specialists and the building tenant, which was a source for problems when specifications for the building were set up.

2.20. Landis & Gyr, Zug, Switzerland

The design team shared the responsibility according to standard contracts for Swiss Building Projects (SIA). The owner/client/user was responsible for the definition of the main aims, the program and the budget. Furthermore, taking part of the planning process as far as to be able to accept proposals and making decisions within a continual decision process.

The architect was responsible for the general design and the co-ordination of the special designs and the engineers. The architect also prepared the decision process, leading the planning and decision process. The energy engineer was responsible for the overall energy concept, calculated energy efficiency and co-ordinated the energy-aspects in the work by the architect and the engineers, and had to control the energy aspects in the work and products of contractors.

The general contractor was responsible for realisation, co-ordination of the subcontractors' work, for the finance and time schedule and for the overall construction guarantee.

It was intended to solve the problems of energy and comfort with technology as less as possible and as normal as possible. The problem approach was the whole problem approach with the main question how to put normal parts together to get a special whole (synergy between space concept and energy concept). The only real but important high-tech-element is the integrated building system IBS

2.21. Durant School, Wake County, North Carolina, United States

The design team shared the responsibility.

Decisions were based on Life cycle cost analysis for all technologies proposed. The design was then made on first cost, payback and operation and maintenance cost.

2.22. Development Centre, Ingolstadt, Germany

The design team shared the responsibility. The architect co-ordinated the knowledge of each participant in the design process.

The interpretation and reflection of effects from different versions in all its complexity were accomplished through weekly joint design sessions, which pointed at the chosen solution with the biggest total sum of advantages for minimising functional restrictions, maximise flexibility in depth rooms, thermal comfort, daylight luminance, protected internal sunscreen and buffer zone as additional function area.

2.23. SurTec, Zwingenberg, Germany

The owner was the client building for own use. The architect held the central role in the planning process. He was solely and completely responsible for structuring the planning process and controlling it. The focal position of the architect meant that he could influence all factors, which naturally implied a lot more time, energy and much greater responsibility.

Individual decisions on the applied concepts were prepared by the architect. He used information provided by the experts in charge, but intervened, making far-reaching adjustments. The individual components were always analysed in the light of the total concept. The decisions were submitted to a constant cost control, so that technologies, which were still unprofitable without public sponsorship, were excluded from the concept.

Generally, the decisions were prepared on the basis of the experiences and knowledge of the architect. The fundamental selection of passive components followed the principle of avoiding trouble-prone systems. Technology would account for the fine-tuning, whereas the basic principles should be self-adjusting. During the planning time changing technologies were discussed again and again. This entailed an increased planning time but resulted in the owner's application of state of the art technology.

2.24. Dienstkringkantoor RWS, IJmuiden, The Netherlands

The contract form is mainly traditional, but differed in the design phase as the consultants and the constructors collectively discussed the project. Contracting the construction, however, was done in accordance with the traditional procedure.

The energy conception had been integrated in the design process from the beginning. The energy conception comprises the following four issues: reducing energy losses, using passive solar heat, minimising the installations in the building and using sustainable energy for the remaining energy required in the building.

2.25. Social Housing Promotion, Madrid, Spain

The owner contracted the architect team and main contractor. The architect is the only responsible for the design supported by system engineers, surveyor and structural engineer, doing the budget and finally, is the responsible for direction the construction of the building.

The main contractor is responsible for co-ordination of construction, sub-contracts and for project schedule, budget, administration and guarantees.

The design team had the starting point that a good focus on energy efficiency and environmental concepts should be present from the beginning in the planning. In this case, this has not happened. The shape, dimensions and orientation of the plot predetermined a rectangular-type of block with a double corridor and interior patio in which the longitudinal axis is in a north-south orientation. This carried some inherent negative item conditions.

3. Overview of Issues

The decisions taken for the 25 Case Story Buildings were based on the following issues (criteria, goals, requirements, methods etc.).

Costs:

- comparison of operational and investment costs *(method)*
- cost-benefit analysis *(method)*
- cost effectiveness had to be proven *(criterion)*
- budget *(criterion)*
- achieve given functions as cheap as possible *(requirement)*
- comparison of extra costs, energy savings and environments aspects *(method)*
- performance and costs were compared to conventional design *(method)*
- costs, payback, operation and maintenance cost *(criterion)*

Energy:

- energy simulations *(method)*
- 50% energy performance improvement compared to good practice *(goal/requirement)*
- energy efficiency *(criterion)*
- energy use and comfort *(criterion)*
- synergy between space concept and energy concept *(goal)*

Environment:

- minimise impact on environment *(goal/ requirement)*
- environmental goals had to be met *(requirement)*
- life cycle analysis *(method)*

Comfort:

- temperature distribution bins during occupation obtained by simulation *(description)*
- better light in the working areas - daylight without glare problems during 85% of the working hours *(requirement and criterion)*
- all employees should have a work place close to the windows *(requirement and criterion)*

Summarising the issues from all the buildings it turned out that for most of the buildings cost was issue number one. As long as the buildings do not use too much energy and do not have a too large influence on the environment costs was the overall decision parameter.

The following matrix (next page) is used for an overview of the distribution of the project-related issues and criteria identified for each project. The more stars, the more important (maximum is 5 and minimum is one). For a particular project, there might be other aspects being equally or even more important than the ones mentioned (e.g. architecture, functionality or flexibility).

The matrix should not be used to compare the various projects, since e.g. building tradition and regulations differ from country to country. Instead the matrix should be used for a relative comparison of the various criteria within one project.

Project-related design issues and criteria identified for each Case Story building. The more stars, the more important issue.

No.	Case Story Project	Cost		Energy		Environment	Comfort
		Investment	Operation	Saving	Renewable		
01	Primary School Austria	**	****	**	**	*****	***
02	Sparkasse Austria	****	***	**	**	**	***
03	Crestwood 8 Canada	***	***	****	**	***	**
04	Green on Grand Canada	***	***	****	***	****	***
05	Danfoss HQ Denmark	***	*****	***	**	**	*****
06	Brundtland Centre Denmark	***	**	*****	****	****	***
07	Arktikum Finland	***	****	***	**	**	****
08	Maisema 2000 Finland	****	**	**	*	*	***
09	Gniebel HQ Germany	*****	****	****	***	*	****
10	WAT Germany	****	**	****	***	****	***
11	Tokyo Gas Japan	**	**	****	*	***	***
12	Science institute Japan	****	**	****	***	*****	***
13	Welfare Centre Japan	**	**	****	**	****	***
14	KIER Korea	****	*	*****	***	****	*
15	Bellevue Netherlands	***	**	****	***	****	****
16	Seterbråten Norway	****	*	***	*	****	*****
17	Marine Centre Norway	*****	***	***	**	****	****
18	La Junta Spain	****	***	****	***	**	***
19	Federal office Switzerland	*****	****	**	**	****	**
20	Landis & Gyr Switzerland	*****	***	***	**	***	**
21	Durant School USA	*****	***	**	**	**	****
22	Development C. Germany	****	****	****	**	***	***
23	SurTec Germany	*****	***	****	**	***	**
24	RWS Netherlands	***	**	****	***	*****	**
25	Social Housing Spain	****	**	****	**	***	***

4. Appendix

This appendix includes design process charts for some of the Case Stories. The Actors Relation Chart and the Work Flow Chart are developed by Günter Löhnert.

1. Primary School Munchendorf
3. Crestwood 8
4. Green on the Grand
5. Danfoss HQ
6. Brundtland Centre
7. Arktikum
8. Maisema2000
15. Bellevue
18. La Junta
20. Landis & Gyr

SurTec

24. Dienstkringkantoor RWS
25. Social Housing Promotion