Energy Policy 87 (2015) 347–358

Contents lists available at ScienceDirect

Energy Policy

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

Valuing carbon assets for high-tech with application to the wind energy industry

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HIGHLIGHTS

- Carbon asset dimension for high-tech evaluation.
- Valuing wind energy technology by Weibull distribution.
- Greater impact of the carbon sink price on the carbon asset value than that of production output.
- The environmental risk could be measured based on the carbon asset assessment.

ARTICLE INFO

Article history:
Received 27 April 2015
Received in revised form
17 September 2015
Accepted 18 September 2015

KeyWords:
Carbon assets
Value assessment
High-tech
Carbon emissions
Wind energy
Weibull distribution

ABSTRACT

In contrast to the traditional methods for high-tech evaluation, we introduce a new, more active idea for considering the carbon asset effect, in addition to the economic and technological considerations for strategic significance. The method proposed in this paper considers a reduced amount of carbon emissions, less than that of the current industry baseline, to be an asset that is beneficial to a firm that adopts a new technology. The measured carbon asset values vary across different technologies, in different industries and over time. The new method is applied to the valuing of wind energy technology and uses the Weibull distribution to estimate the wind energy capacity and a concrete sensitivity analysis. These applications support the validity of the new method and show that the impact of the fluctuations of carbon sinks on the values of carbon assets is significantly greater than that of volatility in the production output. The paper also presents some policy recommendations based on the results.

1. Introduction

The global energy crisis and environmental issues have driven the development of the high-tech sector. In addition to traditional attributes, such as physical function and economic efficiency, the effects of this new environment should be considered as an assessment criteria for technologies in an attempt to meet the emerging and strategic requirements. Therefore, we should reconsider the existing methods and develop a new type of methodology for technology assessments.

The evaluation methods of effects on an industry have undergone a lengthy development. Different methods related to high-tech evaluation have gradually developed. In 1976, the establishment of the Office of Technology Assessment in the United States introduced an official and normative evaluation process. Currently, a technological evaluation system that conducts a comprehensive and systematic analysis of new technologies and weighs their pros and cons before production could help companies make reasonable choices.

Technological assessment is divided into three parts: informative technological assessment, strategic technology assessment and constructive technology assessment (CTA) (Schot, 1992). Among these parts, CTA focuses on technologically escalating internal guidance, and it examines the impact of complexity and policy guidance during the development of new technologies (Schot, 1992). It has concluded that technological assessment can play an important role in increasing the social and economic returns on investments in the development of advanced technology (Smits et al., 1995). On this basis, Guston and Sarewitz (2002) combined the hybrid method of engineering investigation with social sciences to present real-time technology assessment, which focuses on the predictability of planning and directing technology development. They emphasized that real-time technology assessment is indeed necessary because perfect planning and foresight are illusory.

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http://dx.doi.org/10.1016/j.enpol.2015.09.025
0301-4215/© 2015 Published by Elsevier Ltd.

From a review of the research results in the field of technological evaluation, it can be observed that the traditional evaluation of advanced technology has had two functions: one is warning, by which it can predict the adverse effects caused by advanced technology and adopt appropriate methods to weaken or eliminate these effects; the other is strategic policy guidance, during which various interest groups discuss possible impacts. Although traditional technological evaluation has briefly considered the environmental effects of advanced technology, it has not provided specific methods and tools for assessment.

Currently, emissions of carbon dioxide have been undergoing significant increases worldwide, and at the same time, low-carbon economic principles and sustainability have already become important indicators of business technology promotion. Traditionally, technology evaluations have focused more on the technological and economic effects brought by technological advancement. Hence, when determining how to conduct a risk assessment for certain technology, decision-makers would be inclined to consider the company's overall strategic policy and to ignore low-carbon principles. Different scholars have held different opinions about the evaluation of carbon assets. Chevallier (2009) surveyed the empirical relationships between the returns on carbon futures and changes in macroeconomic conditions. The results suggested that, compared with stock and bond markets, the carbon trade market is only remotely connected to the macroeconomic environment, and it is more closely related to the fuel-switching behaviors of power producers. Bredin et al. (2014) used high-frequency data to assess the degree of development of the EU Emissions Trading Scheme in the futures market, and they indicated a negative contemporaneous relationship between trading volume and volatility, drawing the conclusion that liquidity traders dominate any role played by informed traders. Jenkins (2014) reported that traditional polices, such as carbon taxes, emissions caps and permit trading, would result in opposition to the industrial sector, causing mitigating effects on the entire industry, agency failures and other consequences. Therefore, as Jenkins (2014) said, the presence of combining political and economic constraints has created "a significant 'opportunity space' for the design of creative climate policy instruments with superior political feasibility, economic efficiency and environmental efficacy, relative to the constrained implementation of carbon pricing policies". Until now, all of the research related to carbon asset values has only concentrated on macroeconomic principles and has not yet involved the level of individual businesses. Conventional macroeconomic analysis of carbon emissions concentrates mostly on the overall impact on society, such as carbon taxes, emissions caps and permit trading. However, it scarcely motivates individual businesses to reduce carbon emissions. It is hoped that the status will be resolved with our proposed method. Enterprises regard carbon assets as a part of their properties to obtain benefits. Emissions of corporations with more advanced technology are inferior to the baseline level of industrial carbon emissions. The more carbon assets they own, the more profits they gain. The paper alters analytic perspective from the macro level to the micro level. It is more practical for individual businesses to cut carbon emissions. In addition, based on carbon asset valuation, the government and financial institutions can enact incentive mechanisms for companies to promote technological update for carbon emissions.

Compared with traditional, conservative methods, we introduce new, more active ideas for carbon asset evaluation. This paper attempts to assess environmentally friendly advanced technologies in their carbon asset dimensions, and it comprehensively measures the strategic significance of advanced technologies for enterprise development from three dimensions—the economic, the technological and the carbon asset dimensions—as shown in Fig. 1. In light of specific measures to affect the wind industry and with application to the effects of the wind industry, the paper seeks quantifiable evaluation indicators and then defines variables and builds system dynamic equations to calculate the carbon asset values of wind energy technology. The paper also predicts the values of carbon assets by Weibull distribution, based on data on the wind velocity and CER (Certification Emission Reduction) settlement prices of the European Climate Exchange from 2011 through 2013.

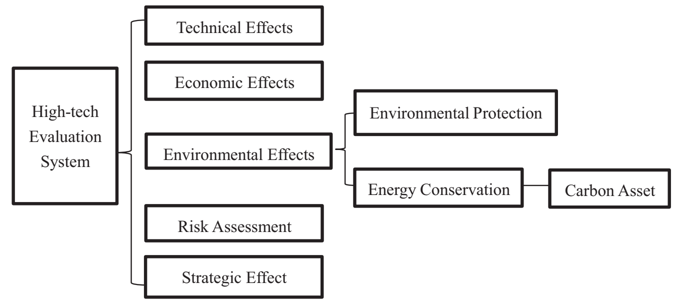

Fig. 1. High-tech Evaluation System.

The remainder of this paper proceeds as follows. Section 2 proposes a carbon asset assessment model and presents a general sensitivity analysis method. Then the model applies to the wind power technology by Weibull distribution. Section 3 values the carbon assets of wind energy technology using Weibull distribution to describe production capacity. In this section, we analyze the benefits that high-tech wind power brings to enterprises from its carbon asset dimensions, and we use sensitivity analysis to determine the extent of impact of two variables in the model. Section 4 discusses the carbon asset evaluation from five respects. Section 5 ends the carbon asset assessment model and offers some policy recommendations.

2. Methods

2.1. Carbon asset evaluation

With the rapid development of the international carbon trading market, carbon assets have gradually become an important part of corporate assets. The innovation of this paper is to propose a carbon asset evaluation for advanced technology, and it concludes that the superiorities of advanced technology lie not only in its new features and high economic efficiency but also in its carbon asset attributes.

In many studies, the carbon asset concept has been elaborated on from different angles, resulting in carbon emission reduction. Lin (2010) defined carbon assets as objects with value attributes, which can embody or hide in all fields of low-carbon economies and are suitable for the storage, distribution, or wealth conversion of tangible and intangible assets. Therefore, carbon assets include not only present assets but also future assets; it includes CDM (the Clean Development Mechanism) asset and appreciation calculated by the YOY (year-on-year) and MOM (month-on-month) methods due to the implementation of a low-carbon strategy. Bigsby (2009) expanded on the scope of carbon assets, allowing for all natural resources that can store carbon, such as forests, to constitute a part of carbon assets. Wan et al. (2010) considered narrow carbon assets to be resources that can bring economic interests to enterprises by maintaining the amount of greenhouse gases emitted into the atmosphere at less than the baseline required by the government. Hence, enterprises should support projects that reduce greenhouse gas emissions. Carbon emissions therefore act as an intangible property with the nature of an asset from the