STS364

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Spring 2016

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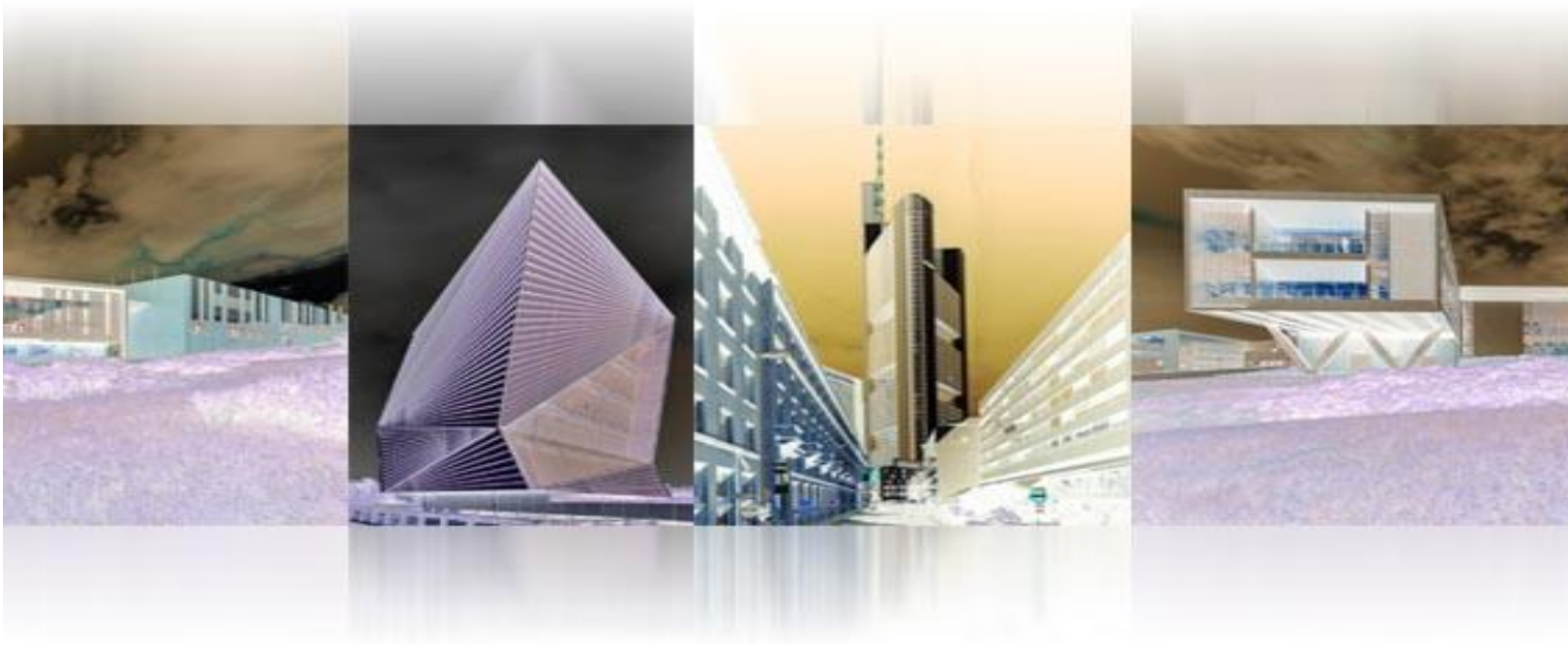

[BUILDING ENERGY EFFICIENCY IN CHINA, GERMANY AND UNITED STATES]

Submitted in partial fulfillment of the requirements for the course Sustainability Policy and Practice (STS 364/H) in the Science, Technology, and Society Program at the New Jersey Institute of Technology. May 10, 2016

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1. Introduction

Countries around the world are increasingly aware of the urgent need to change their approach to the use of energy. Concerns about energy security, socio-economic consequences of high energy source prices and growing awareness of climate change have led many countries to realize the importance of development of policies and measures to promote energy efficiency. Becoming clearer in two points:

- For more effective use of energy resources it requires policies, including wide spectrum of approaches. There is a growing understanding that often the most cost-effective, proven and accessible means of achieving this goal is to increase energy efficiency.
- Creating and maintaining rational policies, requiring high-quality, timely, comparable and detailed data that go far beyond the energy balances and reflect the distinctive of characteristic economic activities and resources available in each country.

For decades, countries used the data contained in the energy balances, as a tool to monitor energy consumption by type of energy and sectors, as well as for the calculation of consolidated indicators (e.g., total energy consumption per capita). Enlarged indicators have the advantage that they are often easily and quickly accessible: so, in simple terms, they show changes in the general plan in energy consumption. However, their practical applicability is limited and if used improperly, they can be misleading. For example, it would be incorrect to evaluate energy efficiency in the countries on the basis of total final energy consumption per unit of gross domestic product (GDP) or per capita, because at this rate is influenced by many factors (e.g., climate, prosperity, economic structure).

Getting the most advanced indicators is quite a difficult task and requires financial and human resources for the collection of detailed data and analysis. Recent activities in several countries to collect more detailed data on final consumption has helped to develop indicators for energy efficiency, yielding valuable information for understanding past trends, assessment of potential energy savings and improvements in energy efficiency policies. However, much more remains to be done. For several years, it is impossible to develop a whole range of detailed indicators. It is important that the country initially identify priority sectors or segments within the priority sectors, and then moved on with experience.[1]

The research paper aims to analyze and compare energy efficiency policies and codes in buildings and energy efficient buildings in China (Centre for Sustainable Energy Technologies (CSET), Ningbo), Germany (Commerzbank, Frankfurt), and the United States (National

[1] Book: Urban Green Architecture for the Future, Neil B. Chambers, First published in 2011 by PALGRAVE MACMILLAN, Energy better sized [125]

Renewable Energy Laboratory (NREL), Golden, Colorado). To provide better understanding of today's green building practices.

2. Standards and Building energy efficiency rules

Building's energy consumption worldwide for the period from 2005 to 2015 rose by 18%, and is expected to grow by 6.6% by 2020. At the same time, huge potential still remains unsolved in the sector. The main instrument of economic policies to improve the energy efficiency of buildings is the rules and regulations for energy efficiency of buildings. Such an approach is to establish the absolute minimum energy efficiency requirements for buildings projecting the total power consumption in heating, cooling, ventilation, and providing hot water and so forth. In addition, prescribing the rules and regulations set out the requirements for each element of the building - walls, windows and so on. Other tools to improve the energy efficiency of buildings and facilities include certification mechanisms of buildings, energy labeling of buildings, and financial incentive mechanisms.[2]

China

China is one of the world's largest manufacturers of household appliances, lighting equipment and other household and office equipment. The main objective of the 12th Five-Year Plan is the development of energy-efficient technologies and the adoption of 33 energy efficiency standards and labeling. Currently in China, there are 46 minimum energy efficiency standards, and the mandatory energy efficiency labeling (Fig.1A) applies to more than 25 kinds of household, commercial and industrial products.[3]

Germany

EU eco-design directive establishes requirements in accordance with which manufacturers of energy consuming devices are required to reduce energy consumption of its products. The Directive covers the whole energy consuming products sold in the residential, commercial and industrial sectors, with the exception of all forms of transport, which are other legislative acts.

[2] MONETARY BENEFITS OF AMBITIOUS BUILDING ENERGY POLICIES, Published in Janurary 2015 by Global Buildings Performance Network, Diana Urge-Vorsatz, András Reith, Katarína Korytárová, Mónika Egyed, János Dollenstein
[3] Energy Efficiency Labeling System & Its Development in China Cheng Jianhong Berkeley, U.S. 6 May, 2011

The updated Directive, adopted in November 2009, covers practically all energy consuming products, as well as windows, insulation materials, and certain types of plumbing products, such as shower heads and cranes (Fig.1B). For various types of products are developed and adopted detailed arrangements and measures, and manufacturers are obliged to ensure compliance of the products offered standards for energy efficiency and environmental protection, as defined by such measures. Revised edition of the EU Directive on the energy labeling 2010/30 / EU, it extends the directive for products related to energy consumption, in commercial and industrial sectors, such as cold stores and shopping machines. Expanding the scope of an "energy-using products" to "products associated with power "(including building products), it means that it is now The Directive covers any type of product that has any impact on the power consumption during use. Such products do not consume energy, but it has a significant direct or indirect impact on energy savings. Examples include window glazing or exterior doors. Energy labeling is already in force for a number of products. The EU Commission will take delegated regulations on the energy labeling at the same time regulatory approval of environmental design.[4]

USA

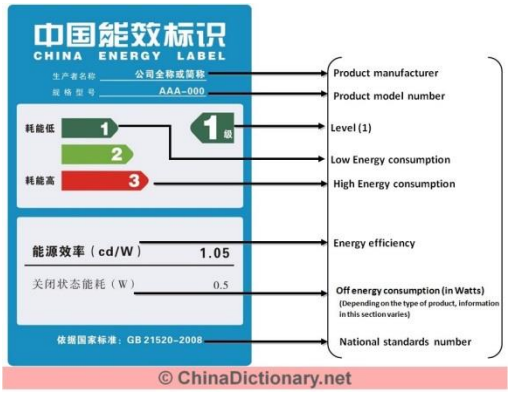
In the US, it is a large list of minimum energy efficiency standards, Energy labeling and comparative labeling, designed to increase energy efficiency of equipment and devices (Fig. 1C). At the scope of the US Department of Energy program to introduce standards for appliances and commercial equipment developed control procedures and minimum energy efficiency standards for domestic appliances and commercial equipment. The first standard on the devices was introduced in 1987, and since has been adopted, periodically updated with series of laws, and regulations of the Ministry of Energy, energy efficiency standards and water for more than 50 categories of equipment and equipment used in residential, commercial and industrial sectors. Since 1980, manufacturers of individual devices were denoted by their using comparative product labeling to provide consumers important information on energy efficiency. Terms of marking instruments Federal US Trade Commission now require the use of labeling indicating Information on energy consumption in the refrigeration and freezers, dishwashers, washing machines, room air conditioners, water heaters, furnaces, boilers, central air conditioning systems, heat pumps, heaters for swimming pools and television equipment.[5] US Department of Energy and the US Environmental Protection Agency together implementing a program of voluntary labeling of consumer goods “ENERGY STAR “, which was launched in

[4] European Commission, Energy Labeling Directive

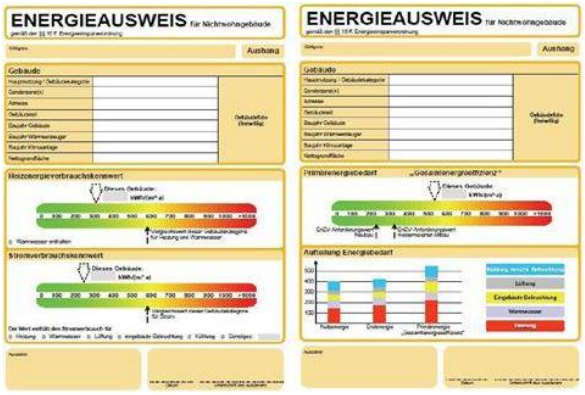
[5] Federal Trade Commission: Protecting America's Consumers

1992, marking" ENERGY STAR "can be used for more than 60 product categories, including home and business appliances, buildings and household appliances.[6]

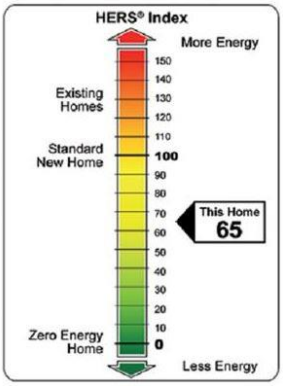
Fig.1



China A)



Germany B)



US C)

3. Evaluation and monitoring of energy consumption and greenhouse gas emissions of buildings.

Energy Certification in China

Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD) has developed a rating system for evaluating residential and commercial buildings using computational and operational performance. MOHURD Rating System is a voluntary program, but mandatory for the following 4 types of buildings:

1) new office premises of government agencies and commercial building area of more than m2 (thousands of BTU per square foot per year (kBTU/ft2/yr) or kWh/m2/yr.),
2) existing offices of government agencies and commercial buildings that use public funds for capital repairs;
3) national and regional demonstration projects on energy efficiency;
4) buildings that are planning to develop a national eco-label.

MOHURD Ratings system consists of five levels, from one to five stars, where five stars is assigned to the most energy-efficient buildings. Rating Level consists of 3 components: (a) a

[6] DEPARTMENT OF ENERGY

base component (calculated or measured power consumption per m2), (b) the minimum requirements for building structures (walls, roof, windows, doors, etc...), heating and cooling systems and (c) an option (the use of renewable energy sources, new energy-saving technologies and management systems that exceed the established norms).[7]

Energy Certification in Germany

In Germany, the energy certificate is mandatory document since 2002 for new or significantly upgraded buildings.

In Germany, there are two types of energy certificates:

1) certificates on the basis of pre-calculated energy needs of the building - calculated approach;
2) certificates based on the actual energy consumption building - an instrument approach.

Certificates based on the calculation approach, as a rule, are quite expensive. The certificates often require a visit to the building by energy expert who could provide detailed information about the building and its energy needs. A certificate based on the instrumental approach, in contrast to the previous type, do not require a visit by building expert and therefore are regarded as relatively cheap.

In this case new and substantially upgraded buildings must have energy certificates based on the calculated approach. All other buildings, as a rule, can choose between certificates on the basis of the calculated or instrumental approaches (residential buildings with a total area of less than five apartments, and which do not correspond to the German Regulation on thermal insulation of 1977 are required to obtain certificates based on the calculation approach).

The method of calculating the energy used today in Germany - holistic method described in detail in the standard DIN V 18599 (introduced in 2005). This standard certifies that the requirements of the Regulation on Energy Conservation were fully implemented, and generates energy efficiency standards for energy certificates on the basis of the calculated approach. Standard DIN V 18599 is a single method of calculation of the energy required for heating and cooling buildings, as well as its normal functioning. This standard assesses the energy efficiency of lighting and heating, ventilation, cooling and hot water.

In order to simplify the work and reduce the costs associated with energy count for existing buildings, within the DIN V18599 it was developed and implemented a method of "simplified

[7] Ministry of Housing and Urban-Rural Development (MOHURD)

accounting data." This method allows the expert to make calculations based on the standard estimates.[8]

Energy certification in the US

In the US, there are several types of power ratings: Residential Energy Services Network (RESNET), "Energy star", Commercial Energy Services Network (COMNET), American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).

Power rating, by which the assessment of buildings in the United States is called RESNET. This rating includes both design performance and testing on-site, which holds a certified specialist. Rating uses a scale from 0 to 100 called Home Energy Rating System (HERS) Index, according to which the building with zero energy corresponds to the index 0. This rating is required for the building to qualify for preferential crediting of energy saving measures and to obtain tax benefits of energy efficient residential buildings. In addition, the rating is required for labeling from the US Agency for Environmental Protection under the name "Energy star".

Rating "Energy star" for commercial buildings based on a statistical method. This takes into account the size and location of the building, weather conditions, the number of tenants, number of computers, and so on. The system then compares the actual energy consumption with a national base for building energy data and assigns a score based on the distribution of the scale when compared buildings to similar buildings.

Rating COMNET system established to assess the energy efficiency of commercial buildings and multi-family buildings. This rating allows building owners to qualify for tax breaks. Rating is designed to be compatible with the "Energy star" program for commercial buildings, as well as other applications used in some states.

ASHRAE labeling system is an assessment of building energy efficiency in accordance with the Building Energy Quotient (bEQ ™), which is carried out of the building energy efficiency compared to the technically feasible baseline. Zero energy balance corresponds to zero on the scale, and the average value corresponds to the aggregate rating of 100. Rating of 125 and above indicates poor energy efficiency.[9]

The advantages of the German approach

German experience in the implementation of high standards of energy efficiency has been very successful and has even become a model to be followed for the EU member states.

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[8] The German holistic energy performance calculation method for the implementation of the EPBD
H. Erhorn, J. de Boer, S. Wössner, K. Höttges, H. Erhorn-Kluttig Fraunhofer Institute of Building Physics, Germany
[9] Association of Energy Engineers

Through resolution on energy efficiency, as well as other activities aimed at improving the energy efficiency, Germany was able to increase energy security and reduce greenhouse gas emissions. The main advantages of the German energy standard are as follows:

- Available funding. KfW (Germany's government-owned development bank) provides low interest loans for the construction (modernization) of buildings in accordance with energy efficiency standards.
- Providing the necessary information. Information on energy efficiency is widely distributed and easily accessible. Furthermore, different agencies provide consulting services and comprehensive solutions for the implementation of energy efficiency standards in the construction industry.
- Creating a framework for effective cooperation at the regional level. The government is working with consumer associations, consulting organizations, and regional energy agencies in order to achieve the best results in energy saving.
- Particular attention is paid to the achievement of energy efficiency standards at minimal cost. In order to reduce costs, Germany uses an integrated approach in the implementation of energy efficiency standards.
- Considerable attention is also paid to the use of renewable energy sources. Renewable energy sources currently occupy a significant place in the structure of the energy balance of the country, and represent more than 9% of the total energy used.[10]

4. Building codes by country

Table 1 shows the codes and types of buildings under the code "coverage" for the residential and commercial buildings. Often the building codes apply to specific building types, such as single or multi-family homes in residential buildings sector. The more detailed the code, more types of buildings the code apply to. At the commercial sector, "commercial" – offices, retail and wholesale, retail outlets, hotels, hospitals. "Public Buildings" public services hospitals and educational buildings.[11]

In total of 4 possible points, 1 point is given if their codes are mandatory (For each residential and commercial), 0.5 points for mixed and 0 points for a voluntary or no code, making a total possible allocation points of 2 for stringency.. Countries can also earn up to 2 points for commercial and residential code coverage. Residential, 1 point for coverage both single- and

[10] Concerted Action, Energy Performance of Buildings, Implementation of the EPBD in Germany, November 2010
[11] Global Approaches: A Comparison of Building Energy Codes in 15 Countries, Rachel Young, American Council for an Energy-Efficient Economy

multi-family housing. For commercial, the code should include all commercial and public buildings to get 1 point. If coverage is partial in commercial or residential, they will receive 0.5 points.

Table 1. Building codes by country

Country	Residential		Commercial		Points
	Stringency	Coverage	Stringency	Coverage	
China	Mandatory	One Family; Multifamily	Mixed	Commercial and Public Buildings	3.5
Germany	Mandatory	One Family; Multifamily	Mandatory	Commercial: Offices, Hotels, Hospitals; Public Buildings: Offices, Hospitals	3.5
United States	Mixed [3]	One Family; Multifamily	Mixed [4]	Commercial and Public Buildings	3

3 Thirty-two states have adopted or exceeded the 2009 IECC standards.
4 Thirty-eight states have adopted or exceeded the ASHRAE Standard 90.1-2007.
Sources: Code status: IEA 2013a. Coverage: McDonald and Lausten 2013 and SBC 2013

Table 2 and 3 shows the technical requirements of each country's code. Each country received 0.25 points for technical requirements.

Table 2. Residential building code technical requirements

	Heating and Cooling Requirements	Insulation in Walls and Ceiling	Window U-Factor and Shading/Solar Heat Gain Coefficient	Air Sealing	Lighting Efficiency	Technical Installations	Design, Position, and Orientation	Points
China	X	X	X	X	X	-	X	1.5
Germany	X	X	X	X	X	X	X	1.75
United States	X	X	X	X	X	-	-	1.25

Table 3. Commercial building code technical requirements

	Heating and Cooling Requirements	Insulation in Walls and Ceiling	Window U-Factor and Shading/Solar Heat Gain Coefficient	Lighting Efficiency	Technical Installations	Design, Position, and Orientation	Points
China	X	X	X	X	-	X	1.25
Germany	X	X	X	X	X	X	1.5
United States	X	X	X	X	-	-	1

Sources: McDonald and Lausten 2013, CLASP 2011

In addition, China, Germany and USA have implemented incentives and disincentives to help push contractors and home builders to comply with the codes.
Table 3 and 4 laid out the enforcement standards by country in the residential and commercial sectors as well as their inspection requirements and whether the country has any of the above incentives or disincentives for compliance. A country can have more than one of these Incentives in place and the sturdiest packages are in countries that have all three elements (A, B, and C).

A: Policy packages and incentives that complement or motivate compliance with building codes. For example: green loan programs, financial schemes and incentives, and public incentives including tax credits.

B: If the building does not comply with the code, then they are refused permission for occupancy or construction.

C: Enforcement of building codes includes fines and fees for noncompliance.

Table 4. Residential energy building code enforcement standards.

Country	Are there enforcement standards?	Code enforcement type	A, B, C
China	Local enforcement with third-party inspection.	On-site inspection occurs during construction. Refusal of permission to occupy, refusal of permission to construct, and fines for noncompliance.	B, C
Germany	Accreditation of applicants. The government-owned banking group Kreditanstalt für Wiederaufbau (KfW) plays a central role in the promotion of energy savings by providing subsidies.	None. Refusal of permission to occupy and refusal of permission to construct for Noncompliance.	A, B
United States	Local enforcement, third-party inspection, post-occupancy control commissioning requirements. Sales and use tax exemption for renewable energy equipment, solar renewable energy certificates. Local option—Clean Energy Loan Program, Be SMART Home Efficiency Loan Program, Be SMART Multifamily Efficiency Loan Program, Home Energy Loan Program.	During construction, post-occupancy airtightness testing required prior to compliance. Refusal of permission to occupy and refusal of permission to construct for noncompliance.	A, B

Table 5. Commercial energy building code enforcement standards.

Country	Are there enforcement standards?	Code enforcement type	A, B, C
China	Local enforcement with third-party inspection. Green Building Rating Systems, Green Olympic Building Assessment System, Evaluation Standard for Green Building.	During construction. Refusal of permission to occupy and refusal of permission to construct for noncompliance.	B, C
Germany	Accreditation of applicants. The government-owned banking group Kreditanstalt für Wiederaufbau (KfW) plays a central role in the promotion of energy savings by providing subsidies.	During construction and post completion. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, B
United States	Local enforcement, third-party inspection, post-occupancy control commissioning requirements. Sales and use tax exemption for renewable energy equipment, solar renewable energy certificates, local option—Clean Energy Loan Program, Be SMART Home Efficiency Loan Program, Be SMART Multifamily Efficiency Loan Program, Home Energy Loan Program	During construction, post-occupancy airtightness testing required prior to compliance. Refusal of permission to occupy and refusal of permission to construct for noncompliance.	A, B

Sources: McDonald and Lausten 2013, CLASP 2011

Table 6 shows a summary of the points assigned to each of the countries. For technical requirements, each country is awarded 0.25 points per technical requirement within their building code. In addition, countries got 1 point per enforcement mechanism (A, B, or C).

Table 6. Summary of all metrics with points

Country	Building energy codes	Technical requirements in residential	Technical requirements in commercial	Enforcement mechanisms for residential	Enforcement mechanisms for commercial	Total points
China	3.5	1.5	1.25	2	2	10.25
Germany	3.5	1.75	1.5	2	2	10.75
United States	3	1.25	1	2	2	9.25

5. Sustainable Building Aspects in China, Germany and United States

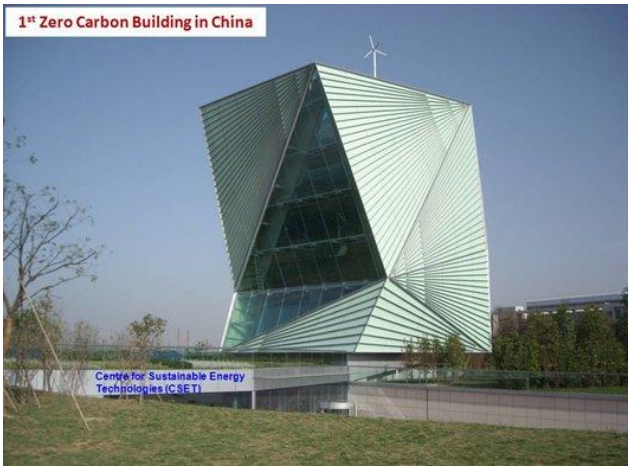
Energy-efficient buildings are designed to meet the lowest possible energy consumption during their operation. Energy efficiency in buildings can be achieved through the use of high-quality building and insulation materials, which helps to minimize thermal bridging and to ensure the airtightness of structures. A prerequisite for energy efficiency of buildings are high-quality structural design and expert execution of construction works.

As a lens for comparison and analysis, for the three buildings the report will identify six criteria to analyze the energy use in the buildings: Energy efficiency, Indoor environmental quality, Sustainable site planning and management, Material and resources, Water efficiency, and Innovation.

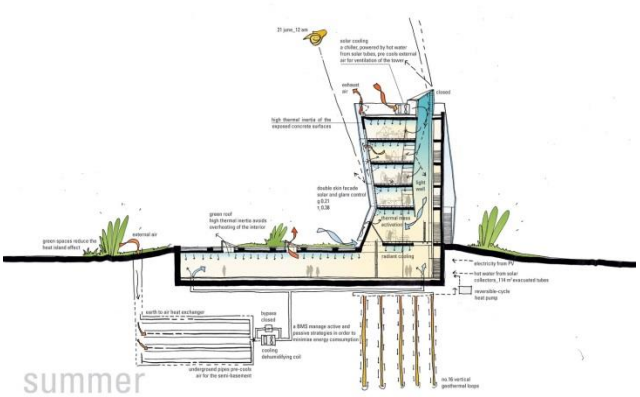
China

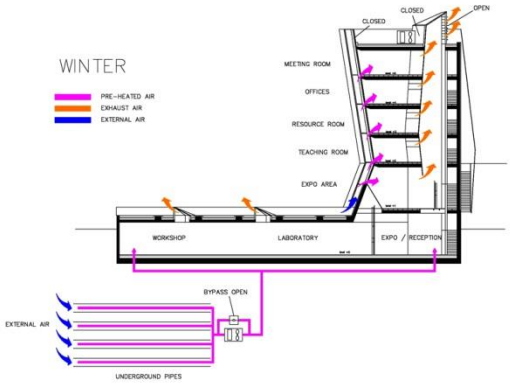
Centre for Sustainable Energy Technologies (CSET), Ningbo

The Center for Sustainable Energy Technologies, Ningbo China (CSET) is an overseas campus of the University of Nottingham, located in the coastal city of Ningbo in Zhejiang province, near Shanghai, China. The University was the first Sino-foreign University to open its doors in China in 2004, with the approval of the Chinese Ministry of Education. It is run by the University of Nottingham (UK), with cooperation from Zhejiang Wanli Education Group.



CSET building, designed by Italian firm Mario Cucinella Architects (MCA), it is filled with modern solutions that enable the fullest possible use of natural lighting and thermoregulation. And, of course, the building itself is self-sufficient in electricity. Decent size glazed wall facing south. Thermal insulation- double walls supporting a zero energy balance (Zero-energy building). While zero energy buildings are still small count, but counting: buildings that do not depend on the reliability of electric or oil price shocks – depend on its own energy sources.





Sources: http://www.mcarchitectsgate.it

CSET total area of 1300 “squares” provides energy at the expense of photovoltaic panels, which lie side by side, and wind turbines. Wind turbine and solar panels offer CSET electricity,

furthermore the building is equipped with batteries capable of storing energy for two weeks in the building of five aboveground and one underground floors. All of them are connected by a wide shaft that goes to the roof (but veiled by rain). This element is responsible directly for the CSET two features - it allows the reflected rays of the sun to penetrate deep into the building, reducing the need for electric lighting and sets the path of air flow. Direct and reflected sunlight makes the use of artificial lighting unnecessary. In combination with geothermal energy that allows heating the inside of the building in winter and cooling it in the summer with minimal costs.

According to the Italian firm, for cooling CSET spends only 8.7 kilowatt hours per square meter per year, which is about two times less than the cost of a conventional office building on classical conditioning in a region where most of the year, it's hot . Building CSET accommodates audiences and offices, a small exhibition hall, as well as several laboratories: for testing of facades, thermal laboratory for testing of construction materials, climatic chamber and wind tunnel laboratory of sunlight simulation etc.[12]

The center for sustainable energy technologies is built with maximum use of local materials. And yet this building boasts rainwater collection and reuse system technology. Representatives of the University of Nottingham called the center a "beacon of green technologies in the world."

The estimates for CSET building reflect into reducing coal combustion at 448.9 tons, and carbon emissions by 1081.8 tons over the next 25 years. Across China - small numbers. But this is only an example, a guiding star.[13]

[12] Designboom magazine, February 16 2009
[13] Treehuger: China's First Zero-Emissions Building: Ningbo's Sustainable Energy Technology Center

Germany

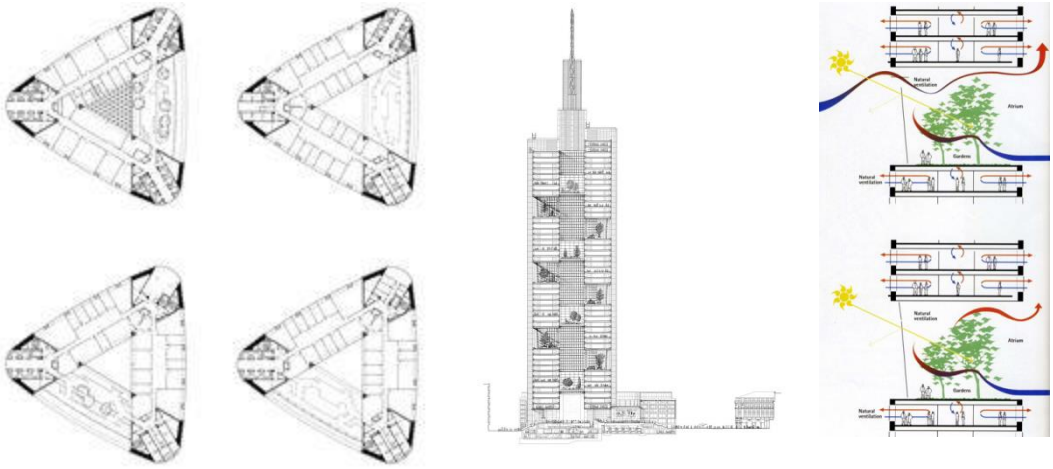
Commerzbank, Frankfurt

Commerzbank - the tallest building in Frankfurt, 259 meters in height. The building was designed by the British architect Norman Foster and his studio "Foster and Partners" (London), in collaboration with Arup and Krebs & Kiefer (structural design), J. Roger Preston with a P & A Petterson Ahrens (engineering design) and Schad & Hilzel (design of electrical systems). The Building was completed in May 1997; it takes 24th place in the world by height and is a radical revision of the whole concept of high-rise buildings.

The ground plan of the building is a triangle with rounded tops and slightly convex sides. The central part (usually elevator shafts), occupied by a huge triangular central atrium extending over the entire height of the building, and is a conduit for the natural ventilation of adjacent office spaces.

Norman Foster looked plants as something more than just decoration. The magnificent Winter Gardens are a fundamental element in his concept. Nine gardens spiral the entire building - three are located on the east side, three - from the south, and three - to the west. In the botanical aspect of the plants reflect geographical orientation: the east - Asian vegetation on the south - the Mediterranean, from the west - North American.

Each floor has three wings, two of which are allocated for offices, and the third is part of a four-story winter garden. Four-gardens - "green lung" of the building, placed in a spiral around the triangular shape of the building, provide for each tier view of the vegetation and eliminated large volumes of undivided office space.



Sources: Sketches + Drawings, Foster+Partners

Reduced heating energy consumption of the building is achieved by using the heat from the heat transfer coefficient of glazing approximately 1.4-1.6 W / (m2 ° C). In addition, the first layer acts as a protective shell, which reduces the convective heat flow outward. In winter, the space between the outer and inner membranes of the facade is sealed at night, forming a static air layer having good thermal insulation properties. Reductions of energy consumption for heating together, with the winter gardens provide additional heat gain due to accumulation of solar radiation heat.[14]

Double layer wall and shading devices. To reduce air-conditioning energy consumption of the building, as well as for natural ventilation, translucent envelop made of two layers - almost a unique welcome in a modern high-rise construction. Outer sheath (first layer) has slotted openings through which outside air enters the cavity between the layers. Windows, including those located on the upper floors, even facing the atrium, can be opened to provide natural ventilation directly to the level of the 50th floor.

Aerodynamics and natural building ventilation. The high-rise building is divided vertically into four 12-storey module called "villages". Each module has, as already mentioned, three four-story winter gardens connected vertically by means of a central atrium. Gardens connected to the atrium to increase the efficiency of natural ventilation. Each module is controlled by its own independent air-conditioning installation. Every 12 floors on the borders of the atrium units divided horizontally to equalize the pressure and protect against the spread of smoke. The gardens, the atrium and office spaces on the perimeter have operable windows and ventilating the offices is carried out primarily in a natural way.

[14] Foster+ Partners, Projects / Commerzbank Headquarters Frankfurt, Germany 1991 – 1997

Approximately 2/3 of the employees of the bank may regulate their own natural ventilation by opening windows. Only under difficult weather conditions the automatic air-conditioning equipment includes mechanical ventilation system it is in operation. Through this scheme, Commerzbank achieves 30% lower power consumption in the organization of ventilation high-rise building than conventional skyscrapers of the same size.

In winter, the natural ventilation of all the office space, located on the perimeter of the building, provides comfortable microclimate parameters. However, you must pay attention to the fact that mechanical ventilation allows you to create comfortable microclimate parameters with simultaneous energy savings through heat recovery from exhaust air. Natural ventilation of internal (adjacent to the conservatory) of office space more efficiently than ventilation offices located around the perimeter of the building, because the internal offices are located close to the winter gardens. Winter gardens act as a thermal buffer zone in which a direct or diffuse solar radiation helps to warm the entire room. During the transition period, when the outside temperature is in the range from + 5 ° C to + 15 ° C, mechanical ventilation is not necessary because of the acceptable outdoor air temperature.

At night, in anticipation of a hot summer day the heat capacity of the building is cooled by cool outside air, while the cooled ceilings with integrated pipes rendered monolithic absorb and release heat. The equipment of approximately 50% of the area of premises cooled ceilings provides sufficient heat capacity to create a comfortable room temperature the next day in the range of 21 ° C (8: 00 am) to 28.5 ° C (6: 00 pm) without the use of air conditioning.

Thus, the principle of using the garden as the main component of new generation buildings displays that gardens in architecture now are playing not only aesthetic, but also a major practical role. In the end, it improves the environment of the building, creating a comfortable environment for living, work and improves the quality of life itself.[15]

[15] Commerzbank: A Sustainable Skyscraper, Structure Innovations, Christian Noble

United States

National Renewable Energy Laboratory (NREL), Golden, Colorado

When the US Department of Energy decided to transfer the staff of the National Laboratory of Renewable Energy division into a new office building in the city of Golden, in advance it was clear to all that it will be sustainable. The result met the expectations of construction – the building received LEED Platinum certification, and has become an excellent example of practical application of developments in the area of the Department of Energy to reduce energy consumption and renewable energy sources.

The design-build team of Haselden Construction and the architectural firm RNL won the design-build competition and began work in July 2008.

The success of the construction of the building with about zero-energy is a contract for the design and construction, which recorded future energy consumption and methods of measurement and control. It is along this path and go customers from the National Renewable Energy Laboratory (NREL), to develop appropriate terms of reference for the tender.

The objectives of such an approach:

- motivate the designers and builders to consider the widest range of solutions for the design and implementation of the most daring and creative ideas;
- improve intercommunication and interaction between all participants in the project;
- reduce the overall risk by shifting the responsibility for the final result to the designers, and thereby strengthen supervision.

Creating a workable contract for energy consumption in itself is time consuming and complicated process. It should be clear and available to formulate some targets energy consumption and available to formulate restrictions, including the period of construction and the cost.

In this project, the most difficult is to provide zero-energy construction project and the creation of energy generation systems from renewable sources, located on the site.

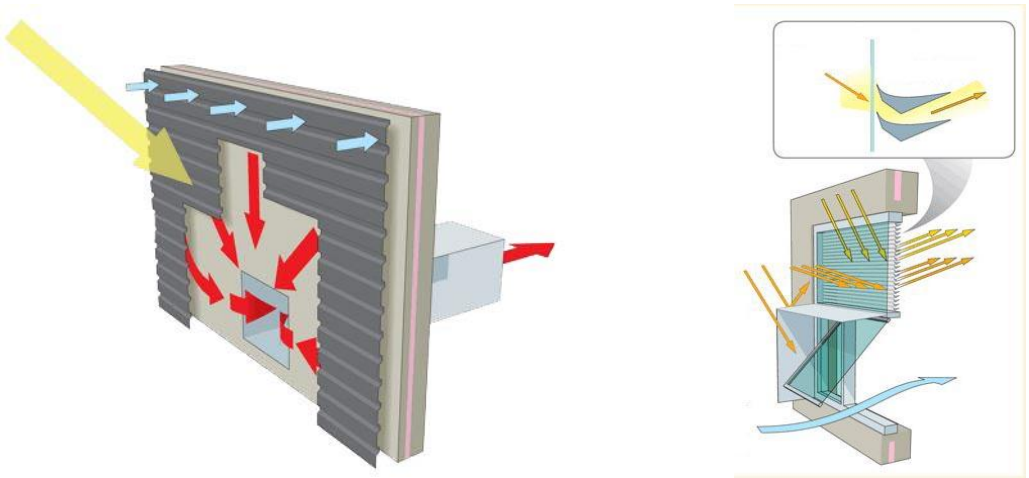
Last of all, solar photovoltaic modules - the system was installed and put into operation in summer 2012. After that, the project has reached the required rates of energy consumption.

The easiest way to save energy - do not need it. The development of the architectural concept should be carried out with due regard to the energy consumption of the building. With this approach, the load on the lighting system and sanitation system can be significantly reduced. Particular attention in the technical design assignment was given to the requirements to ensure 100% natural light, as well as adequate ventilation and the ability to control glare and reflections. The result was an architectural form which resembles the letter H (the width of the wing of the building - 18 m). The building is oriented on the axis east – west.[16]

In order to avoid the effect of heat bridging, the following solutions were used:

- a frame structure used in sandwich panels with low thermal conductivity materials;
- openings in to the metal frame.

The windows on the south side of the facade are an excellent example of architectural solutions aimed at reducing the energy consumption of the building. The window is divided into two zones.



Sources: Department of Energy National Renewable Energy Lab

The upper zone is used for natural lighting. Made of glass with a high transmittance and a daylight luminous flux reflecting shutters on the inside. Light directed upwards, deep into the room.

The lower zone is made of triple insulating glass and has a visor to shade. Options to reduce heat leakage and the risk of glare are not needed, so no internal blinds.

[16] The Right Tool At The Right Time, Energy Systems Integration Facility at the National Renewable Energy Laboratory Golden, Colorado, 2014 Lab of the year

This part of the window is used for natural ventilating the premise. Fold in two-thirds the size of the window is opened by hand, one-third automatically by a signal from a building management system. The office staff is notified of the possibility to open the window sash on the monitor of their computer. The climate in Colorado is perfect for natural ventilation of premises in spring and autumn.

During the summer, hot weather during the day gives way to night quite cold weather. In those days, automatically controlled sash windows on the south and north facades open for night cooling the premises. The thermal mass of the building is large enough that allows you to effectively use this process to reduce the load on the air conditioning during the day.

Another important architectural and engineering element is the "air" solar collector.

Perforated metal acts as the outer grille for air intake system with a mechanical drive. Getting behind the perforated metal, the air begins to warm. Next, the heated air flows into the underground labyrinth. Labyrinth partitions are made of concrete. Thermal energy allows you to supply air heats up to 5 K.

The ventilation system uses all opportunities to reduce energy consumption. Supply air can be reheated, and due to the warm air from the data center and at the expense of the underground labyrinth of the storage of thermal energy, and a more traditional way of exhaust air heat recovery.

Given the high demand for energy in the building, the cost of delivery and installation of renewable energy, needed to obtain zero energy consumption from external networks, amounted to only 8% of the cost of the entire project.

The total capacity of the three systems of photovoltaic solar collectors amounted to 1.6 mW. The first system of photovoltaic modules was installed on the roof of the building immediately after the completion of construction. Its power was 449 kW.

The second system (power 524 kW) was installed on the guest parking lot in July 2011. The last operation in the summer of 2012 introduced a system of 706 kW in the parking lot for the laboratory staff.

Additional modules have been installed during the expansion of the building laboratory. In the parking lot for employees to add the module power of 450 kW, the roof of the main building has replenished 408 kW modules.[17]

Solar photovoltaic modules system allowed achieving zero energy consumption.

[17] Engineering, The Most Energy Efficient Building In America - Science Insider

Table 7 shows a summary of the points assigned to each of the buildings. One point is awarded per building performance in each category.

Table 7. Comparative summary with points

Country	China **CSET**	Germany **Commerzbank**	U.S. **NREL**
Energy efficiency	2 times less for cooling than conv. Bld.(most hot) Self- sufficient	30% less energy demand for ventilation than conv. Bld.	Zero energy
IEQ	Natural light. Thermoregulation. Inner core.	Natural light and ventilation. Winter gardens. Inner core.	Natural light and ventilation. Control glare and reflection. Interior reflecting shutters.
Sustainable site planning and management	Passive thermal control. Glazed wall facing South. Photovoltaic modules. Wind turbines. Geothermal energy.	Double facade layers. Aerodynamics. Passive thermal control.	Photovoltaic modules. Bld. Orientation E-W. Passive thermal control.
Material and resources	Maximum use of local materials	X	Low thermal conductivity material.
Water efficiency	Rain water collection. Reuse system technology.	X	X
Innovation	Batteries store energy for up to two weeks.	Window design	Window design. Air-solar collector.
Points	13	9	11

The teams of the three projects succeeded the main goal - to make the next generation of commercial buildings. Solutions can vary from project to project, but common approaches and practices applied can be widely used in constructing a building with low energy consumption and without a significant increase in investment.

6. Correspondence

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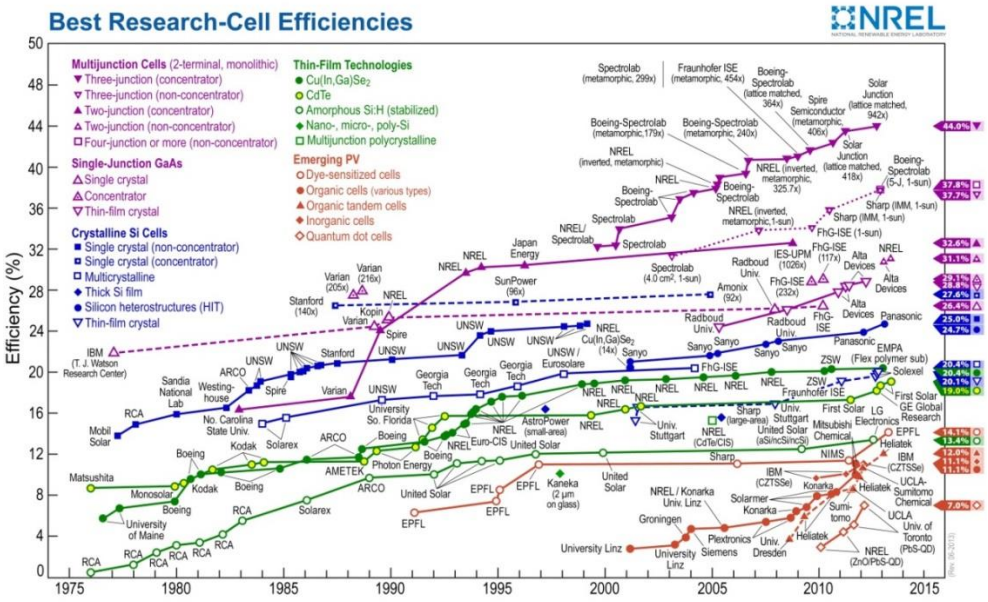
One of the most common questions that arise when deciding to install solar panels for personal use is the question: What solar panels are most efficient in performance and value? However, the wording is not entirely correct. First of all, the literal answer to this question for the average consumer does not matter, as Lisa Glass (National Renewable Energy Laboratory) explains it:

“In fact, the important question is not how to choose the most efficient solar cells, and which of them have the best value for your money. If there is space on your roof for the installation of ten solar panels and there is a choice between solar panels with a nominal energy efficiency class "A", which are a bit more effective, but at twice the price of solar panels class "B", then most likely, from the point of saving expedient to select "B" class panels. In short, the main task is to find out what options are available in a particular situation and to analyze the economic impact of each of them.

In any case, if you really want to know the most efficient solar panels (or solar modules), some of which are listed below with an indication of the manufacturer and the values of the coefficient of performance.”



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Considering the factors that directly impact occupant's indoor comfort (too cold or too hot, too humid or too fast air movement, not enough or too bright light). What would be a typical everyday experience working at Commerzbank?

"The idea of combining gardens and workplace is clearly unique approach where light and greenery allow for a person to work and to feel comfortable. The atrium space is also repository of fresh and refreshed office air. All office spaces are connected to a winter garden- providing a close contact with the natural environment for the people working here.

The gardens are giving a new quality office space to work comfortable, people here at work live with a sense of lightness, freshness and abundance of the air in the surrounding space of the premises. Each office in the tower is lit and equipped with operable windows, which allows employees to control their ambient environment and saving energy."

VII. Conclusion

Buildings are not just buildings. They are interconnected with the larger dynamic of ecological impact from the manufacturing and processing of materials, the transportation of those materials and products to and from factories, and ultimately to their installation in homes and offices.

This makes the view of a building much more expensive. We cannot fix the problems of buildings by simply dealing with individual buildings. We have to look at the problem from the perspective of cities, towns, regions, and, eventually, nation and multiple nations. Creating green buildings by today's measure helps, but it doesn't go far towards addressing our many critical problems with infrastructure, particularly energy and water.

The current mentality is that new innovations in technology will fix the problems of the old technologies. As noted, current green building practices are wonderful when trying to reduce utility bills, but they do little to reduce the energy generated upstream. The debate about energy is confusing, sometimes purposefully so and sometimes by accident, and it is been

leading us down the wrong path for years. If we continue to try to solve the problems created by using fossil fuels with technology-based sustainability, the only thing we will be making is a mess.

It is time for humankind to look at the problems of energy from a new perspective.

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