D 2.1 Rules and practices in building design and operation

Proposals of good practice

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1 Introduction

When a building is conceived typically the architect and the client define the targets. The modern design is defined by large glass facades which make air conditioning systems necessary. As energy efficiency is not the core business of an architect, the focus lies on the design. Thus it is the logic way that building services engineers/HVAC designers have to install air conditioning systems. As this is the typical way of conceiving a building, building services engineers are used to antiquated technologies and processes, are not enough informed about new technologies, operation of new technologies, investment costs and savings potential. Thus on the one hand it is important to inform architects about sustainable cooling and to participate building service engineers at the planning process. Furthermore incentives have to be offered to make energy efficient building attractive for all participants, especially for HVAC designers.

This document describes the rules and practices of building design as it is at the moment including standards and regulations to be met. Disseminating information about successful projects is a very important action. Therefore this guideline also offers proposals for good design and ideas to influence the education offers.

2 Planning and construction process – the usual process

In the planning process there is a definition of targets together with the architect and the client. At this target setting the starting position is discussed and the procedure how to cool the building (e.g. compression refrigeration machine or absorption refrigeration) is defined. To work out a technical concept further details have to be found out:

- Which rooms should be cooled?
- Which temperatures should be reached?
- Which room occupancy is given (when, where)?
- Basic data for calculating the cooling load
- Is there a climate centre?
- Which possibilities exist for wiring?
- Which cooling system should be realised?
- Which control system should be used?
- Etc.

National building codes or norms do not impose a maximal thermal cooling load.

The calculation of the cooling load is calculated according to ÖNORM 6040. The room cooling load is the sum of the external and internal cooling load.

The internal cooling load consists of:

- Heat emissions of persons
- Lighting waste heat
- Heat emission by electric equipment
- Heat flux from neighbour rooms

For accounting the internal heat loads, data from electricity planners or standard values are used.

The external cooling load consists of:

- Heat flux through ambient air
- Heat flux through opaque components (Walls, Roof, …)
- Heat flux through transparent components (Windows, doors, …)

The exact calculation of the cooling load is done with computer aided calculation programs most of the time. For smaller buildings (>100 kW_{th}), the simplified calculation VDI 2078 can be followed.

Furthermore the requirements of the regulations for employment protection (e.g. amount of fresh air, maximum pollutant concentration, free of drafts, humidity etc.) must be met, as well as EN 15251 and other EN standards. Thus the comfort standards for the air conditioning system are defined. To check the performance of the room climate, special en-suite measurements are done sometimes. If there are no complaints of users, then usually no checks are made.

Are the necessary data available, the planning of the plant starts. Are smaller plants required, compact solutions of different producers can be used. Otherwise an individual planning for the specified building is done. Therefore standard components (e.g. chillers) of single producers are integrating in the planning. Energy experts only play a secondary role in the planning process and are not involved from the early planning phase on.

During the construction phase the technician of the executing company has to ensure that the individual components are installed correctly. Otherwise a correct usage of the plant is not possible. For the correct installation of the plant the accomplishing Company is responsible. For the protection of people, the environment and the plant, standards, guidelines, laws and regulations have been developed and enacted.

When operating cooling plants, high pressures and temperatures can occur, therefore these legislative conditions have to be followed when planning, installation and maintaining the cooling plant to

- avoid a breakage with the risk of catapulted plant components,
- avoid leakage of refrigerants to the atmosphere,
- prevent an incorrect use or a inadequate maintenance,
- counter the danger of fire or explosion by exhausting refrigerants.

The competencies for operating the building are different from case to case. An external entity, which is normally responsible for building operation and maintenance is sometimes responsible for operating the building. In other cases a professional department related or belonging to the building owner maintains the building. In smaller companies employees of a building are doing the maintenance.

The biggest barriers to implement measures for sustainable summer comfort during the use of the building are the lack of know-how of users and property management companies about the operation of the building. Furthermore there is a basic lack of knowledge about investment costs and cost savings.

Monitoring systems are only installed, when the client requires them. They are mainly used to produce a remote diagnosis for the correction of defects after an alert. Energy monitoring is done a few times, but isn't standard at the moment.

Energy monitoring is used when energy contracting is performed to get energy data continuously. Thereby the contractor is in the position to evaluate the energy savings and if necessary to set special measures to realise the guaranteed energy saving.

The major player to constrict measures for sustainable summer comfort in the planning phase is the architect and the planning team as well as building owners and planner of the cooling system. Lack of interest and awareness is a big issue.

The major barrier for implementing measures for sustainable summer comfort is the use of antiquated experiences and rules of thumb in the planning process as well as the lack of incentive and reward for professionals to do something different than their usual way. Lack of information regarding energy savings potential and cost savings as well as the general assumption that sustainable summer comfort would be more expensive and contracts with suppliers (price conditions) are further barriers. User oriented planning would help increasing the dissemination of sustainable summer comfort.

During the installation phase the design of the outlets of the air conditioning systems – summer and winter case - are major barrier.

In the sense of the building owner an approval by the planner or architect is done.

2.1 Relevant standards and regulations

- ÖNORM EN 378 cooling plants and heat pumps – security technical and environment relevant requirements

  Part 1: Basic requirements, definitions, classifications and choosing criteria

  Part 2: Construction, production, marking and documentation

  Part 3: Place of installation and security for persons

  Part 4: Running, maintenance, servicing, recovery

- ÖNORM H 5195-1 Brine in heating plants and other plants with heat transfer media
- ÖNORM H 5195-3 Closed cold water and cooling systems for air conditioning systems and industrial usage
- ÖNORM H 5058 Total energy efficiency of buildings – cooling technical energy demand
- Regulation for cooling devices

In which cases which standard is to be used doesn't depend on the power of the cooling plant but on the kind and filling volume of the used refrigerant furthermore there are other criteria like the place of installation.

The ÖNORM EN 378-1 contains classification regarding to the place of installation and regarding the refrigerant.

2.2 Classification of refrigerants ÖNORM EN 378-1

2.2.1 Classification according to the flammability

(paragraph 5.4.2.1, page 23)

The refrigerants are classified by their explosion limit at atmosphere pressure and surrounding temperature to the groups 1, 2 and 3.

- Group 1: Refrigerants, which are not burning at any concentration when they are present in the air
- Group 2: Refrigerants, which mixture with air has an lower explosion limit of 3.5 % V/V at minimum
- Group 3: Refrigerant, which mixture with air has an lower explosion limit of less than 3.5 % V/V. The lower explosion limit is calculated after certain standards, e. g. ANSI/ASTM E 681.

2.2.2 Classification according to their toxicity

(5.4.2.2, page 23)

The refrigerants are classified in regard to their toxicity to the groups A and B.

Group A: Refrigerants with a time depending, averaged concentration, which have no negative effect on the most employees, who are exposed to this concentration during a normal 8 hour working day and a 40 hour working week, which value equals or is higher than 400 ml/m³ (400 ppm (V/V)).

Group B: Refrigerants with a time depending, averaged concentration, which have no negative effect on the most employees, who are exposed to this concentration during a normal 8 hour working day and a 40 hour working week, which value is lower than 400 ml/m³ (400 ppm (V/V)). Toxic products of decomposition can be produced, under certain circumstances, when exposed to flames or hot surfaces. Significant products of decomposition of refrigerants of group L1(A1), excluding carbon dioxide, are hydrochloric acid and fluorhydric acid. Despite being toxic, they are recognisable by their noticeable smell.

2.2.3 Security groups

(paragraph 5.4.2.3, page 24)

The refrigerants are dedicated to security groups:

		Security group	
Increasing Flammability ↑	Higher flammability	A3	B3
	Lower flammability	A2	B2
	No flame propagation	A1	B1
		Lower toxicity	Higher Toxicity
		→ Increasing toxicity	

Table 1:Security groups

For the application of this standard a simplified group allocation is valid:

L1 = A1

L2= A2, B1, B2

L3 = A3, B3

As long as it is unsure, which group a refrigerant is allocated to, the group with the ongoing requirements is valid for the allocation.

In this regard, the regulation for cooling devices, which foresees yearly inspections for specific plants and defines professionals therefore, is also important.

Furthermore the standards contain a tool (TEWI) to calculate the greenhouse effect.

3 Proposals of good practice

The two following examples were realised in Austria in the last years. The concept of both buildings is the passive house concept for office buildings. Best quality of the building envelope is the requirement for sustainable summer comfort.

3.1 Weizer Energie-Innovations-Zetrum (W.E.I.Z.)

3.1.1 Basic information

Figure 1: Weizer Energie-Innovations-Zentrum (Source: http://www.georgmoosbrugger.at/weiz.html)

The W.E.I.Z. offers offices with flexible sizes for innovative companies which lay the focus on energy. The building was the first passive house office with that size in middle Europe. A total floor area of 2.000 m² is divided in 3 floors. The target was to build an energy efficient and economic building for approx. 100 employees.

3.1.2 Energy concept

- Conditioning of ambient air with an earth tube collector and a heat exchanger, if needed with district heating or an electric re-heater room by room
- Abdication of an air conditioning system by installation of variable shading elements at the office windows and the atrium and a moderate share of window areas of 40 %
- Supply of ambient air through automatically opening fanlights, manually opening windows and overflow openings to the atrium ensure a cross ventilation during the night
- Double sided natural lighting of offices through the L- and U-formed situation around the atrium; thus large spatial depths are possible

The central air conditioning appliance has filters, ventilators sound absorber systems as well as two cross flow heat exchanger, which are able to retrieve exhaust air heat for the supply air heating. One feature of the ventilating appliance is that the propulsion engine for the supply air ventilator is on the exhaust air side. So, when cooling, the supply air doesn't heat and because of the rejected heat of the motor, the exhaust air can be used for heat recovery.

In addition, the escalator engine room can be aerated and ventilated. This way, it's also very useful for the exhaust air heat and heat recovery in winter.

Besides the thermal buffer- effect in winter, the atrium has a crucial function for the passive gravity cooling in summer nights.

3.2 ENERGYbase

Figure 2: ENERGYbase (Source: arsenal)

Innovative office design and engineering technologies make ENERGYbase an international cutting-edge project when it comes to ensuring energy efficiency, the use of renewable energies and workplace quality. Starting in the middle of 2008, companies as well as research and educational facilities can network and expand their technological know-how in the field of renewable energies.

The Energy concept of ENERGYbase was developed in an integrated planning process. It is a innovative, modern and energy efficient office building. The ENERGYbase meets its total energy requirements for heating and cooling purposes from renewable energies – primarily heat extracted from the ground. For cooling the building in summer there is only a solar cooling plant which is driven by solar energy. 285m² of solar thermal collectors are supplying the solar cooling system with energy in the summertime, whereas the thermal energy is used to support the heating system during the winter season. The "solar sorption supported acclimatisation" represents an innovative climate control system, which is being applied in Austria to this extent for the very first time.

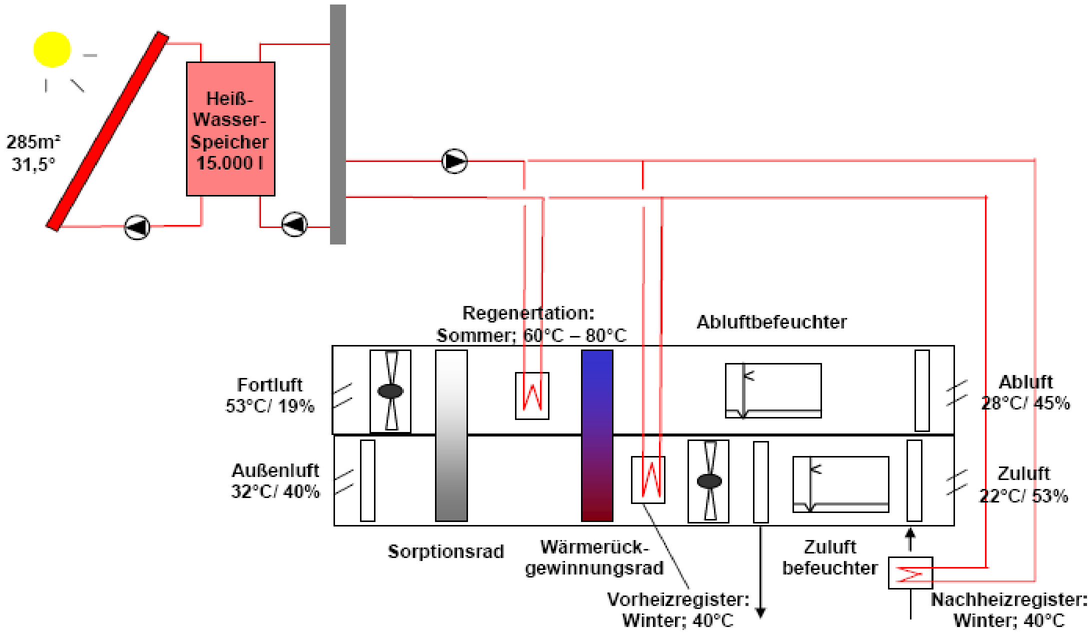

Figure 3: DEC-System (Source: arsenal)

Although the process of sorption-assisted air conditioning has been known for a long time, it has only been used in Europe for about 15 years. In principle, under middle European climate conditions, sorption-assisted air conditioning systems can be operated everywhere an air conditioner is wanted, for example in ventilation control centres. Their economical operation is then possible if cost-effective heat energy is available, i.e. from cogeneration plants, rather than from over loaded district heating systems. New heat sources, offering much promise, are solar thermal systems. Open sorption-assisted air conditioning systems are fresh air systems, that is they dry the outside air through sorption, pre-cool it with a heat reclamation rotor and finally cool it to room temperature through evaporation-humidification. The main principle of sorption-assisted air conditioning is shown in the graphic. The solar energy is used to dehumidify the sorbent. The primary advantage is that the solar thermal energy facility generates the maximum quantity of energy during the summer months, when the demand for cooling is at its peak. In winter, the energy stored in the solar thermal collectors is supplied to a buffer energy storage unit to support the heating system.

The layout of ENERGYbase and the south facade concept makes it possible to supply the entire building with daylight, which helps minimize the need for artificial light. In comparison, conventional offices require 40% artificial lighting. To save artificial lightning is also important for saving cooling loads. [1]

[1] Source of information: www.energybase.at

3.3 Education offers

In Austria there are some different lobbies and organizations who are offering some kind of further education in the field of sustainable summer comfort. One of this course is called “Certified heat pumps installer”. Participants of this course get an overview of all renewable energy sources as well as the central role of heat pumps in an ecological energy supply system. The dimensioning and projecting of heat pump systems with different heat sources is also a part of this course.

Another course offers the basics of cooling technologies. The association tells participants about the ÖNORM EN 13313.This further education is mainly based on the conventional technologies. The reason for that is, that most of the education suppliers tries to satisfy the market and the mass market is still the one of cooling compressors.

Thus it is very important to improve the education in the field of sustainable cooling. Now the architects, builders and planers are mainly constructing buildings with cooling technologies they know. As the survey resulted the biggest barrier is the lack of knowledge of new technologies, and the implementation of these technologies as well as investment costs and savings potentials. Therefore input to these courses could be given.

Another very important point is the planning process. For sustainable summer comfort it is very important that you have all partners in a very early point in time integrated in the planning process. A lot of factors are influencing the cooling load. Without integrated planning there is no chance to consult all these factors. Conventional and established technology is available on the market with which you can plan the whole building in nearly any way you want. As this would be not sustainable, courses aiming at teaching integrated planning should be offered.

4 Summary

The core business of architecture is to find an optimum solution for urban development, floor plan and interior design. Light air, view and technology are further factors. Facades are an automatic result of quality architecture. The additional value of good architecture has a direct effect on the construction costs and follow-up costs. There are a lot of high qualified architects but there are also enough architects who still have to be convinced by energy efficient building.

Not only architects need to be convinced but also building service engineers have a lack of knowledge of new technologies, investment costs, energy and cost savings potential and comfort improvements.

Our survey showed that the conventional way of designing, is still the majority and innovative strategies to ensure sustainable summer comfort are hardly applied. There are a lot of standards to be followed when conceiving a building and its technical equipment:

- ÖNORM EN 378 cooling plants and heat pumps – security technical and environment relevant requirements
- The ÖNORM EN 378-1 contains classification regarding to the place of installation and regarding the refrigerant.
- ÖNORM H 5195-1 Brine in heating plants and other plants with heat transfer media
- ÖNORM H 5195-3 Closed cold water and cooling systems for air conditioning systems and industrial usage
- ÖNORM H 5058 Total energy efficiency of buildings – cooling technical energy demand
- Regulation for cooling devices
- Etc.

Additional services have to be asked for by the client.

Barriers to implement measures for sustainable summer comfort is the use of antiquated experiences and rules of thumb in the planning process as well as the lack of incentive and reward for professionals to do something different than their usual way. Lack of information regarding energy savings potential and cost savings as well as the general assumption that sustainable summer comfort would be more expensive and contracts with suppliers (price conditions) are further barriers. User oriented planning would help increasing the dissemination of sustainable summer comfort.

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