



A review of renewable energy applications in buildings in the hot-summer and warm-winter region of China



Dayao Li ^{a,b}, Jiang He ^{a,c,*}, Lin Li ^a

^a College of Civil engineering and Architecture, Guangxi University, Nanning 530004, China

^b Qinzhou University, Qinzhou 535000, China

^c Guangxi Key Laboratory of Disaster Prevention and Engineering Safety, Guangxi University, Nanning 530004, China

ARTICLE INFO

Article history:

Received 2 May 2015

Received in revised form

14 October 2015

Accepted 17 December 2015

Keywords:

Renewable energy

Integrated design

Building

Hot-summer and warm-winter climate

ABSTRACT

Renewable energy not only can effectively alleviate the depletion of traditional energy sources, but also meet the need for building development. At present, the applications of renewable energy in buildings are still facing many problems. This paper presents a review of the application of renewable energy systems in buildings, and describes how to make good use of renewable energy for the sustainable development in the hot-summer and warm-winter region of China. The effective measures would improve the calculation methods, design the building and energy system with locality, develop integrated design of renewable energy systems, establish evaluation indexes of renewable energy applicability in buildings, and strengthen project management. Discussion results presented in the paper can provide a guideline for better to apply renewable energy systems to buildings in the hot-summer and warm-winter region of China.

© 2015 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	328
2. Renewable energy applications in buildings around the world	328
2.1. Researches on utilization technology of renewable energy	328
2.2. Researches on design methods of renewable energy systems in buildings	328
2.3. Applications in China	329
2.3.1. Researches on utilization technology of renewable energy	329
2.3.2. Researches on design methods of renewable energy systems in buildings	329
2.3.3. Renewable energy's building applications in the hot-summer and warm-winter of China	330
2.4. Summary	331
3. Applications in the hot-summer and warm-winter region of China	331
3.1. Solar energy utilization in buildings	331
3.1.1. Solar thermal technology for buildings	332
3.1.2. Solar photovoltaic technology for buildings	333
3.2. Shallow geothermal energy technology for buildings	334
3.2.1. Application of the shallow geothermal system in the hot-summer and warm-winter region of China	334
3.2.2. Ground source heat pump (GSHP)	334
3.3. Variety of renewable energy technologies (renewable energy hybrid technologies) for buildings	335
3.4. Summary	335
4. Conclusions	335
4.1. Improving calculation methods for bioclimatic design	335
4.2. Building design integrated with renewable energy	336
4.3. Evaluation indexes of renewable energy applications	336
4.4. Strengthening project management	336

* Corresponding author at: College of Civil engineering and Architecture, Guangxi University, Nanning 530004, China. Tel.: +86 7713232057; fax: +86 7713236273.

E-mail address: kakohejiang@gxu.edu.cn (J. He).

Acknowledgments.....	336
References.....	336

1. Introduction

Various fossil fuel resources such as oil, coal and natural gas are the largest energy sources for human living and production. However, due to the rapid development of modern industrial economy and the sharp increase in population, these conventional energy sources have been gradually depleted. According to the reported data, building energy consumption in many countries has reached more than 35% of total energy consumption. Human beings pursue higher quality of life, so the building energy consumption grows up, such as air-conditioning and hot water production energy. Therefore, it is critical to carry out research related to renewable energy applications in buildings. The application of renewable energy is still not mature in the building field. The literature analysis revealed that there are a lot of problems in the application of renewable energy in the building for the sustainable development.

This paper will describe the current situation and review renewable energy applications in the hot-summer and warm-winter region of China. The problems of renewable energy applications in the region will be also summarized in the paper.

2. Renewable energy applications in buildings around the world

Researches of renewable energy are mainly carried out on two aspects: utilization technology of renewable energy and design methods of renewable energy systems in buildings.

2.1. Researches on utilization technology of renewable energy

The developed countries such as Europe, USA and Japan are at the forefront of the world in the application of renewable energy. India, Brazil and other developing countries are also in a leading position on some types of renewable energy. For the development of renewable energy utilization, it is extremely important to take suitable utilization strategies according to local conditions. Six different strategies have recently been proposed for the European Union (EU) energy system in Energy Roadmap 2050. Recent studies indicate that district heating plays an important role in the implementation of future sustainable energy systems [1]. However, to ease the pressure on biomass resources and investments in renewable energy, future sustainable energy systems must be applied. Thus, the concept of 4th Generation District Heating (4GDH) has been mentioned. Compared to the former three generations, 4GDH meets the challenge of more energy efficient buildings and is an integrated part of the operation of smart energy systems, i.e. integrated smart electricity, gas and thermal grids [2]. Therefore, Renewable energy and building integrated design has become a trend. The development experience of the world is worth for inspiring.

European countries are in the leading position in the field of renewable energy utilization. In the application of wind energy, especially seaborne wind energy, Europe is leading the world both in the scale and the number of the wind power plant. According to the statistical data of 2013 by World Wind Energy Association [3], the most off-shore wind energy plants were installed in Britain, Denmark, Belgium, Germany and China. Europe accounted for four in these five countries. The world largest offshore wind power

plant was put into use in the UK in 2010 [4]. In Denmark, the government implements a 100% renewable energy policies and leads to the challenge of balancing electricity supply and demand. However, with a wind power production, a CHP share meets 20–50% of the electricity demand [5]. The climate of Iceland is decrement, and it is often lack of sunshine in winter. In such climate, the Iceland government has taken full advantage of nature's bounty – geothermal resources. The geothermal resource in Iceland accounted for 55% of the national energy supply in 2005, and it replaced Norway with the name of 'the world most livable countries' in 2007. Icelanders are working hard for becoming the first country in the world without using of fossil fuels now [6]. The pump technology of ground source heat in Switzerland is also richly endowed by nature. The heat pump system of ground source in the Swiss domestic heating occupied for more than 97% in recent years. Germany is the leader of the solar photovoltaic industry and the solar-integrated building in the world. The new installation capacity of solar systems in Germany accounted for about 50% of that in the world each year since 2007 [7].

The United States is the largest energy-consuming country in the world, and it is also the first to carry out photovoltaic power generation and implement grid-connected power supply. As early as ten years ago, solar apparatus such as solar water heaters, has been very popular in the American homes. The occupancy of the solar water heater market is more than 10% [8]. In recent years, many prestigious universities in the United States have invested heavily in supporting the research of developing new energy sources. For example, Stanford University has raised a million dollars to study how to improve the utilization of solar energy and other topics in 2009 [9]. At the same time, the building integrated with renewable energy systems is also very popular in the United States.

Japan is limited in land, and its energy resources are relatively limited. But in terms of using solar energy, Japan has been in a leading position in the world. Before 2007, Japanese production capacity of solar cells had been ranked first in the world. According to the data statistics of IHS firm in US, Japan was expected to be in the first place for the market size of solar cells by the amount in 2013. But the application of solar-integrated buildings is still relatively few in Japan.

India and Brazil are prominent representatives of the development of renewable energy in the developing countries, and they have made great progress in wind power and biomass fuels. India is abundant in wind energy resources, so in the application of wind energy, India is the world fifth largest country of wind power generation, following Germany, Spain, the United States and Denmark [10]. Brazil has a vast agricultural territory, and there is a growing development in biomass energy utilization after the crisis of drought-induced electric power supply in 2001.

2.2. Researches on design methods of renewable energy systems in buildings

Researches on design methods of renewable energy systems in buildings are about the macro perspective, covering aspects such as planning, organization, pre-designed, conceptual design, preliminary design, after design, construction and use, as can be seen in *Integrated Whole Building Design Guideline*, *Integrated Buildings*, *Design is the Problem*, *The Integrated Design Process in Practice*, *Integrated Design Process Guide*, *Integrated design approach for improving architectural forms in industrialized building systems* [11–16].

Download English Version:

<https://daneshyari.com/en/article/8114547>

Download Persian Version:

<https://daneshyari.com/article/8114547>

[Daneshyari.com](https://daneshyari.com)