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Biopower from direct firing of crop and forestry residues in China: A review of developments and investment outlook

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ABSTRACT

This paper reviews developments in the direct-fired biomass power sector and provides an up to date investment outlook by calculating the Net Present Value of new investments, and the appropriate level of Feed-in-Tariff needed to stimulate future investment. An overview is provided of support policies, historical growth in installations, and main market players. A number of data sources is combined to build a database with detailed information of individual biopower projects. This data is used to describe technological and market trends, which are used in a cash flow model to calculate the NPV of a typical project. The NPV for new projects is estimated to be negative, and investment should be expected to stall without proper policy intervention. Increasing fuel prices, local competition over biomass fuel resources, lower than expected operational performance and a downturn in carbon markets have deteriorated the investment outlook. In order to ensure reasonable profitability, the Feed-In-Tariff should be increased, from the current level of 90.9 € MWh^{-1}, to between 97 and 105 € MWh^{-1}. Where possible, government organizations should help organize demand for the supply of heat. Local rural energy bureaus may help organize supply networks for biomass fuels throughout the country, in order to reduce seasonal and local fuel scarcity and price fluctuations.

Abbreviations: CDM, clean development mechanism; CER, certified emission reduction; CF, capacity factor; CFB, circulating fluidized bed; CHP, combined heat and power; FIT, feed-in-tariff; GHG, greenhouse gas; MOA, ministry of agriculture; MSW, municipal solid waste; NBE, National Bio Energy Co., Ltd.; NDRC, National Development and Reform Commission; NPV, Net Present Value; VAT, value added tax.

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1. Introduction

China has ambitious development plans for renewable energy, with an overall target of 15% of primary energy from renewables by 2020, and strong growth in renewable power generation [1]. Chinese installations of renewable forms of power have in recent years grown to be the world's largest [2], with particularly rapid increases in wind and solar PV installations (Table 1).

This development has been the subject of much research, with analysts looking into the role of e.g., the institutional framework [3–6], financial parameters of renewable power projects [7–10], and technological capabilities in the equipment manufacturing industry [11–15]. By comparison, biomass power has grown less rapidly (Table 1), and has received less attention, in particular concerning technological and financial parameters. A small number of analysts have previously commented on the cost and required subsidy levels for biomass power in China. These have been rather rough estimates [16,17] or, as we will demonstrate, require an update against recent developments in technological and financial parameters [17,18].

This paper describes the recent development of China's biopower sector, focusing on developments in technological and financial parameters. These parameters are used to calculate 1) the Net Present Value of current investments in a typical Chinese biopower project, and 2) minimum levels of Feed-In Tariffs required to keep Net Present Value positive. Results of this exercise highlight low returns and high risks associated with current investment in biopower projects in China, explaining at least in part the relatively slow development of this form of renewable power.

This analysis is focused on 'crop and forestry residue based' biopower, a categorization used in Chinese policy to set it aside from biogas and MSW based forms of biopower. This is the largest form of biomass power in China, both in terms of current installations, and in future policy targets (Table 1). It is further focused on grid-connected applications ('main activity producers') as opposed to the in-house use of biopower ('autoproducers'). The latter type consists of numerous, small scale boilers, on which limited data is available. It is further not covered by government subsidies, nor is it expected to increase substantially in the foreseeable future [16,19]. Lastly, it is focused on direct-fired applications and ignores gasification, as grid-connected gasification is estimated to make up a few dozen MW at most [19]. For more information on these other technological pathways, please see the overviews provided by Zhao and colleagues [16] or the ERI [19].

2. Method

The economic desirability of a project can be evaluated using the Net Present Value method. This entails summing up positive and negative cash flows arising from the project. The cash flows are calculated on an annual basis, with future cash flows discounted to give their equivalent present value. The decision to invest is made when Net Present Value is at least zero. At this level, the internal rate of return (IRR) is equal to the discount rate [20].

Although the minimum IRR required for an investment to occur usually depends entirely on investor preference, Chinese regulations on investment in the power sector has set a benchmark IRR of 8% (post-tax) as feasible and reasonable [21] and this value is used to discount cash flows in the NPV estimation here. Project cash flows include investment, operational cost, production level, revenue and tax levels.

The proper (range of) values to be used in the NPV estimate have been determined through 3 data collection steps; 1) a review of policy documents and scientific literature on China's biopower sector; 2) compilation and analysis of a detailed database of individual Chinese biopower projects, followed by 3) a round of expert interviews correct or verify and enrich preliminary results from steps 1 and 2. A total of 19 experts were interviewed, including 7 academics, 2 market analysts, 5 representatives from industry and 5 representatives of government organizations.

The database of biopower projects in China (appended as Supplementary material) was compiled from the following data sources:

1. CDM applications

A large majority of Chinese biopower projects has applied for registration as a Clean Development Mechanism (CDM) project. Applications are publicly available [22] and include information on location, developer, capacity, boiler brand and

Table 1 – Chinese renewable power capacity (MW), actual and targets, 2000–2020.

	2000	2005	2010	2015	2020
Wind	340	1,260	44,781	100,000	200,000
Solar	19	70	800	35,000[a]	50,000
Biopower (all), of which:	1,100	2,071	4,952	13,000	30,000
Crop and forestry residues based[b]	1,000	1,741	3,452	8,000	24,000
Biogas based	0	30	1,000[c]	2,000	3,000
MSW based	100	300	500[c]	3,000	3,000
Total, non-hydro renewables	459	3401	50,553	148,000	280,000
Total, all forms	319,320	517,180	966,410	1,465,000[d]	1,750,000[d]
Non-hydro renewables (% of total)	0.14%	0.65%	5.23%	10.1%	16.0%

Notes: grid-connected capacity only; a) the 12th Five Year Plan originally included a 21 GW target for solar; this was increased to 35 GW in early 2013 [78]; b) includes bagasse power; c) target rather than actual; d) forecast rather than target.
Sources: wind power: [57]; biopower: [16,55]; solar PV: [79]; totals: [55]; 2015 and 2020 targets: [1,80].