Renewable and Sustainable Energy Reviews 42 (2015) 43–55

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

China's small hydropower and its dispatching management

Chuntian Cheng [a,*], Benxi Liu [a], Kwok-Wing Chau [b], Gang Li [a], Shengli Liao [a]

[a] *Institute of Hydropower and Hydroinformatics, Dalian University of Technology, Dalian 116024, China*
[b] *Department of Civil & Environmental Engineering, Hong Kong Polytechnic University, Hong Kong, China*

A R T I C L E I N F O

Article history:
Received 1 March 2014
Received in revised form
31 August 2014
Accepted 26 September 2014

Keywords:
Small hydropower
Large-scale
Dispatching management
Yunnan

A B S T R A C T

With a huge energy demand, the small hydropower (SHP) has undertaken a rapid development in the past six decades in China. Especially in the recent three decades, the increasing environmental pressure has promoted its development rate and the significance of its management and operation. The number of SHP stations in China has exceeded 45,000 with a total installed capacity of more than 68 GW, ranked the first in the world. SHP provides approximately 5% of China's gross electricity generation and is the major backbone for rural electrification. However, how to manage and operate SHP effectively is still a difficult problem in China. In this paper, the current status of SHP in China is investigated. A special emphasis is given to their dispatching management. The southwestern province of Yunnan, ranked second in exploitable potential and first in established capacity of SHP in China, is taken as a typical example for the management and operation of SHP. The difficulties and challenges of management and operation of SHP in Yunnan province are depicted. A case system for the SHP management in Yunnan is introduced in details. It is believed that the system should be beneficial for regions with rich SHP resources in China and elsewhere as well.

© 2014 Elsevier Ltd. All rights reserved.

Contents

* Corresponding author.
E-mail addresses: ctcheng@dlut.edu.cn (C. Cheng), liubxi@126.com (B. Liu), cekwchau@polyu.edu.hk (K.-W. Chau), glee@dlut.edu.cn (G. Li), shengliliao@dlut.edu.cn (S. Liao).

http://dx.doi.org/10.1016/j.rser.2014.09.044
1364-0321/© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

In the past several decades, China has been in the process of rapid industrialization, urbanization and modernization. Inevitably, a huge energy demand is accompanied with the process [1]. Fig. 1 demonstrates the evolutionary development of electricity generation of China. The yearly electricity generation reached 351.4 TWh in 1983 and 5347.4 TWh in 2013, with a 15-fold increase in 30 years [2–4]. Among the electricity generation mix in 2013, thermal power contributed 78.4%, hydropower 16.8%, nuclear 2.1% and other renewable energy of wind and photovoltaic only 2.8% [4].

Coal-based thermal power dominates China's energy structure of electricity generation [3]. Nearly half of China's carbon dioxide emission comes from thermal power and heat production [5]. This unsustainable energy production pattern contributes alarmingly to global warming and leads to serious air pollution due to CO_2 and SO_2 emissions [6,7]. China is a typical country that has the most severe air pollution [8]. It is facing such an imminent environmental challenge that 16 out of the world 20 most polluted cities are in China and less than 1% of the 500 biggest cities in China meet air quality standard recommended by the WHO [9,10]. Developing renewable energy and optimizing renewable energy management are of great importance in alleviating environmental pollution.

China has attached great importance to renewable energy development, aiming at reducing its dependence on coal and other fossil fuels [11–13]. Owing to its vast territory and large physiographic diversity, China has the largest exploitable hydropower potential in the world. As the most mature sustainable technology and one of the most flexibility sustainable energy sources [14,15], hydropower is actively pursued in China with great achievement in recent years [16,17]. Its gross installed hydropower capacity has reached 280.02 GW by the end of 2013 [4], exceeding the cumulative values of the USA, Canada and Brazil which ranks just after China in terms of hydropower installed capacity [18]. With several huge hydropower stations put into operation in 2013, the newly installed hydropower capacity in 2013 is 29,930 MW which is equivalent to the total hydropower capacity of Norway, a country with the 8th largest hydropower capacity in the world [4,18].

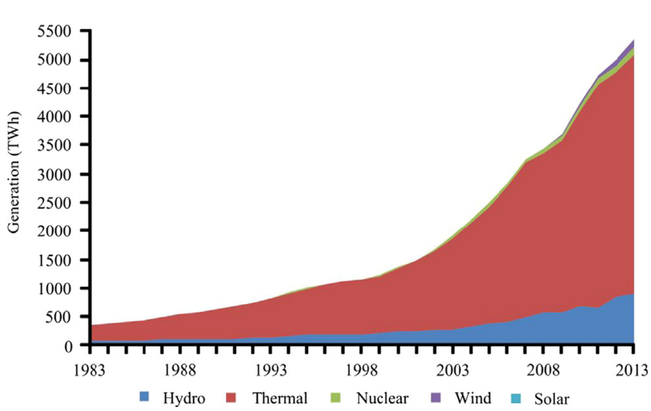

Fig. 1. Structure of electricity generation osf China (1983–2013).
Data source: [2–4]

Small hydropower (SHP) is a kind of renewable energy with no pollution, mature in development, reliable and flexible in operation, easy to maintain and financially competitive [19–22]. With these advantages, SHP becomes a favorable energy source for rural and mountainous areas to get access to electricity [23–25]. In addition, SHP is the preferential project of the clean development mechanism (CDM) activity [26,27]. Hydropower accounts for up to 26% of all carbon offsets projects registered under the Kyoto Protocol's CDM, 34% of China's CDM projects, most of which are SHP stations [28]. Considering its economic, technological and environmental advantages, SHP is widely developed in China and other countries [29–36].

As the main contributor to rural electrification, SHP stations are wildly distributed in more than 1700 counties in China. They provide electricity for nearly half of the territories, one third of the counties, and a quarter of the population in China [6,37]. Furthermore, SHP plays a great role in reducing rural poverty and protecting the environment. By the end of 2013, China has built more than 45,000 SHP stations with a total installed capacity of more than 68 GW and annual generation over 200 TWh [38]. SHP is of utmost importance to both social and economic development of China nowadays.

There has been a flurry of study in SHP worldwide in recent years. Capik and Yuksel outlined the importance of SHP as sustainable energy in Turkey, emphasizing its effect on environment protection and sustainable development [20,39]. Kumar compiled a list of sustainability indicators to guide sustainable development of run of river hydropower projects in India[40]. Darmawi and Sipahutar discussed the trend of small hydropower in the future and its environment impacts, arguing that SHP will play an important role in rural electrification in remote areas in the coming decades [41]. Panić and Urošev paid special attention to the prospects for the development of SHPs in Serbia. They indicated some administrative and financial problems that hinder the development of SHP and provided some suggestions [42]. Kaunda pointed out that SHP resources can be exploited to improve national energy supply and rural electrification in Malawi, but human resource and financial constraints were the main challenges [43]. Abbasi paid attention on the adverse environmental impacts of SHP in India and advocated much greater circumspection in developing SHP [44]. Kucukali assessed the environmental risk level of SHP with a multi-criteria and gave some recommendations in SHP development and assessment in order to develop SHP in a sustainable manner [45].

So far, existing studies mainly focused on stimulating the development of SHP stations, with minimum attention paid to dispatching management of existing SHP stations. In China, the management and operation of SHP is still not effective. Improvement in management system does not keep up with the fast development of SHP, implying

Download English Version:

https://daneshyari.com/en/article/8117576

Download Persian Version:

https://daneshyari.com/article/8117576

Daneshyari.com