Energy Policy 108 (2017) 645–656

Contents lists available at ScienceDirect

Energy Policy

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

Will recent boom in coal power lead to a bust in China? A micro-economic analysis

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ARTICLE INFO

Keywords:
Coal power
LCOE
Project financial appraisal
China

ABSTRACT

In this paper, by adopting the levelized cost of electricity model and the financial appraisal method, we provide an economic interpretation for China's recent coal power bubble under weak demand growth. The study surveys the economics of a typical 600 MW newly-built pure condensing coal-fired power plant in six case provinces (Shanxi, Inner Mongolia, Xinjiang, Hebei, Jiangsu and Guangdong), where the profitability margins of coal power are above national average by the end of 2015. Results indicate that the continuous falling in coal prices have lowered the generation costs but there has been insufficient adjustment to the benchmark on-grid tariff, enabling coal power to obtain unprecedented excess profits. Such excess profits have spurred the investment and caused local government to over-rely on coal power under economic downturn. However, in the context of cost escalation by deteriorated operation efficiency, higher environmental and climate change compliance costs and fierce market competition, the profitability of coal power will dissipate soon. Integrated power capacity plan consistent with the new economic normal, stringent control on the scale of new coal power projects and deep power market reform are the key policy implications of our analysis.

1. Introduction

With a 2.3% reduction in thermal power generation and only 0.5% growth in total electricity consumption, China's new addition of coal power capacity in 2015 is incompatibly high at 52 GW (CEC, 2016a). Regarding the operation efficiency and profitability of coal power, the paradox is also self-evident. The annual utilization hour of thermal power was only 4329 h in 2015, down by 410 h as of 2014 level, and hit the lowest record since 1969 (CEC, 2016a). But in term of profitability, coal power sector appears to take advantage of the apparent imbalance between coal price and on-grid benchmarking tariff to continue to reap high profits, reaching a history record since 2000s (Polaris Power Net, 2016). In China, the on-grid tariff levels of coal power are strictly regulated by the central government, although coal price is largely determined by market force. Though a co-movement mechanism to adjusting on-grid tariff had been formulated by National Development and Reform Commission (NDRC) since 2004 and updated three times since then, it was only loosely and arbitrarily implemented (Polaris Power Net, 2016; NDRC, 2015a, 2015b).

It seems that the interest of generation companies in investing new coal power projects is strong. A recent study by Greenpeace and CoalSwarm (2016), indicating that there is currently approximately 73–79 GW capacity under construction, which collectively represents significant growth compared to the new installation in the previous year. Such a discord in supply and demand is further illustrated by the project scale under the Environment Impact Assessment (EIA) approval announced by either Ministry of Environment Protection or its provincial counterparts in 2015. The total capacity amounted to 169 GW, among which 159 GW have been granted or pre-granted the EIA approval (Yuan et al., 2016b). This represents a significant increase when compared with the total EIA-approved capacity for the same period in 2014—which was 48 GW (Greenpeace, 2015).

The energy ministry, National Energy Administration (NEA) (NEA and NDRC, 2015), declared to establish lump-sum control on new projects approved by provincial governments with an integrated national power planning and strengthen ex post facto regulation. However, the de facto inaction lasting for at least one year had led to a rush in approving and investing in new coal power projects. Finally, NDRC (2016) and NEA (2016) stepped in by issuing a document to urge local governments and generation enterprises to slow the pace in

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http://dx.doi.org/10.1016/j.enpol.2017.06.035
Received 18 September 2016; Received in revised form 3 May 2017; Accepted 15 June 2017
Available online 22 June 2017
0301-4215/

building new projects in April. However, according to the most recent new installation data in the first half of 2016 (21.5 GW), it looks that such a brake is not 'hard' enough to slow down the pace of new installation (CEC, 2016b).

Although thermal power is in the best economic performance since the downturn of coal price from 2014, the sector's profitability is not necessarily "good for every enterprise", and discrepancies are apparently there. In 2015, the thermal power utilization hours of Yunnan, a province well-known for its rich resources in hydropower, was recorded at only 1879 h, while utilization hour in Sichuan was 2682 h. Additionally, in Gansu, a province rich in renewable energy resources less than 3800 h of annual utilization was recorded, while Jilin documented with only 3300 h. In these provinces, the coal power sector fell below the break-even point more rapidly than in other areas. The industry institution, CEC, expressed its deep worry on the profitability of coal power sector by issuing a report in March of 2016 (CEC, 2016c). NEA (2016) subsequently issued a pre-warning mechanism, which is consisted of an economic warning indicator, a capacity adequacy indicator and a resource constraint indicator. The first pre-warning is for new projects that will be commissioned by 2019. With "red","orange" and "green" as the composite reading, result shows that the alert status of 28 provincial grid regions are rated as "red", and only Jiangxi, Anhui and Hainan Province are rated as "green", while Hubei Province is in the "orange" status. For capacity adequacy indicator, results show red alert for 24 provinces, that is only Jiangxi, Anhui, Hainan, Southern Hebei, Sichuan and Yunnan obtain "green" pre-warning. For the economic warning indicator, 14 provinces are given red alert, while the remaining 17 provinces, including five case provinces in our study (Inner Mongolia, Hebei, Xinjiang, Zhejiang and Guangdong) are read as green. Our economic analysis will show that, when considering all the pertinent factors, such warning results are actually misleading. In a sense, our study can provide a strict economic perspective on how to construct economic warning for the new coal power projects.

Though the future of coal in China's primary energy supply has been extensively discussed in literature (see for example, Yuan et al., 2012, 2014; Hao et al., 2015; Tang et al., 2015; Tang et al., 2016; Zhang et al., 2016; among others) and its declining role has been confirmed, academic inquiry on the role of coal in China's power system is surprisingly rare and has yet to reach a consensus. Na et al. (2015) and Hui et al. (2016) analyzed the penetration potential of clean coal power without addressing the overall role of coal power in China's power generation mix, while Yuan et al. (2016b, 2016a and 2016c) highlighted the prospective of overcapacity and identified peak capacity and peak coal use for power generation in China by 2020. In addition, China's industry development under energy policy regulation, environmental constrains and uncertainty in commodity price is an interesting field. See for example Zhang (2012) on an empirical study on the impact of government target and electricity price on industrial enterprises' progress of energy efficiency and Zhang et al. (2016) on a study in rare earth industry. However, none study has addressed China's coal power sector in this perspective.

This paper adopts the levelized cost of electricity (LCOE) model and the financial appraisal method to systematically explore the economics of a 600 MW newly-built pure condensing coal-fired power plant in six case provinces under multiple scenarios. The layout of the paper is as follows. Section 2 presents the methodology of the study. Section 3 reports the results and provides relevant discussion. Section 4 addresses policy implications and concludes the paper.

2. Methodology

2.1. LCOE estimator

Projection of the economy of coal power firstly necessitates the estimate of generation cost and its dynamics. LCOE refers to the costs of electricity per kW h of power generation during the entire operation period and is a widely recognized and highly-transparent calculation method for electricity costs (Branker et al., 2011). This paper will calculate the LCOE by calculating the percentage between the present value of total costs and expenses from initial construction to operation and the economic time value of the energy output during the life time of a 600 MW coal-fired plant project. A 600 MW unit is chosen as the study objective because currently in China 600 MW ultra-supercritical (USC) unit is the mainstream model of new installation. The derivation process is as follows:

The value of each known future period (F) is lower than the value of current period (P), and the discount rate (r) shall be used to measure this difference, i.e.:

$$P = F(1+r)^{-n} \tag{1}$$

And NPV is the set of present value of different periods, which usually refers to revenues a project earn during its life time. The definition of LCOE comes from the identical equation (revenues' NPV equals to costs' NPV), that is:

$$\sum_{n=0}^{N} \frac{Revenues_n}{(1+r)^n} = \sum_{n=0}^{N} \frac{Cost_n}{(1+r)^n} \tag{2}$$

$$NPV = \sum_{n=0}^{N} PV = 0 \tag{3}$$

$$\sum_{n=0}^{N} \frac{(LCOE_n)\times(E_n)}{(1+r)^n} = \sum_{n=0}^{N} \frac{Cost_n}{(1+r)^n} \tag{4}$$

$$LCOE = \left(\sum_{n=0}^{N} \frac{Cost_n}{(1+r)^n}\right) / \left(\sum_{n=0}^{N} \frac{E_n}{(1+r)^n}\right) \tag{5}$$

Based on the above formula (1)-(5), the complete calculation method of LCOE can be inferred as formula (6):

$$LCOE = \left(\sum_{n=1}^{N} \frac{(CAPEX_n + OPEX_n + TAX_n)}{(1+r)^n}\right) / \left(\sum_{n=1}^{N} \frac{(C\times H\times(1-o_u))_n}{(1+r)^n}\right) \tag{6}$$

Where,
$CAPEX_n$: annual value of the costs of initial investment, including proprietary funds, loan and depreciation;
$OPEX_n$: annual value of operation and maintenance costs, including fuel, operation and maintenance costs, insurance premium, and labor costs, etc.;
TAX_n: annual payable taxes of the plant, including VAT, income tax, education surcharge, urban maintenance and construction tax and land use tax, etc.;
C, installed capacity; H, annual utilization hours; o_u, auxiliary power consumption rate; N, operation years of the plant; r, discount rate.

2.2. Project financial appraisal

Appraising the economics of new coal power involves project financial appraisal. It is an economic appraisal method that analyzes the investment, costs, revenues, taxes and profits of the engineering projects under existing accounting system, tax regulations and price system of the State (Fu and Quan, 1996). It involves a study of the profitability, solvency and financial viability of the project after being put into operation, and makes judgment upon the financial economics of the project based upon such an appraisal. In addition to specifying the value of the engineering project to the financial entity and the contribution to investors, the project financial appraisal also provides a basis for investment and financing decision-making. The composition of funding sources, the method of repayment of lending capital and other factors will affect the cash flow, which, in return, affects the