



让我们共同打造气候中和的未来
Building a climate-neutral future together

Sino-Swiss Cooperation on Zero Emissions Building

Technical Report

Zero Emission Districts and the 2000-Watt-Certificate

ENGLISH VERSION



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Building a climate-neutral future together

This report has been produced within the framework Sino-Swiss Zero Emissions Building Project; an international collaboration funded by the Swiss Agency for Development and Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development.

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The Sino-Swiss Zero Emissions Building Project is an international collaboration funded by the Swiss Agency for Development Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development. The project aims to reduce greenhouse gas emissions and enable carbon neutral development of the building sector in China by sharing Swiss know-how on sustainable and zero emission building.

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Cover image: First certified 2000-Watt-Site Erlenmatt West, Basel, Switzerland. It is build on a former freight rail terminal and consists of a good mix of uses, but mainly dwellings, a strong community and a green outer space. © 2000watt.ch

Contents

1. 2000-Watt-District Certificate in Switzerland	2
2. Concept Zero-Emission-District (ZED) Certificate for China	9



Image: ZEB China Demonstration project. Training building, Long Shan Shu Yuan Middle School, Shaoxing, Zhejiang Province.
Courtesy of Shaoxing Future Community Development and Construction Co.



1. 2000-Watt-District Certificate in Switzerland

2000-Watt Society

The Vision

The 2000-watt society is an environmental vision, first introduced in 1998 by the Swiss Federal Institute of Technology in Zürich (ETH Zurich), which pictures the average first-world citizen reducing/increasing their overall average primary energy usage rate to no more than 2'000 watts (i.e., 2 kWh per capita per hour or 48 kWh per day) by the year 2050, without lowering their standard of living. The concept addresses not only personal or household energy use, but the total for the whole society, including embodied energy, divided by the population.

Two thousand watts is approximately the current world average rate of total primary energy use. This compares to averages of around 6'000 watts in western Europe, 9'000 watts in the United States, 3'000 watts in China, less than 1'000 watts in India and in Africa and only 300 watts in Bangladesh in 2021. Switzerland itself, currently using an average of around 4'000 watts, was last a 2000-watt society in the 1960s.

The vision was developed in response to concerns about climate change, energy security, and the future availability of energy supplies. It is supported by the Swiss Federal Office of Energy, the Association of Swiss Architects and Engineers, and other bodies.

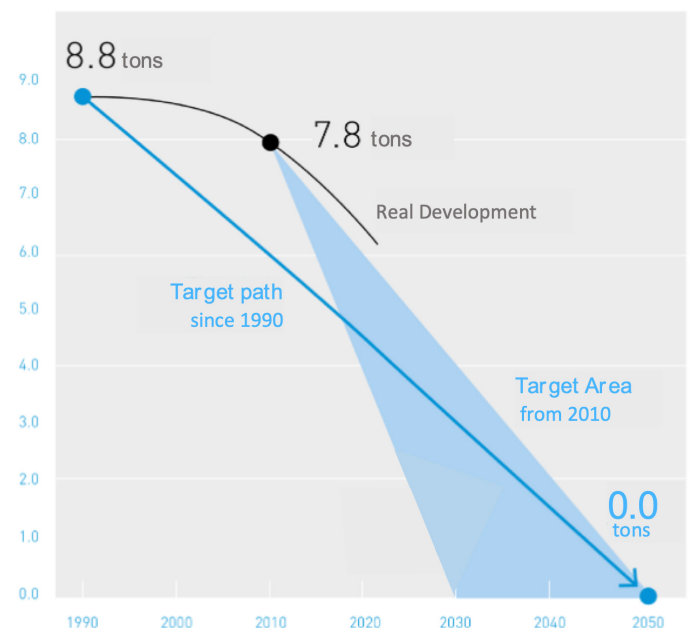
The Guiding Concept

The guiding concept for the 2000-watt-society from 2021 is primarily intended to provide cities and municipalities, but also other sectors and actors, with a uniform orientation aid for taking national and international energy and climate targets into account.

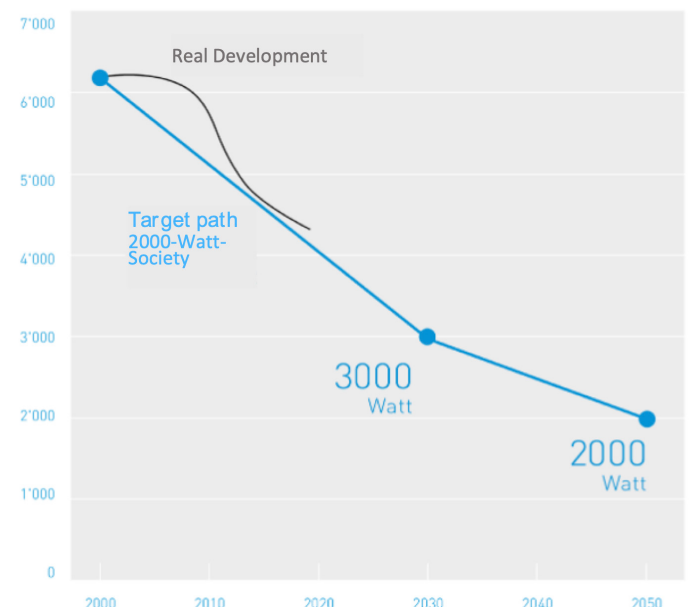
The aim is to methodically standardize the quantitative approach to these various energy and climate policy objectives. At the same time, an awareness of their congruence and convergence is to be achieved to generate strength in implementation and maximum impact via the common target definition.

The guiding concept has three main objectives:

1. Reduction of the primary energy from to-day around 4'000 Watt per capita (black line) down to 3'000 Watt by 2030 und 2'000 Watt per capita by 2050. This can only be reached by increasing the energy efficiency. Switzerland is pretty much in line with the forecasted target path.



2. Reduction of energy related GHG Emissions from today around 6.5 t per capita (black line) down to Zero latest in 2050. The longer we wait the steeper the target path gets.



2000-Watt Building

Background

The 2000-Watt Society considers the total primary energy use and total greenhouse gas emissions from all consumption sectors in Switzerland. Based on these overall and per capita goals the Swiss Engineer and Architect association (SIA) has developed a standard called SIA Energy Efficiency Path (SIA Instruction Sheet 2040). Its aim is to create the best possible preconditions for achieving targets for the building sector; the course should be set in such a way that the structural development proceeds in big steps in the right direction. As the most important sector in Switzerland in terms of energy consumption, the building sector takes on a pioneering role here, showing that it is already possible to embark on the path towards the 2000-Watt Society today.

Target values

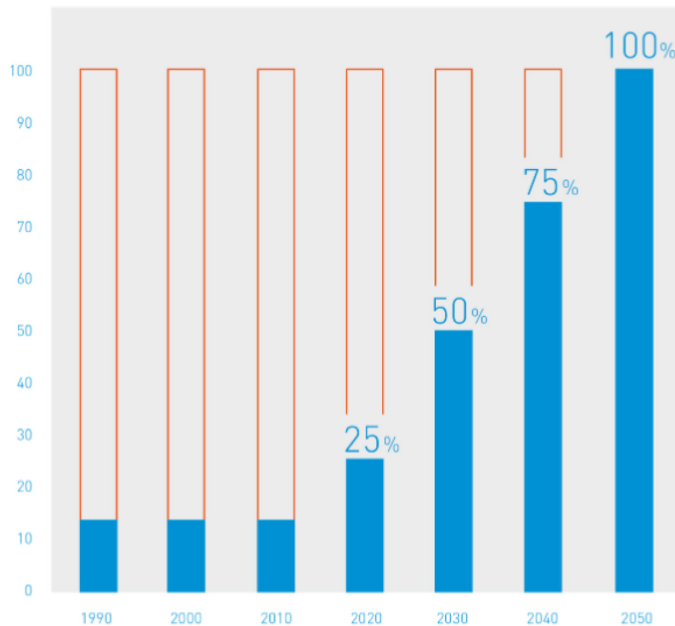
The target values were determined for the building categories Residential, Administration, School, Specialised Store, Food Store and Restaurant, proceeding from the assumption that the proportional share of total energy use represented by energy use in the building sector remains constant during the period from 2010 to 2050. For this purpose, the current status was determined for each building category and reduced to the target status in the year 2050 using the reduction factors from the targets of the 2000-Watt Society.

The target values are related to the energy reference surface; the consumption values in the 2000-Watt Society are related to a per capita reference. It's converted by means of standard surface per person.

In SIA Instruction Sheet 2040 it is assumed that the surface requirement per person remains constant during the period of validity of this technical specification. This simplification should be reviewed periodically. If the energy reference surface per person continues to increase in the future, the target values will need to be tightened accordingly.

The target values correspond to the average acceptable demand for primary energy use or the greenhouse gas emissions in buildings in 2050, including location-dependent daily mobility from the inhabitants. It shows that individual building categories cannot fully achieve the reduction targets. However, for the building categories considered in the SIA

3. Increase of the amount of renewable energy in the Swiss energy supply mix. Energy from waste is counted as renewable energy.



Additionally, two more requirements are included in the guiding concept:

- A step-by-step reduction on consumption related GHG-Emissions. This includes mainly scope 3 products as for example building materials and products.
- Monitoring of the GHG Emissions, the primary energy, and the amount of renewable energy to supervise the success.



Instruction Sheet 2040 (which comprises around 80 % of the total energy reference sur-face in Switzerland), the overall implementation is possible.

Project values

The project values are always calculated using the data normally available at the relevant stage of the project. During the preliminary study and preliminary project phases there exists a calculation aid that can be used to arrive at an initial estimate of non-renewable primary energy use and greenhouse gas emissions for construction, operation, and mobility. For later planning stages different energy simulation software are available and must be used.

Assessment

If buildings including one or several building categories have a lower project value than the target value for the indicators primary energy use and greenhouse gas emissions, they can be called 2000-Watt Buildings.

2000-Watt-District

Introduction

The 2000-Watt-District certificate builds on the SIA Energy Path of Efficiency (2000-Watt Buildings) and distinguishes settlement areas that can demonstrate sustainable use of re-sources for the construction of buildings, their operation and the mobility caused by their operation. The label is awarded by the Federal Office of Energy and can also only be used in operation. Regular performance reviews serve as quality assurance and support the process.

The main prerequisites for obtaining the certificate are that the owner has the power to act on behalf of the site and that the total floor area or property area is at least 10' 000 m².

Until now, the 2000-Watt-District certificate was supported by the Swiss Federal Office of Energy. Due to a building label harmonization, the label will no longer be maintained from 2024. However, the concept will be retained and can also be applied to districts in the future.

Requirements

Quantitative Verification

The site target values and additional requirements for primary energy use and green-house gas emissions from the three areas of building construction, building operation and mobility are determined in-

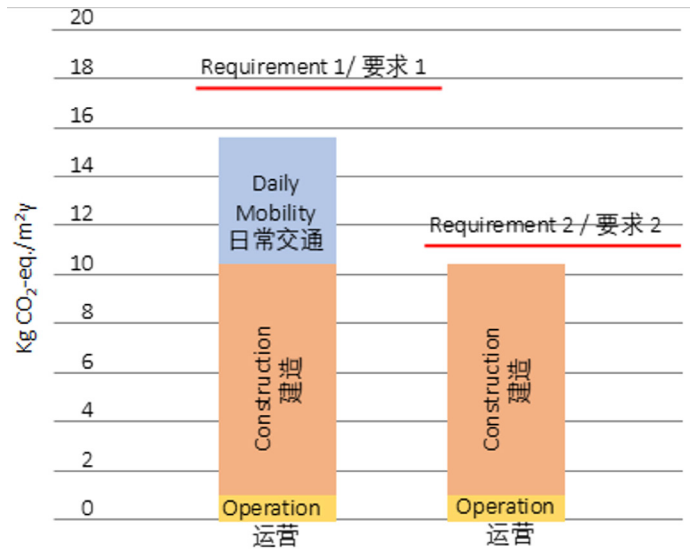


Figure 4. Example of the results for greenhouse gas emissions

dividually for each district according to the location and the building and mix of use using a standardised instrument ("Calculation Aid II"). Quantitative proof that the target values are met is provided in the operating phase with the effective, measured operating values and the surveyed mobility values.

This means, the goals are set, not the path which is very attractive for architects and planners as it gives great freedom.

Qualitative Assessment

For the qualitative assessment, there is a simplified catalogue of criteria with 6 thematic fields and a total of about 100 criteria. The six thematic fields are:

- Management
- Communication, Cooperation, and Participation
- Use of Site and Urban Development
- Supply and Disposal
- Buildings
- Mobility

In the qualitative assessment, at least 50% of the achievable number of points must be fulfilled per thematic field.

The catalogue of criteria is structured in such a way that the individual requirements of the site and the achievements and objectives of the responsible body can be considered and documented flexibly and as comprehensively as possible. The criteria catalogue ensures the comparison of different sites and individual measures. It is thus also to be understood as a collection of "best practice" solutions for sustainable site development.

Qualitative Criteria

The six thematic fields have the following focus/content:

- **Management:** The landowners must be organized very well, the district needs guiding principles, a monitoring needs to be put in place etc
- **Communication, Cooperation and Participation:** It is important that during planning there is a good communication with the municipality, the neighbours, and the future users. After the district is build and in operation the communication will focus on the triangle between owner, facility manager and users as well as between the users.
- **Use of site and urban development:** The focus here is on a good mix of uses, a high-quality outdoor space with enough green and good shading, enough services as a café, a store, childcare etc. as well as a project competition which considers energy and climate issues.
- **Supply and Disposal:** This subject area focusses on the quality and regionality of the energy as well as water supply and waste disposal
- **Buildings:** The 2000-Watt-District certificate is considering all common labels and standards for buildings in Switzerland. The wider the sustainability range and the better the achievement, the more points. Furthermore, also the Life Cycle Costs and the person density is assessed. This means, the less living area per person is consumed, the higher the rating. This is a clear link to the 2000-Watt Society and a so called “sufficiency” criteria.
- **Mobility:** The focus here is on all different measures which can't be assessed quantitative, but which have a clear positive effect on the reduction of the motorized private transport. Topics are for example: number of parking lots for cars and bikes, bike sharing services, quality of connection to public transport, etc.
- For each subject area, a degree of fulfilment of in minimum 50% must be achieved. This means here as well, the goal is set, not the path to follow.

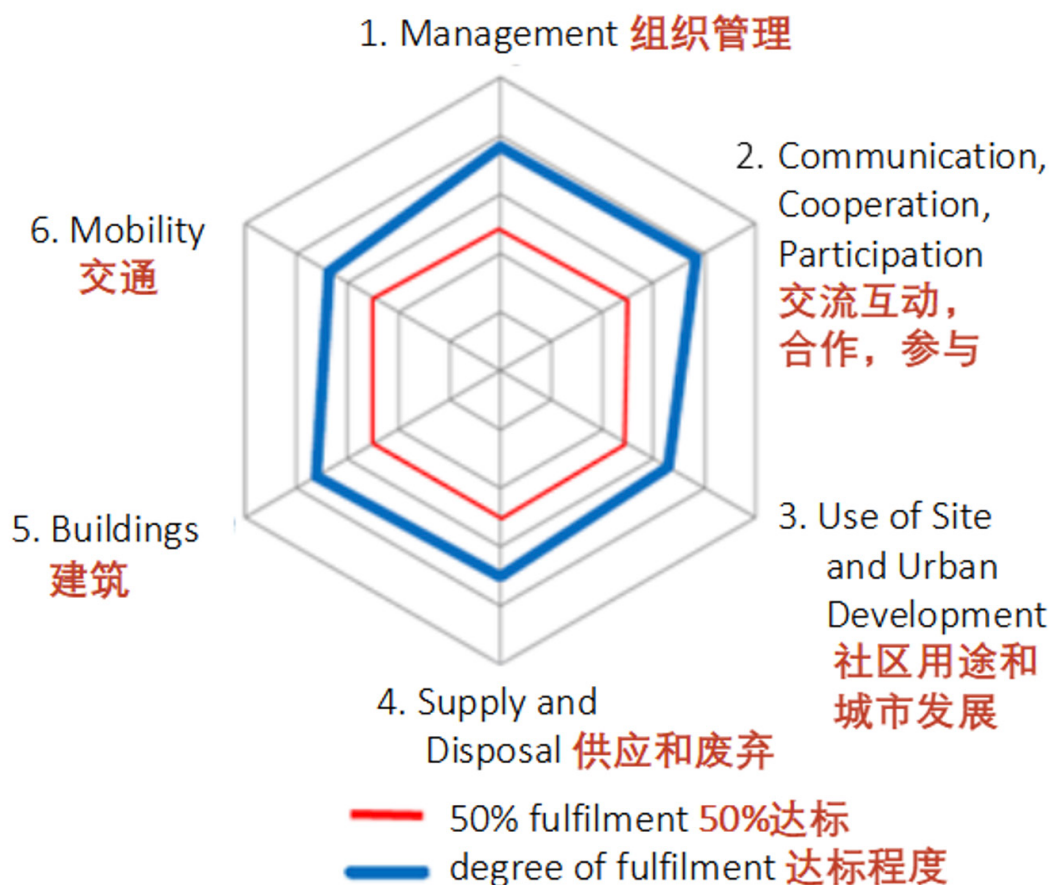


Figure 5. Results of the qualitative assessment shown in a spider diagram



Three Specifications

The 2000-Watt-District certification scheme offers three different specifications:

- For new developments (green), the goal is to be below the quantitative requirements during the whole planning process. Basis are the model-based project values.
- After the district is in operation (blue), again the goal is to stay below the quantitative requirements. Basis are the measured energy consumptions as well as the mobility behaviour which is assessed through a survey. The embodied carbon and energy are not assessed again.
- For existing Neighbourhoods (grey), the starting point is in most cases clearly above the goals of the 2000-Watt-District as the energy supply is mostly still based on fossil fuel. When the landowners can present a binding strategy showing that with certain measures (e.g., retrofitting, change of energy supply or replacement constructions) the goals can be achieved within 20 years, the neighbourhood will be awarded a certificate already today.

With these three specifications almost all new developments, districts in operation as well as existing neighbourhoods with a transformation strategy can be certified

Certification Process

By agreeing to the certification process, the owner must run through several certifications in different cycles:

- For a certification in Development, it's cycle of two years with a yearly evaluation in between.
- For a certification in Transformation or in Operation it's a cycle of four years with a yearly evaluation in between
- There is a need to work with an accredited consultant. There are about 30 of these consultants in Switzerland by the time.

The advantage of this process certification is that the landowners are forced to keep on going and will so be sensitized regularly and very deeply.

The 2000-Watt-District certificate is one of the only certificates which make the transition from model data to real data and the past has shown, that the performance gap over the whole district is very small. This can be quite different on a single building perspective.

Overall, the certification process is very clear and simple which is one of the reasons that the 2000-Watt-District label is so successful.

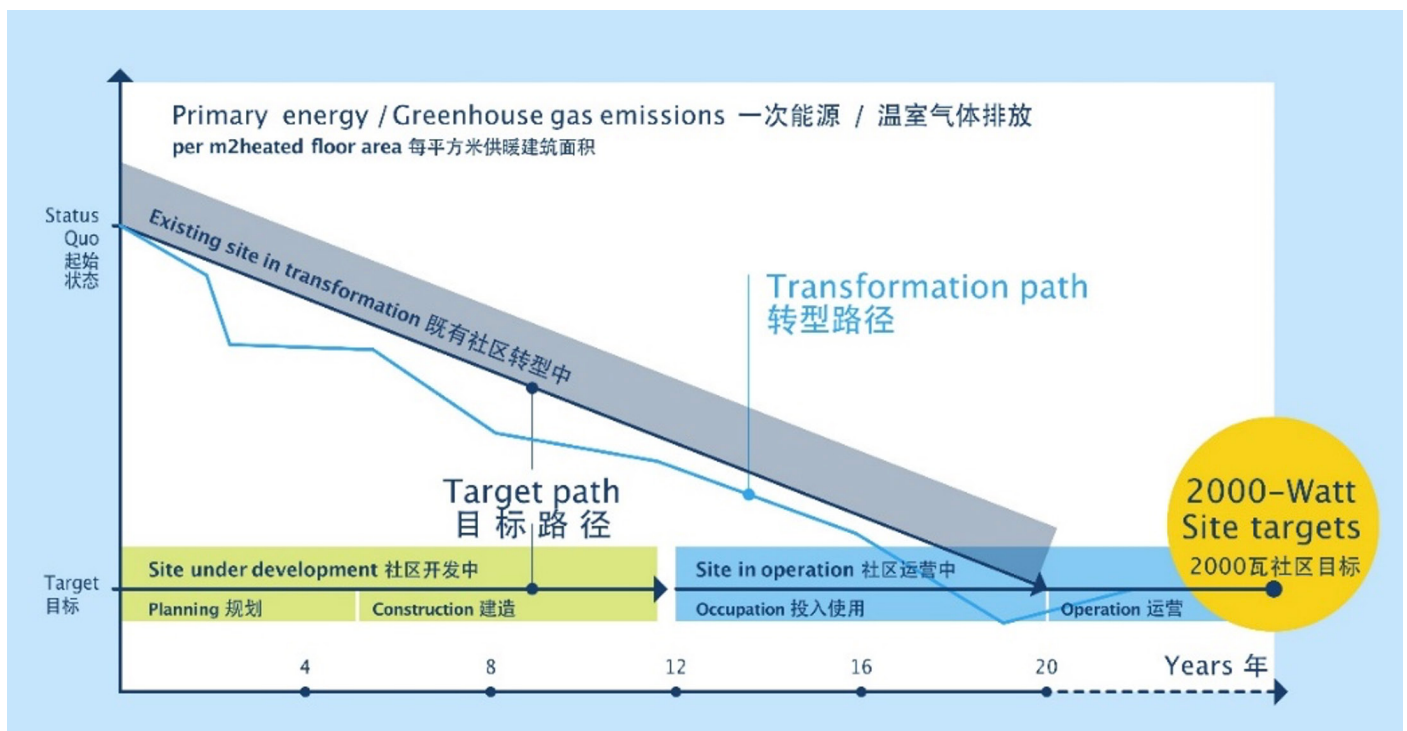


Figure 6. Specification of the 2000-Watt-District (© 2000watt.ch)

Benefits

General

The greatest opportunity of a 2000-Watt-District lies in understanding and designing a sustainable district/neighbourhood. In this way, districts achieve much greater effects than several independent individual buildings. The 2000-Watt-District requirements are demanding, but at the same time they ensure that there is a well-coordinated process. Both planning and construction as well as operation are considered.

The certificate is valid for 2 years (in development) or 4 years (in operation). The sites are thus evaluated on an ongoing basis. The aim of this long-term monitoring is to ensure that the sites continue to develop or improve instead of only fulfilling the required criteria once. In this way, they can optimally exploit existing but also new potentials, e.g., innovative technologies and communication. The 2000-Watt-District consultants supports the owners, architects and planner in doing so.

For Municipalities

In local municipalities, a 2000-Watt-District certificate makes sustainable urban development visible. The sites are often lighthouse projects. With the catalogue of criteria for 2000-Watt-Districts, the municipalities receive a tool to specifically demand the energy and climate goals of the 2000-Watt Society in site developments.

Specific benefits are:

- The certificate guarantees that energy consumption and greenhouse gas emissions meet the target values and are climate friendly.
- 2000-Watt-Districts create attractive living spaces with optimal conditions for non-motorised traffic and low-emission vehicles. This also makes settlements attractive that are located somewhat outside of centres.
- The districts promote the use of public transport as well as walking and cycling. In this way, urban traffic flows are managed in a resource-friendly way.
- Municipalities with a 2000-Watt-District promote internal development. Attractive, lively, and mixed residential areas are created in the urban area.
- The dialogue between authorities and site owners is firmly anchored in the development process. The same applies to the definition of clear, transparent goals for all parties involved.

- 2000-Watt-Districts are suitable for derelict sites, old industrial sites, or existing neighbourhoods in need of renewal.
- The 2000-Watt-District also serves as a comprehensive specification in special use and design plans of municipalities. The certificate sets clear target values and gives the development teams a great deal of freedom in implementation. This means that each site can exploit its specific strengths and the municipality does not have to act as an enforcement authority.

A 2000-Watt-District makes a significant contribution to the Swiss Energy Strategy 2050 and to the climate goals of the Paris Agreement 2015, especially through the additional “Zero” award (ready but not yet implemented).

For Architects and Planners

With 2000-Watt-Districts, urban development, architecture, environmental design, energy, infrastructure, and mobility can all be actively integrated and implemented from a sustainable point of view. Far-sighted and integrated planning is essential. Innovative solutions will also be awarded in the 2000-Watt-District.

Specific benefits are:

- The concerns of all necessary experts are considered at an early stage and considered in order to achieve the objectives. Coordination and joint processing of the planning tasks are a central element in the process.
- All stakeholders can have a positive influence in the planning phase, which results in broadly supported and accepted solutions.
- The quality assurance of energy and climate compatibility can be made based on the certificate from the test planning, in the preliminary studies, and in the project planning and operation stage.
- Planning each building in accordance with comprehensive building certification and standards is a prerequisite for the certificate. The low energy consumption and greenhouse gas emissions can be continuously monitored, and planning deficiencies can be corrected directly and cost-effectively.
- Thanks to their long-term quality, 2000-Watt-Districts are suitable as part of a valuable portfolio strategy.



For Investors

2000-Watt-Districts are a sustainable offer for a growing target group. More and more people want to actively contribute to sustainability and pursue a corresponding lifestyle.

Specific benefits are:

- Certification as a 2000-Watt-District increases the attractiveness for the intended target group and improves rentability.
- The investors contribute to sustainability and the certification proves the credibility of the commitment.
- With the certificate, the high sustainability quality can be credibly communicated (high reputation).
- High standards of building quality ensure a long service life for the site.
- The costs for certification are comparatively low (compared to other sustainability labels).
- Re-certifications and monitoring create the basis for a qualitative, continuous further development and optimisation of the site.
- Monitoring identifies cost drivers and potentials in the areas of operation, energy, mobility, waste, water, and user satisfaction. In this way, costs can be reduced, and the community strengthened.
- Due to the high level of identification with the area, there is generally a lower fluctuation of tenants and thereby reduces the costs.



2000W sites Kalkbreite (top), Sihlbogen (middle, bottom)

2. Concept Zero-Emission-District (ZED) Certificate for China

Background

Based on the successful Swiss Certificate 2000-Watt District (see Brochure Part 1) a development for China is possible. This paper offers suggestions on how this could be implemented.

Quantitative Proof

System Boundary

For the quantitative proof following aspects should be considered as they all have a significant impact on global warming and can be influenced by the architects/planners:

- Embodied carbon Emission from materials (Construction)
- Carbon Emissions from energy demand (Operation)
- Carbon Emissions from daily mobility (Mobility)

To able to come up with this proof, it is necessary to calculate the project values in different planning stages and to have target values for the different uses (resp. building categories, see chapter “Target values”).

The idea is to base the quantitative proof on the ZEB Standard but to use the target values over the whole district. This allows for certain buildings to not fulfil the quantitative requirements and others clearly undercut the target values of the ZEB-Standard.

Project Values

Operation

The energy for following uses could be considered:

- Space heating
- Space cooling
- Hot water
- Electric auxiliary energy used for heat generation
- Ventilation
- Lighting
- Appliances (incl. process units and general building services)
- Use of renewable Energy onsite

Today there are sufficient technologies available to

achieve a zero-emission operation of the building resp. a district.

If a building produces more energy, then it consumes (e.g., PV-Panels), the surplus energy could be considered as negative.

Construction

All materials needed for a new or retrofit building must be considered:

- Type of materials
- Amount of materials

Difficult to consider are the transports from a regional warehouse to the construction site. The background datasets must include the whole life cycle of the materials/components with a certain lifespan, including the upstream processes (from cradle) to the manufacturing process and the disposal at the end of life (to grave). The functional unit will be per kg or m3 of material and year.

In a first approach (maybe for 15 years) carbon trading could be an approach to achieve zero carbon emission for construction. This needs to be defined clearly.

Mobility

Only location-dependent everyday mobility is considered. Following information is necessary to assess mobility:

- Type of means of transportation resp. car (e.g., bus, train, electric car, etc.)
- Distance travelled (only one way)
- Average number of persons travelling in the car

After people have moved in the new building the impact from transportation can be assessed by a survey.

In Switzerland the model to calculate the impact from mobility in the planning stage is based on a regular national survey including the mobility behaviour of the Swiss inhabitants. This will most probably not be available in China. Therefore, a new model needs to be developed.

If it is not possible to come up with a China-specific model to calculate in a simple way the impact from mobility in the different planning stages, then we would recommend to only assess mobility on a qualitative basis.



Database

Based on the above-described necessary information for Construction, Operation and Mobility, these must be linked to the related impacts listed in one or several databases. These databases must contain the different impacts of following sectors and if possibly calculated consistently:

- List of different energy systems (e.g., energy from wood fired heater, from gas heater, etc.). Functional unit: per kWh end and/or net energy
- List of different electricity consumer mixes (e.g., regional, products, etc.). Functional unit: per kWh end energy
- List of all building materials (e.g., concrete, timber, reinforcement steel, window glass, etc.). Functional unit: per kg or m³ material
- List of all different means of transportation (e.g., train, bus, car). Functional unit: per person-km
- Some research is needed to find out, what databases are available. If necessary new and consistent data must be collected. We recommend adding these data in ecoinvent (www.ecoinvent.com) as this is an international database with high and consistent quality.

It is recommended to commission a specialist for a comparison of the different impact data in the KBOB-list with data from China to see where and how big the differences are. If they are not too big, it might be possible to use the Swiss data if no other China-specific data are available.

Target Value Definition

Introduction

The main indicator to be considered are the greenhouse gas emissions measured/calculated in kg CO₂-eq. per m² heated floor area. Another indicator, covering the resource consumption, could be total primary energy in kWh per m² heated floor area. This needs to be checked in case related data are available and if this is wanted.

The target value is defined as the sum of the guiding values from Construction, Operation and Mobility. Another requirement in Switzerland is the so-called “additional requirement” which covers only the sum of Construction and Operation (excl. Mobility). It needs to be clarified, if only the additional requirement or also the target values are of interest in China. The experiences in Switzerland have shown that it is hard to achieve the target values with rural properties whereas the additional requirements are harder to achieve with urban properties which usually have good connection to public transport.

Derivation of target & guide values

The target values in Switzerland were developed for the building categories Residential, Administration, School, specialised Store, food Store and Restaurant, proceeding from the assumption that the proportional share of total energy use represented by energy use in the building sector remains constant during the period from 2010 to 2050. For this purpose, the current status needs to be determined for each building category in China and reduced to the target status in the year 2050 using the reduction factors calculated for China. (Top-down approach).

The building categories to be represented in China must be defined. In minimum they should cover the most important ones: Residential (Dwellings) and Administration (Office). Maybe there will be a differentiation between single family houses, multi-family houses, high rise buildings, etc. We recommend starting with the most common residential buildings and then define further categories.

The guiding values in Switzerland were derived by searching for the today best available technologies for Construction, Operation and Mobility and then calculating the related impact factors which are hard but feasible to achieve (Bottom-up approach). The sum of the guiding values from Construction, and Operation must reach the target value and from Construction, Operation and Mobility the additional requirements (Top-down approach).

Operation

The guiding values for operational energy related to the carbon emissions must be Zero as there are enough technologies available to achieve this. For the indicator total primary energy, which is an indicator representing the insulation quality of the building, a guiding value must be defined for China.

Construction

The guiding values for construction related to the carbon emissions must be dynamic as today it is not possible to achieve Zero Carbon Emission. Based on a hard but feasible value for today a reduction path for the next years must be defined. In 2050 it should be possible to build without any carbon emissions (e.g., raw timber constructions, renewable materials, etc.) For the indicator total primary energy, a corresponding dynamic (based on the reduction path) guiding value must be defined for China.

The guiding values would then be tightened every couple of years (e.g., every 5 years)

Mobility

The same approach as for construction must be taken to define the guiding values for mobility.

Qualitative Assessment

It is recommended to base the qualitative criteria on the Indian 2000-Watt-Smart City concept. This concept is assessing the following themes:

- Smart Governance
- Smart Centrality
- Smart Mobility
- Smart Energy & Environment
- Smart Buildings
- Smart Food Production & Tech Centres

The content of each of the themes possibly need to be adapted as well as the max. points per theme.

Other Important Issues

Following open questions must be answered:

- Should there be target values and additional requirements only for new or also for retrofit constructions? Probably depending on whether a simple model to calculate the impact from mobility during the planning stage can be developed.
- Definition of a District is needed. What are the minimum requirements they must fulfil to be authorized for certification? E.g., minimum floor area, number of buildings, number of uses, etc.

Research Fields

In following working fields further work must be done and could be realized through Swiss-Sino co-operation:

- Definition of the target values resp. the additional requirement for the most important building categories (uses) in China based on the reduction path of China (collaboration China/Switzerland)
- Development of a simple model to calculate the impact from Mobility in different planning stages (China together with Switzerland)
- Comparison of the today available LCA Data with the Swiss Data in the KBOB-List (Swiss expert)
- Research on existing China LCA Databases for construction materials, heating systems, electricity mixes (regional?) and mobility with the related quality guidelines (China)
- Collection of LCA data from most important building materials and means of transports (China)
- Research on existing LCAs of buildings in China and what's the potential regarding low emission constructions (China)
- Comparison of the today available LCA Data with the Swiss Data in the KBOB-List (Swiss expert)



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