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Incentives for Renewable Energies in Colombia

F. Villada[1], J.D. Saldarriaga-Loaiza[1] and J.M. López-Lezama[1]

[1] Department of Electrical Engineering
Universidad de Antioquia
Calle 67 # 53-108, Medellin (Colombia)
Phone/Fax number:+0057 42198556, e-mail: fernando.villada@udea.edu.co, juand.saldarriaga@udea.edu.co, jmaria.lopez@udea.edu.co

Abstract. This work analyses the potential effects of the incentives for renewable energies approved in Colombia by two main acts. A methodology involving adjustments for tax reductions and accelerated depreciation is used to evaluate the Levelized Cost of Electricity (LCOE) for the four main clean energy resources available in Colombia. The results show important reductions in the LCOE specially, under the act approved in the development plan of the new government, where the LCOE of three technologies is below the grid parity.

Key words. Renewable energies, levelized cost of electricity, grid parity, public subsidies.

1. Introduction

New renewable energy installations have experienced rapid growth in recent years. Only in 2011, the new installed capacity of renewable energy generation, accounted for half of the total energy added capacity (about 208 million kW) [1].

These new installations have not been equally distributed across the world, because of the higher cost of the electricity generated compared with conventional plants. Countries with a larger proportion of renewable energy capacity, have implemented programs with public subsidies and other incentives to promote new projects.

The efficiency of the different incentives schemes for the development of renewable energy sources was studied in [2]; where it was concluded that a system of feed-in tariffs is more efficient than a bidding system, but highlights the theoretical interest of green certificate trading which must be confirmed though practice, given the influence of market structures and rules on the performance of this type of approach.

In recent years, renewable energy industries have received increasing support in many countries; with feed-in tariff (FIT) and renewable portfolio standard (RPS), as the most popular regulatory policies [1]. The authors of the last reference established a two-stage game model to compare the effects of these two policies. It was found out that FIT is more efficient than RPS to increase the quantity of the renewable energy installed capacity, and that RPS is more efficient to reduce the carbon emissions and to improve the consumer surplus.

The effect of FIT to promote renewable energy projects in Latin America and the Caribbean region is analyzed in reference [3], where there are found certain similarities when comparing five countries. First, most of them include a wide range of eligible technologies under their national support schemes. Second, most of the countries guarantee a tariff payment over a long period of time (10-30 years). Nevertheless, the analysis reveals that FIT policy design may not be the primary constraint to renewable energy market growth, because the policies have not resulted in a significant market response.

Solar photovoltaic (PV), as another source of renewable energy, has experienced rapid growth over the past few years. One of the reasons that explain its growth is the dramatic drop in the price of panels, as an evidence of the increasing competitiveness of this energy source. Nonetheless, skeptics attribute the rapid growth of solar photovoltaic power, primarily to generous public policies in the form of tax subsidies. In particular, there seems to be no consensus as to whether photovoltaic power is approaching grid parity [4].

Reference [4] provides an assessment of the cost competitiveness of the electricity generated by solar power, based on the concept of Levelized Cost of Electricity (LCOE) in order to identify the factors that are crucial to determine the economic viability of solar photovoltaic: geographic location of the facility, technological improvements, as well as, public subsidies in the form of tax breaks and regulatory mandates for renewable energy. It concludes that utility-scale PV installations are not yet cost competitive with fossil fuel power plants. In contrast, commercial-scale installations have already attained cost parity. This conclusion is shown to depend crucially on both the current federal tax subsidies for solar power and an ideal geographic location for the solar installation.

Factors influencing the grid parity on a country-by-country basis are analyzed in [5]. The paper accounts for both the quality of solar resource and the cost of capital in order to differentiate LCOE from solar PV. The results suggest that Northern countries may not be an unwise location to subsidize PV construction. Moreover, it suggests that the efforts to expand PV installation in developing countries may benefit greatly from policies designed to make low cost finance more widely available.

The Colombian electricity market is made up of four main markets: a spot market, the non-standardized contracts market, the AGC market, and the reliability market. Even though the high competitiveness of the electricity market, less than 1% of the generation comes from renewable energy resources.

The potential for renewable energy deployment in Colombia is estimated to be large for wind resources [6], solar PV [7], biomass [8], [9], and water resources suitable for small runs of river hydropower plants [10]. Nevertheless, the share of renewable energy in the electricity basket is still tiny due to the delay of the government for establishing incentives.

Fortunately, the Colombian parliament approved the renewable energy regulation which, encourages the construction of new clean energy projects [11]. This regulation, approved in the Act 1715 of 2014 provides a series of incentives covering income tax reduction during the first five years of operation, accelerated depreciation, and exemption of tariffs on some imported equipment; in order to make these technologies competitive with conventional power plants.

A proposed tax-adjusted LCOE to analyze the effects of the new regulation for renewable energy in Colombia is presented in [12]. The results show some restrictions for small or new business from applying for investment tax reductions during the first five years of operation. The paper proposes two complementary mechanisms to allow small business ventures.

Given the high potential of forest biomass resources in Colombia, reference [9] analyzes the effects of the Act 1715 of 2014 in their LCOE. The results show important reductions in the LCOE; nevertheless, complementary mechanisms are still necessary to achieve grid parity with these resources.

A simulation model using systems dynamics to evaluate incentives of renewable energies in Colombia for energy policy recommendations is proposed in [13]. The authors tested four incentives: tax reduction, feed-in-tariffs, tradable certificates, and technical subsidies; showing that a combined scenario using feed-in-tariffs and technical subsidies can boost their deployment, avoiding significant price increases for the final consumer.

The development plan of the new Colombian government for the period 2018-2022, approved in the Act 1955 of 2019 [14], took into account the restrictions for small or new business found in reference [12]. Specifically, it increased from 5 to 15 years the possibility of investment tax reductions.

The effects of the regulation to promote the development of renewable energies in Colombia, and the modifications approved in the development plan of the new government are analyzed in this paper. The LCOE method is used to determine the change in the cost of generating electricity from wind, solar PV, biomass and small hydro projects for different scenarios.

2. The Levelized Cost of Electricity (LCOE)

A. Definition

The levelized cost of electricity (LCOE) represents the life cycle cost per unit of electricity generated and can be interpreted as the minimum price per kWh that an electricity generation plant would have to obtain in order to break-even on its investment over the entire life cycle of the facility [4]. LCOE can be divided into the unit cost of capacity (c), the time-averaged operating fix costs (f), and the time-averaged operating variable costs (w), as shown in equation (1).

$$LCOE = w + f + c \quad (1)$$

B. Tax-Adjusted LCOE

The effects of the incentives for new renewable energy projects can be represented as a tax factor affecting the unit cost of capacity as shown by equation (2).

$$LCOE = w + f + c.\Delta \quad (2)$$

Where, the tax factor Δ takes into account the effects of incentives including the accelerated depreciation and the tax deductions that can be applied at the time of investment. This tax factor can be calculated according to equation (3) [12].

$$\Delta = \frac{1}{(1-t)}\left[1 - t\left(\sum_{j=1}^{j=T1}\frac{i_j}{(1+r)^j} + \sum_{j=1}^{j=T2}\frac{d_j}{(1+r)^j}\right)\right] \quad (3)$$

Where i denotes the investment tax credits, t is the effective corporate tax income rate, $T1$ represents the maximum number of years to apply the investment tax credits and $T2$ is the useful life of the power generating facility for accelerated depreciation purposes (in years).

3. Results

LCOE was calculated for the four main renewable energy resources available in Colombia. These technologies are solar photovoltaic (PV), wind, small hydropower (S-hydro), and forest biomass (B-forest). Table I shows the input parameters, where: Inv represents the total investment, WACC is the discount rate calculated as the weighted average cost of capital, CF is the capacity factor, FC is the fixed cost in US$/kW-year, and VC represents the variable cost in US$/MWh.

Table I. – Input Parameters

	PV	Wind	S-hydro	B-forest
Inv (US/kW)	1300	1200	2130	1650
WACC (%)	8.10	8.10	8.10	8.10
CF (%)	18.77	40.0	62.56	77.0
Lifespan (years)	25	25	30	15
FC (US$/kW-yr)	60	52	54	83
VC (US$/MWh)	0	5.80	5.00	12.00

Source: references [9], [12], [15].

A. Reference case

The reference case corresponds to the LCOE without incentives calculated for the four technologies described in table I. Table II shows the results, where small hydro has the lowest LCOE with a price below the grid parity in Colombia. The other technologies are not competitive in this case.

Table II. – LCOE for the Reference Case (US$/MWh)

Type of technology	LCOE (US$/MWh)
Small hydro	55.40
Wind	58.29
PV	123.41
Forest biomass	57.76

B. Scenario 1

In scenario 1, the tax-adjusted LCOE is calculated using equation (4), incorporating the incentives approved in the Act 1715 of 2014 and the restrictions for small business. Table III shows the results, where reductions in the LCOE is not enough for small business ventures. Only small hydro continues being competitive for them.

Table III. – LCOE for Scenario 1 (US$/MWh)

Type of technology	LCOE (US$/MWh)
Small hydro	53.20
Wind	56.24
PV	118.68
Forest biomass	55.94

C. Scenario 2

In scenario 2, the tax-adjusted LCOE is calculated using equation (4), incorporating the incentives approved in the development plan of the new Colombian government (Act 1955 of 2019). Table IV shows the results, where three of the technologies attained cost parity and only PV is still above this price.

Table IV. – LCOE for Scenario 2 (US$/MWh)

Type of technology	LCOE (US$/MWh)
Small hydro	45.43
Wind	49.03
PV	86.91
Forest biomass	49.53

4. Conclusions

Colombia has a huge potential of renewable energy resources that had no previous incentives for development, representing less than 1% of the total capacity of the system.

Restrictions in the Act 1715 of 2014, allow small business ventures to apply for only one of the incentives, then the reduction in the LCOE is not enough to attain the grid parity for this type of companies.

The development plan of the government for the period 2018-2022 recognized the restrictions to apply to incentives for small business. The LCOE calculated under scenario 2 demonstrates that small hydro, wind and forest biomass are competitive, attaining the grid parity. Solar PV generation cost is above grid parity, but is comparable with electricity prices in isolated regions.

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