Research for Compiling a Mandatory National Standard《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》

Ruicheng Zheng, Tao He, Bojia Li, Min Wang and Xinyu Zhang

China Academy of Building Research, Beijing (China)

Abstract

It is introduced a China's research item from the Ministry of Housing and Urban-Rural Development of PRC in this paper. The title of the item is Research for Compiling a Mandatory National Standard《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》. The main contents of the paper are background introduction for reformation of China's national engineering standard system and research results of the item in the field of renewable energy application which mainly are compiling principles for this mandatory national standard and key technical stipulation of the standard for renewable energy application including solar thermal systems, solar PV systems, ground and air heat pump systems etc. On the base of this research item, a compiling work for Mandatory National Standard《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》will start in near future.

Keywords: Mandatory national standard, energy efficiency in buildings, renewable energy application, solar thermal systems, solar PV systems, ground-source heat pump systems, air heat pump systems

1. National engineering standard system in China

There are two kinds of national engineering standards now in China, one is mandatory standard and another is voluntary standard. Compiling and publishing for national standards, professional standards and local standards were all managed by governments, but the association standards which are in common use in many developed countries had not key status in the past. So this situation has not been suitable to the requirement of market economy development in China.

Therefore a reformation for this national engineering standard system has been started since 2015. Only the mandatory standards are National Standards and their compiling are still organized by governments, but voluntary standards compiling will be changed to organizing by associations or companies etc. gradually. To strengthen the management for mandatory standards and ensure basic supply for voluntary standards of public welfare, a new standard system will be set up in the future.

2. Research for reformation of compiling principle

2.1. Background

For making sure a successful reformation several research items have been issued by the Ministry of Housing and Urban-Rural Development of PRC. So the item "Research for Compiling a Mandatory National Standard《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》was started in 2016 and it will be completed in 2018. The chief research unit of this item is China Academy of Building Research (CABR). After completing research of this item a compiling task for 《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》will be started formally.

National mandatory engineering standards are divided into two types, engineering projects standards and common technologies standards. A common technology standard is aimed at a special technical profession and its content should cover the general performance demands and key technical measures for planning,

doi:10.18086/eurosun2018.03.03 Available at http://proceedings.ises.org

reconnaissance, survey, design, construction, pilot run and inspection etc. The mandatory technical demand to be entered in a common technology standard can be quoted by engineering projects standards which need not repeat providing. 《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》 belongs to common technology standard.

2.2. Research for reformation of compiling principle

At the present situation if having even one compulsory provision in a standard, this standard is a mandatory standard, but in the future an important reformation is that all contents should be compulsory provisions in a mandatory standard. The mandatory national engineering standards (technical code) are technical bottom lines to guarantee safety, healthy, engineering quality, ecological environment, public interests etc. and technical stipulations to promote energy and natural resources saving and to manage community economy.

In the past the compulsory provisions of mandatory national standards are only concerned personal security, person's physical health, engineering safety, ecological condition safety and public interests etc. But in the future some contents related to promoting resources conservation and energy saving will also be put in compulsory provisions and it is a reformation for compiling principle.

The main research tasks include following aspects: to collect and refer all concerned requirements such as public security, environment protection and energy efficiency etc. in China's national laws and regulations, to investigate the compiling inscapes, contents and technical indexes etc. in concerned laws, codes and standards of foreign countries such as EU, US, UK, Japan etc., to analysis the practicability and operability of compulsory provisions in present concerned mandatory standards. Undergoing about one year's work, a research report was completed in the end of 2017 and some useful research results were gotten.

3. Main research results for key technical stipulation

The research results of this item include all provisions which will be entered in 《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》 and mainly they are some technical stipulations in different technology application fields. These provisions of different technology application will be introduced briefly in the next.

3.1. General regulation

The total energy consumption for heating and air conditioning of new-built residential buildings, for HVAC and lighting of new-built public buildings shall decrease 30% and 20% respectively compare with energy efficiency index of the present design standards for energy efficiency of residential buildings/public buildings in 2016. The energy consumption limits to various types of buildings in different climate areas are given. The design indexes for energy consumption of various typical public buildings in different climate zones at standard working condition are shown in Tab.1.

Tab. 1: Design indexes for energy consumption of various public buildings in different climate zones (kWh/m^{2}a)

Type	Severe cold zone	Cold zone	Hot summer and cold winter zone	Hot summer and warm winter zone	Moderate climate zone
Common office buildings Area < 20000m^2	**≤ 50**	**≤ 45**	**≤ 55**	**≤ 55**	**≤ 40**
Large office buildings Area ≥ 20000m^2	**≤ 55**	**≤ 50**	**≤ 60**	**≤ 65**	**≤ 50**
Common hotel buildings Area < 20000m^2	**≤ 40**	**≤ 40**	**≤ 50**	**≤ 70**	**≤ 40**
Large hotel buildings Area ≥ 20000m^2	**≤ 45**	**≤ 45**	**≤ 60**	**≤ 75**	**≤ 45**

Market buildings	**≤ 70**	**≤ 65**	**≤ 70**	**≤ 80**	**≤ 40**
Hospital buildings	**≤ 75**	**≤ 70**	**≤ 70**	**≤ 85**	**≤ 40**
School buildings	**≤ 35**	**≤ 30**	**≤ 35**	**≤ 40**	**≤ 30**

Investigation and evaluation for renewable energy application in buildings shall be taken during the stage of planning design, to decide rational application patterns and to confirm application effects according to local solar energy resource etc. and suitable conditions. The design documents should include special articles for renewable application in scheme and preliminary design period. The technical requirements of construction and operation concerned with renewable energy application should be noted in detail design documents.

3.2. Solar thermal systems

A solar thermal system should be comprehensive utilization in all year, has the capacity to supply hot water, heating or cooling for building according to user's requirements, local climate and suitable condition.

The performance of solar collectors shall meet related stipulation in concerned National Standards and collector's working life shall not lower than 15 years. The average efficiency of solar collector systems for solar thermal application in buildings shall meet the requirement in Tab.2.

Tab. 2: Requirement for average efficiency of solar collector systems η (%)

Solar water heating system	**Solar heating combisystem**	**Solar cooling system**
η≥42	**η≥35**	**η≥30**

Note: for solar water heating system η is average value in one year, for solar heating combisystem η is average value in one heating season, for solar cooling system η is average value in one summer.

Solar thermal systems shall have related technical measures for freeze-proofing, frosty-proofing, overheating-proofing, hot water leakage proofing, lightning protection, hail preventing, wind resistance, anti-seismic and electric safety etc. according to different areas and using conditions.

The relief valves in the systems shall be mounted at a place where discharge steam or high-temperature hot water could not endanger surrounding persons and related facilities shall be allocated. All electrical instruments used in solar thermal systems shall have safety measures for earth potential, residual current protection and interruption of power supply etc.

3.3. Solar PV systems

Solar PV grid-connected systems shall have related protection capacity, install switch cabinet for special use of grid-connected system and necessary metering apparatus. Gap device shall be set up between a solar PV grid-connected system and a public power grid.

"Electric Shock Risk" warning label shall be put at the grid-connected place and where installed PV systems of buildings. The PV systems installed in buildings shall have related protection measures for electric safety and lightning protection.

3.4. Solar systems integrated in buildings

Design of integrated in buildings should be adopted in the design for solar systems (solar thermal systems and solar PV systems) used in buildings.

The brackets of solar collectors/solar PV panels shall be firmly connected to superstructures of the buildings through embedded parts which shall meet the demands of anchoring bearing capacity.

The safety protection measures for system operation/maintenance and broken components falling down shall be set in buildings which are installed solar systems.

A solar system installed on roof of the building shall not create sunlight shelter to adjacent buildings and decrease the sunshine level of adjacent buildings.

When using solar collectors instead of balcony breast boards, the total performance such as rigidity and strength etc. shall meet the requirement for protection capacity of the balcony.

In the case of fire poisonousness grade for burning smoke of solar collectors/solar PV panels shall not be lower than the second security level AQ_2.

Checking for structure security must be passed before additionally to build solar systems in existing buildings.

3.5. Ground heat pump systems

Before scheme design for a ground heat exchanger system the investigation and survey to construction field and geothermal resource shall be taken. The feasibility and economy analysis to practice ground heat exchanger system shall be carried out.

A thermal response test shall be done when building area for application ground heat exchanger system is larger than $5000m^2$.

Dynamic load calculation of one year at least for ground heat exchanger system shall be taken. The total quantity for heat storage and heat supply of the ground shall be balanced during calculation period.

Design for a groundwater system shall be taken according to survey data of hydrology and geology. The reliable recharge measure must be taken and groundwater shall be recharged to same aquifer. The situation of groundwater waste and pollution is not permitted and groundwater quality shall be monitored regularly.

Evaluation to water resource and environment influenced by surface water (rivers and lakes etc.) systems shall be carried out and the item construction shall be approved by local departments in charge of shipping and water resource.

The devices and pipes of sea water heat pump system shall be provided with anti-corrosion performance. The measures to prevent sea living beings adhering shall be installed.

Freeze-proofing measures shall be set for ground heat exchanger system, close circle heat exchanger system of surface water and sea water in the areas where freeze will be happened in winter.

3.6. Air heat pump systems

The effective heating capacity of a unit of air heat pump shall be corrected in accordance with outside temperature, humidity, operating mode of frost and defrost. The correction shall be also in accordance with connective pipe length and height difference between inside unit and outside unit for a multi-connected split unit of air heat pump.

Auxiliary heat resource shall be set when design indoor temperature is lower than temperature of balance point of a unit of air heat pump.

During continuous heating operation for an air heat pump unit the total defrosting time shall not exceed 20% of one continuous heating period.

The necessary freeze-proofing measures shall be taken when an air heat pump system is used in severe cold and cols zones.

The winter heating COP of an air heat pump system operated in severe cold zones, cold zones, hot summer and cold winter zones shall not be lower than 1.6, 1.8 and 2.1 respectively.

3.7. System installation and acceptance

The main components and materials related to safety, energy efficiency and environment protection used in systems shall be retested through witness random sampling on construction site. The retested contents include: safety and thermal performance of solar collectors, generation power and efficiency of solar PV panel.

Orientation and tilt angle for installation of solar collectors and solar PV panels shall meet the design requirements and deviation shall not be more than $\pm 3^0$.

During installation for solar systems structure such as roof and anti-water layer etc. in existing buildings shall not be damaged.

The testing items for thermal performance of a solar thermal system shall include heat gain and efficiency of solar collector system, total energy consumption and solar fraction of solar thermal system. The efficiency of solar collector system shall meet design requirement.

The test of drawing water from a heat resource well and recharge water to same heat resource well for a ground-source heat pump system shall be done and accepted alone. The sustained water output and recharge quantities shall be checked with design drawing and be stable.

The testing of water quality and sediment concentration for a ground-source heat pump system shall be done. The water quality and sediment concentration shall meet the using requirement of equipment in system.

Before the final acceptance for a ground-source heat pump system operation testing during winter and summer shall be carried out. The testing results of system performance shall be compared with design requirement and evaluation shall be given.

3.8 System operation and management

The energy efficiency management system and directive rules for energy efficiency operation of equipment shall be made.

The detail operation plan for a combination system of common energy with renewable energy shall guarantee to give priority to using renewable energy.

The obvious sign of season exchange in winter and summer for a ground-source heat pump system shall be set and operation for valve exchange shall be completed before season exchange.

The surfaces of solar collectors and PV panels in solar systems shall be cleaned at regular intervals.

During operation of a solar collector system, checking and maintaining for system shall meet following stipulations:

1) The integral checking up for solar collectors shall be done every one year.
2) The safety of lighting protection measures of solar collector systems shall be checked at regular intervals.
3) Freeze-proofing measures of solar collector systems shall be checked before winter operation.
4) The exposure and stagnation of solar collector shall be avoided during operation of a solar collector system.
5) There shall be effective measures to avoid overheating of a solar collector system when operation stops for a solar cooling system after summer.

3.9. System metering and building energy labelling

Metering parameters for a solar heating or cooling system shall include outside temperature, temperatures in typical rooms, input and output water temperature of solar collector system, circle water flow of solar collector system and total solar irradiation.

Metering parameters for a solar PV system shall include outside temperature, surface temperature on back side of solar panels, total solar irradiation and generating capacity.

During operation of a ground-source heat pump system, metering and analysis for temperature in the side of ground source shall be taken.

The statistic period for energy consumption in buildings shall be whole one calendar year. The renewable energy system shall be metered solely.

The building owners or operation units shall record original data for energy consumption accurately and set statistic standing books. The metering instruments shall be calibrated at demand regular intervals.

The statistic for energy consumption in buildings shall include power consumption, coal gas or oil consumption, heating consumption, cooling consumption and renewable energy consumption.

The energy using efficiency of buildings shall be tested, evaluated and labelled before final acceptance. The testing and evaluation for energy using efficiency of buildings by the third part shall be done after building using one year and occupancy rate of a residential building is more than 30%. The building owners shall open the evaluation results.

The building energy labelling shall be directed against one single building. The labelling contents include basic building information, energy efficiency grade and relative fractional energy saving, case of new technology application, testing and evaluation results for building energy efficiency.

The information of building energy labelling shall be given in agreement, quality guarantee and using instructions which shall supply to purchaser when selling a commercial residential building.

The owners of public buildings shall give publicity to energy consumption of real operation in buildings at the notable location of the buildings.

In management contracts of EPC items the quantifiable targets for energy consumption and environment characters which can be tested and verified shall be given.

4. Conclusion

The results of item “Research for Compiling a Mandatory National Standard 《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》 will ask advice openly in the next months of 2018. The formal compiling for Mandatory National Standard 《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》 will start and complete in 2019.

All study work provides a better basis for compiling Mandatory National Standard《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》. Through the study technical level, engineering quality and real effects for Energy Efficiency in Buildings and Renewable Energy Application will be also raised in the future in China.

5. References

1. China Academy of Building Research, 2017. the Report for Research of《Technical Code for Energy Efficiency in Buildings and Renewable Energy Application》.

2. China National Standard, GB 50364-2018.《Technical code for solar water heating system of civil buildings》.

3. China National Standard, GB 50496-2009.《Technical code for solar heating system》.

4. China National Standard, GB 50366-2005.《Technical code for ground-source heat pump system》,Version 2009.

5. China National Standard, GB/T 50801-2013, 《Evaluation standard for application of renewable energy in buildings》.

6. China Professional Standard, JGJ 203-2010.《Technical code for solar PV system of civil buildings》.