Renewable and Sustainable Energy Reviews 27 (2013) 585–595

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Review of Yunnan's hydropower development. Comparing small and large hydropower projects regarding their environmental implications and socio-economic consequences

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ARTICLE INFO

Article history:
Received 5 January 2012
Received in revised form
11 July 2013
Accepted 14 July 2013
Available online 7 August 2013

Keywords:
Hydropower development
Large dams
Small hydropower hubs
Power transmission
Yunnan/China

ABSTRACT

The PR China has been very fast developing its energy sector in order to sustain its impressive economic growth. China's installed hydropower capacity is not only the highest in the world; it also shows a globally unique dimension in growth and dynamic. The southwestern province of Yunnan has one of the highest hydropower potentials within China. Its development makes the province one of the key suppliers of electric energy in China, supplying the economic and energy hungry load centers of coastal China but also Southeast Asia. In a decade Yunnan will have an installed hydropower capacity that exceeds that of Canada or the United States. The province is therefore often referred to as China's forthcoming (hydro-) powerhouse or as Asia's battery.

Yunnan's rapid development is mainly based on large and prestigious hydropower projects along major rivers, often forming large reservoirs. Secondly it rests on centers of small hydropower development. They are based on small (sub-)catchments where SHP stations mostly form cascades of diversion type projects affecting entire watersheds. Both developments are creating hydroscapes. While Yunnan's large scale hydropower development is relatively well studied, there is an obvious research gap on Yunnan's small hydropower sector. But the latter has not only a huge relevance it also causes serious tangible cumulative implications.

This rapid expansion of Yunnan's hydropower sector takes place in one of the most biologically, geographically and ethnically diverse regions in China. This creates a large need for careful management in order to avoid potentially significant environmental and social conflicts. Therefore the article shows the current status of Yunnan's ambitious hydropower development program including its political frame. It critically analyses the environmental and socio-economic consequences of both large and small hydropower projects. It further describes the transboundary implications and the relevance of the power grid.

Contents

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http://dx.doi.org/10.1016/j.rser.2013.07.023

1. Introduction

PR China's GDP growth has been the highest in the world for years. The rapidly growing economic development is inevitably accompanied with an increasing demand for energy in general and electric power in particular. China has been fast developing its energy sector in order to sustain its impressive economic growth and provide electricity for the most populated state.

The challenge of the rapidly growing energy and power sector in the 21st century is unique worldwide. A key issue within the present and future energy sector strategy is to generate and supply electrical energy for the rapidly growing economy and urban population, as well as mitigating carbon emissions. Finding a proper solution for this energy bottleneck will determine the economic, social and sustainability future of China.

In 1980, in the early years of China's economic liberalization, it had merely 66 GW of installed capacity, today it has 1139 GW globally the largest capacity (see Fig. 1). This extremely fast growth is unparalleled in the world. Presently, China adds a new installed capacity in less than two years that is comparable to the entire installed capacity of a strong West European economy like Germany or France. Despite this strong growth, China's power sector faces temporary cyclic shortages. The latest were in 2002–2005 and in 2010–2011.

With the breakup of the former Chinese Ministry of Energy in 1997 and the subsequent State Power Corporation in 2002, Chinese power generation was separated from the grid but also from the project planning. As a result of these reforms, large state owned holdings emerged in their field. These holdings control about half of the Chinese power market and are becoming increasingly active on a global scale.

China's primary energy resource is still coal. About two third of the installed capacity is thermal power (mainly coal, but also gas and petroleum); its share in the energy production output is even higher. Although China's coal use grows fast and steadily, over the last years the country closed about 77 GW of old, small or inefficient thermal power plants. Aside from the massive development of thermal power stations, China is seriously working in diversifying its power mix and reducing the ratio of carbon emissions.

These developments place regenerative energy, mainly hydropower, in a prominent role in China's present and future energy sector strategy. China has an ambitious target of meeting 15% of its primary energy demand with renewable energy by 2020. This share should be increased to 20% in 2030. In that scenario the role of hydropower in power generation is substantially greater than any other renewable energy technology.

Therefore, the present growth and dynamic of China's hydropower sector is in a dimension which is globally unique. In 2012 an immense 249 GW were generated by hydropower (see Fig. 1). In the global context China ranks first and has by far the highest installed hydropower capacity and the largest annual growth. These 249 GW are so high that it exceeds the cumulative installed capacity of the USA, Canada and Brazil, which rank directly behind China (see Fig. 2). Over the last years China added in average between 15 and 20 GW/year in new hydropower capacity [1].

Within China, the province of Yunnan, plays a key role in its future hydropower scenario. Yunnan has been implementing >90 GW of hydropower, of which currently almost half is installed. At present makes Yunnan one of the largest hydropower generating regions worldwide. Additional Yunnan has an unique geographic and geopolitical setting. It is characterized by its unique bio-, geo- and ethnic diversity as well as by its six important basins, four of which are international. These unique features have caused a special scientific interest in Yunnan's hydropower development [1–5].

We aim to analyze three major objectives. First, we study the present state of Yunnan's specific and unique hydropower development. Second, we compare social and environmental

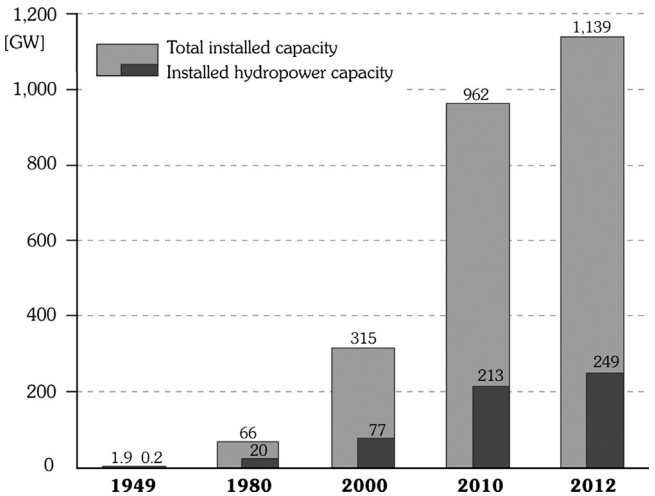

Fig. 1. Growth of China's installed power and hydropower capacity (selected years).

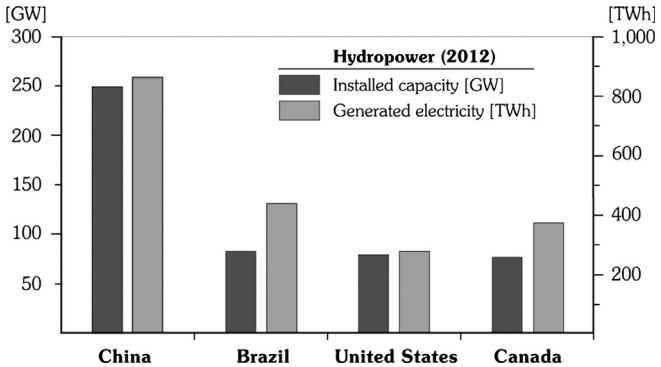

Fig. 2. Comparison of the installed capacity and generated electricity of the four leading hydropower nations in 2012.