Renewable Energy 87 (2016) 279–288

Contents lists available at ScienceDirect

Renewable Energy

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

Incentives for wind power investment in Colombia

Javier Contreras [a], Yeny E. Rodríguez [b, *]

[a] University of Castilla-La Mancha, E.T.S. de Ingenieros Industriales, 13071 Ciudad Real, Spain
[b] ICESI University, Financial and Accounting Department, Cali, Colombia

ARTICLE INFO

Article history:
Received 24 June 2014
Received in revised form
26 September 2015
Accepted 11 October 2015
Available online 24 October 2015

JEL Classifications:
G28

Keywords:
Decentralized level
Wind power
Bilevel programming
Auctions
Moral hazard

ABSTRACT

This paper develops an energy policy measure for renewable sources in Colombia, in particular wind generation. The proposal is done at the decentralized level, in isolated areas of the country, where electricity coverage is below 12% and wind speed is suitable for power generation. The goal of this policy is focused on increasing electricity coverage in those remote areas of the country that have high winds in order to develop clean generation investments that can represent a benefit for low-income users. Thus, a mechanism for financing these kinds of investments is proposed, involving the private sector and using the mechanism known as Public Private Partnerships – PPPs. PPPs are mechanisms used by the public sector to establish a contract with the private sector. The private sector provides capital and ability to develop projects, while the public sector holds the responsibility in service delivery. To model the relationship between public sector and private investors, a bilevel programming method for efficient resource allocation, combining an auction mechanism and moral hazard, is presented. A case study is shown in the Colombian context.

1. Introduction

The development of new technologies and fuel price uncertainty have motivated the search for an energy portfolio of minimum cost and risk, to improve energy security and reduce CO_2 emissions. These energy portfolios include the participation of renewable sources as stated by Refs. [4] and [32]. Among the fastest growing renewable technologies worldwide, wind is prevalent. In 2012 wind power capacity in the world increased by 45 GW, for a total of 282 GW installed. Wind power electricity production accounted for 2.5% of the global electricity demand (IEA, 2013).

In literature, the discussion of the biggest share of renewables in the energy mix has focused on measures to define an acceptable penetration level and determine regulatory instruments to encourage their use. The number of countries that had some type of policy to promote the use of renewable energy increased from 48 in 2005 to 109 in 2012. This was motivated primarily to reduce CO_2 emissions and dependence on fossil fuels [22].

The Latin American case is different. Few countries (Chile, Argentina, Brazil, Peru, Mexico and Uruguay) have policy measures which promote the use of renewable energy [3]. In the particular case of wind energy, the absence of regulation and incentives and the abundance of resources, such as water and coal, stand out as major barriers to the development of this technology in Colombia [26].

Regarding how to implement policy measures that promote renewable energies in an effective way, the two most important factors are: i) definition of clear policies by governments and ii) regulatory stability for market participants (investors and utilities) [22]. However, it must be noted that the use of renewable energies, in particular wind energy, will not reduce the need for conventional power plants. This is because the demand for electricity is continuous, and wind power is intermittent and more expensive to produce most of the time, making it difficult to store on a large scale. Also, according to [33]; electrical system integration of intermittent power at levels of penetration below 5% does not have a significant impact on system reliability.

1.1. Electricity generation in Colombia

In Colombia, the market architecture is centralized and is characterized for having a market operator (XM) responsible for managing market bids and subject to the technical constraints of the system.

* Corresponding author.
E-mail addresses: Javier.Contreras@uclm.es (J. Contreras), yerodriguez@icesi.edu.co (Y.E. Rodríguez).

http://dx.doi.org/10.1016/j.renene.2015.10.018
0960-1481/

In December 2012 the generation resources that were connected to the National Interconnected System (NIS) had a hydraulic capacity share of 63.65%, followed by thermal (31.43%), and other minor sources, with a share of 4.92%. In particular, wind power represented 0.15% of the installed capacity [40]. These figures reflect the emerging use of non-conventional energy sources (NCES) in Colombia and their lack of diversification of energy sources.

Regarding costs, wind technology costs are higher than the ones of conventional technologies [15] and [16], however, in some isolated areas of Colombia the most abundant resource is wind.

In Colombia, the efforts to define a policy and regulatory incentives by Congress have been focused on defining different mechanisms such as FAZNI (Fondo de Apoyo Financiero para la Energización de las Zonas No Interconectadas), FAER (Fondo de Apoyo Financiero para la Energización de las Zonas Rurales Interconectadas), PROURE (Programa de uso racional y eficiente de energía y otras fuentes no convencionales de energía), tax exemptions and reliability charges. In spite of the existence of these funds there is no definition of promotion mechanisms to achieve these goals.

1.2. Literature review of mechanisms to encourage the use of renewable energy

Mechanisms to promote the use of renewable energy gained close attention in the power sector, a detailed literature review is presented in Ref. [27] According to these authors the mechanisms can be classified into price- and quantity-based.

1.2.1. Mechanisms based on prices

Public authorities manage prices when offering subsidies to encourage activities that are valuable from a public perspective but not adequately supported by consumer demand [41]. Mechanisms based on prices provide economic incentives, which can be given in the form of extra payments or guaranteed rates (Feed in Tariff – FiT), guaranteed premiums (Feed in premium – FiP), tax incentives, investment and financing incentives, exemptions of fees, and allocation of subsidies in a competitive way.

FiT guarantees a specific price for each kWh that is generated from renewable energy, including subsidies. This mechanism is guaranteed from 10 to 30 years, and the amount may depend on technology, plant size or capacity factor [27].

FiP consists of a guaranteed payment to renewable generators in the form of premiums or bonds that are above existing electricity market prices [24], which changes with the time. Similar to FiT, this is a long-term payment as well and the premium may depend on the facility characteristics [27].

Tax incentives are options used by governments in order to reduce the cost of financing from investors. The ones which have been widely used are: i) accelerated depreciation, ii) fuel taxes, and iii) tax exemptions.

Investment subsidies have been granted to renewable energy technologies, offering down payments that depend on the total installed capacity.

Financing incentives refer to loan programs with interest rates below the rates that are used in the market.

Payment exemptions have been implemented in markets where the fee is disaggregated.

1.2.2. Mechanisms based on quantities

The purpose of mechanisms based on quantities is to increase the production of energy from renewable sources. The two basic types of quantity mechanisms are: tradable green certificates and renewable energy auctions [27].

Tradable green certificates work as tradable quotas, which are set by the regulator, who establishes which agents have to meet renewable energy commitments. These commitments are represented by certificates of purchase or production of renewable energy. These certificates can be traded in a secondary market, and they are usually awarded per unit of electricity produced with renewable sources. The agents that participate in the certificate market may buy certificates from renewable producers, where a penalty must be paid in case of non-compliance, which represents the maximum cost of the certificate. Sometimes, a minimum cost is established in order to guarantee the profitability of renewable facilities [27].

Auctions are other quantity-based mechanisms but with some of the advantages of price-based mechanisms, therefore, it is halfway between these two mechanisms [27]. Renewable energy auctions are defined by the regulator, who establishes a demand for a certain technology and sets up the price and volume to meet the demand. The regulator guarantees the winner the price reached in the auction through a long-term contract [27]. In this way, long-term contracts can make the expansion in generation relevant and sustainable [7].

1.2.3. Comparison of mechanisms

In developed countries, price-based mechanisms dominate in order to encourage the use of renewable energy. In this case, FiT prevails, presenting lower costs compared to FiP [37] and [30]. This approach has been unsuccessfully used in South America.

Other mechanisms that have been used for promoting renewables are the auctions applied in Brazil, Argentina, Peru, Uruguay, Ontario (Canada) and California (USA), and financing incentives granted by multilateral agencies in countries like Chile and Brazil [2]. The use of tax incentives has been less frequent in countries like the United States, Finland and China [28], but they are present in several countries (also in Colombia and other Latin American countries) and are used in parallel with other schemes.

The quantity-based mechanism has been used by few developed countries (United Kingdom, Italy, Sweden, Belgium, Poland and Romania) and by few South American countries, in particular Chile [41].

Currently, developed countries are offering FiT schemes combined with auctions to support less mature renewable technologies or small-scale renewable projects [6].

1.3. Literature review on allocation of investment projects

When the government requires an infrastructure project, it usually sets a bidding process, inviting interested firms to make offers and selects the one with the lowest bid.

In this process, information asymmetries are observed, leading to problems of adverse selection and moral hazard. The adverse selection problem arises when the government does not know the expected cost of any firm. Moral hazard arises from the fact that the government cannot observe the ex-post effort of the selected firm that allows them to keep low production costs.

The government must design a contract to control these two problems, which would not exist if the principal (government) and the agents (firms) had the same objective function.

In literature [25], model an optimal contract between the government and a firm that makes a project for the government, assuming that both parties are risk neutral and the government has problems of adverse selection and moral hazard. The optimal strategy is obtained with an incentive contract consisting of a fixed payment, a linear announced cost and the existence of project overruns.

When there are firms that are possible candidates for a project