ASSESSING THE SHORT AND LONG-TERM IMPACTS OF POWER PURCHASE AGREEMENT SCHEMES FOR LARGE HYDROPOWER INFRASTRUCTURE: THE CASE OF ECUADOR

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Overview

The concession of newly built hydropower infrastructure in Ecuador is assessed. Hydropower projects Coca Codo Sinclair 1500 MW and Sopladora 487 MW have been open for concession as a governmental strategy to raise capital and withstand economic recession due to low crude oil prices. Short and long-term cash flows are developed to assess the impacts of a power purchase agreement on generation costs and on the tariff for final users. Insights are given regarding the mechanics of Ecuadorian oil-backed loans for energy infrastructure. Results show that a concession scheme would annul the benefits of introducing cheap hydropower generation in the system and cause a steep rise in generation costs.

Keywords – Ecuador, concession, low oil prices, PPA, hydropower

1. Introduction

Uncertainty of fossil fuel prices and global efforts to reduce greenhouse gases (GHG) have incentivised the shift away from carbon emitting technologies towards renewable energy sources for electricity generation. Hydropower is a renewable energy alternative that despite its maturity remains as the world's primary source of clean energy — providing over 80% of renewable energy capacity (WEC, 2015). During the last decade, hydropower development has seen resurgence, particularly in Asia, Africa and South America. This last region is of particular interest where hydropower forms the backbone of many national power systems and has still projections for further deployment (Finer & Jenkins, 2012). Installed hydro capacity in South America in 2015 reached 153GW, compared to 11.7GW of wind and 700MW of solar (BNEF, 2015).

Ecuador is one of the countries that has committed to the expansion of hydropower, seeking to add 2870MW of new capacity by 2017 thus reaching a 90% hydro-based power matrix (ARCONEL, 2015b). To finance the capital intensiveness of hydropower projects, Ecuador has agreed to a number of oil-for-loan deals with China that guarantee oil exports to China in exchange for capital to build large infrastructure (Alves, 2013; Hongbo, 2014). This financing method is continuously growing in commodity exporting developing countries in South America, Africa and beyond (Gallagher & Irwin, 2015). High oil prices averaging US$ 100 per barrel from 2007 to 2014 (EIA, 2016) enabled the Ecuadorian State the concretion of these loans and also justified the shift away from thermal generation towards hydropower. However, the sudden and critical collapse of oil prices from US$ 115 per barrel[1] in June 2014 to less than US$ 27 per barrel in January 2016 and pessimistic projections of further recovery for the midterm has presented a series of challenges for the Ecuadorian economy that depends largely on oil exports (8% of GDP, but 50% of fiscal budget). Repayments of oil-for-loans, justification to use hydropower instead of thermal electricity and even State ownership of hydropower infrastructure is threatened by the critical price reduction of crude oil. In late April 2016 the government announced that it will concession the largest newly built hydropower stations, i.e. Coca Codo Sinclair (CCS) (1500 MW) and Sopladora of (487 MW), thus having to raise capital to withstand the hardships of low oil prices (EL UNIVERSO, 2016).

The objective of this study is to assess the short and long-term financial impacts of the decision to concession newly built hydropower stations. Studying the increase of the marginal generation cost and the increase on the tariff for the final user we assess the impacts on the power sector, as well as the fiscal burden created by a power purchase agreement (PPA) in addition to the debt service that is still pending with China. Insights will be given regarding the mechanics of Chinese oil-backed loans and the implications that low oil prices have for these type of financing mechanisms.

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[1] Europe Brent Spot Price FOB (US Dollars per Barrel)

2. Hydropower development context in Ecuador

2.1. The Ecuadorian Electricity Sector and capacity expansion policy

Ecuador has a hydro-thermal power system, meaning that thermoelectric power plants are used to complement hydropower generation. There is a single national interconnected system that integrates all generation sources in one single grid which is state owned. The effective installed capacity by early 2016 was 5,563 MW[2], of which 2,401MW is hydropower, 2,976MW is oil and gas fired thermoelectric and the remaining wind, solar photovoltaic and biomass. Total generation in 2016 was 26,6TWh composed by 47.6% hydropower, 48.7% oil and gas fired thermoelectricity, 2% from non-conventional renewables (wind, solar PV and biomass) and the remaining 1.1% imports from Colombia and Peru (ARCONEL, 2016). Even though almost half of power generation is from hydropower there is still large untapped water resources in eastern Amazon region of the country; 22,000MW have been identified as technical and economically feasible (ARCONEL, 2015a). Therefore the country has a conservative approach of maintaining a hydrothermal power system in the long-run as stated in the recent National Energy Agenda 2016-2040 (MICSE, 2016).

While historically Ecuador has relied on imports from Colombia to meet peak demand, unusual low levels in the Amazon basin in 2009 and 2010 imposed power shortages in both countries. In order to address capacity shortages and to reduce (at that moment) expensive oil-fired generation, the country looked into hydropower and set a national ‘energy matrix change’ policy in its 2009-2013 National Development Plan (SENPLADES, 2009), which promotes public investment in large-scale hydropower projects (Zambrano-Barragen, 2012). Plans to add 2,827MW of new hydropower capacity consist of eight ‘flagship’ projects[3] that sum up a total investment of US$ 6 billion and are expected to the power generation matrix as shown in Fig. 1. The largest of these eight projects are Coca Codo Sinclair 1500 MW and Sopladora 487MW which began construction in 2010 and were commissioned in 2016.

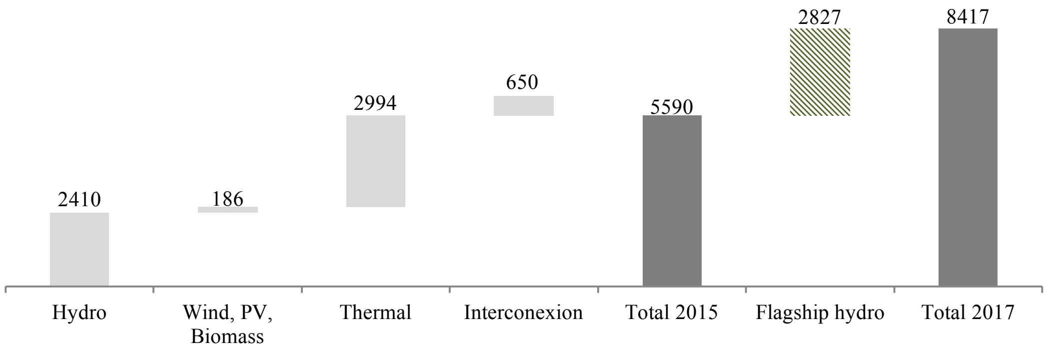

Fig. 1 Power matrix change in Ecuador in MW. Flagship projects increase 2827MW to hydropower capacity in 2017

2.2. Financing hydropower projects with oil-for-loan deals

Ecuador has agreed to a number of oil-for-loan (or oil-backed loan) deals with China that guarantee oil exports to China in exchange for loans, many of which are dedicated to infrastructure projects involving Chinese companies. Oil-backed loans have been largely channelled through two Chinese state banks: China Export-Import Bank (China Exim Bank) and the China Development Bank (CDB). As state banking institutions, they support China’s policies domestically and abroad, including securing energy to fuel China’s economic growth (Downs, 2011). According to The Inter-American Dialogue (2016), since 2005, these two banking institutions have provided more than US$ 141 billion in loan commitments to Latin America and the Caribbean (LAC) countries. Ecuador has received a total US$ 17.4 billion of which US$ 6.1 billion has been used to finance hydropower infrastructure. The repayment term fluctuates between 2 and 10 years and interest rates fluctuate from 6% to 8%, and LIBOR+280bp to LIBOR+50-285bp, depending on the country (Bräutigam & Gallagher, 2014; Jacobs, 2014).

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[2] Includes 465MW of isolated thermal capacity in the eastern Amazonian region belonging to oil companies.

[3] Eight flagship hydropower projects for the ‘energy matrix change’ policy are: Coca Codo Sinclair (1500MW), Sopladora (487MW), Minas San Francisco (270MW), Toachi-Pilatón (254MW), Delsitanisagua (180MW), Manduriacu (65MW), Quijos (50MW) and Mazar-Dudas (21MW).

As Alves (2013) states, contrary to popular belief, oil-backed loans are not repaid in kind (meaning, through oil shipments). Rather, they are guaranteed by the proceeds of oil sales, which are required to be deposited into the borrower's account as a means of guaranteeing repayment. A certain amount of oil normally set in barrels per day (BPD) throughout the loan repayment period is sold to a specified Chinese national oil company (NOC), usually the China National Petroleum Company (CNPC). The Chinese NOC is required to deposit the payment in the borrower's account with the Chinese lending institution e.g. China Exim Bank, which is then used to service the loan. This arrangement allows China to limit lending risks, it also serves China's energy-security purposes by ensuring a continuous flow of oil over the repayment period.

Oil-backed loans secure more oil than the necessary to pay back the loan, since it would be politically untenable for the borrowing countries to give China oil and get nothing in return. For example, Venezuela has agreed on a ten-year, $20 billion loan-for-oil in 2010. To pay back this loan with $110 barrels over the ten-year tenor, Venezuela would only have to send 50,000 BPD. However, Venezuela committed to send between 200,000 and 300,000 BPD to China, four to six times as much (Gallagher et al., 2012). By incorporating the repayment into a larger supply contract, Venezuela can have CDB only deduct a portion of the revenues to cover loan interest, while the rest will return to the country. For the case of Ecuador, CNPC deposits 79% of the oil revenue into Petroecuador's CDB account and diverts the remaining 21% to pay back the loan (Crooks and Rodriguez Pons 2011). The mechanics of the oil-for-loan are depicted in Fig. 2.

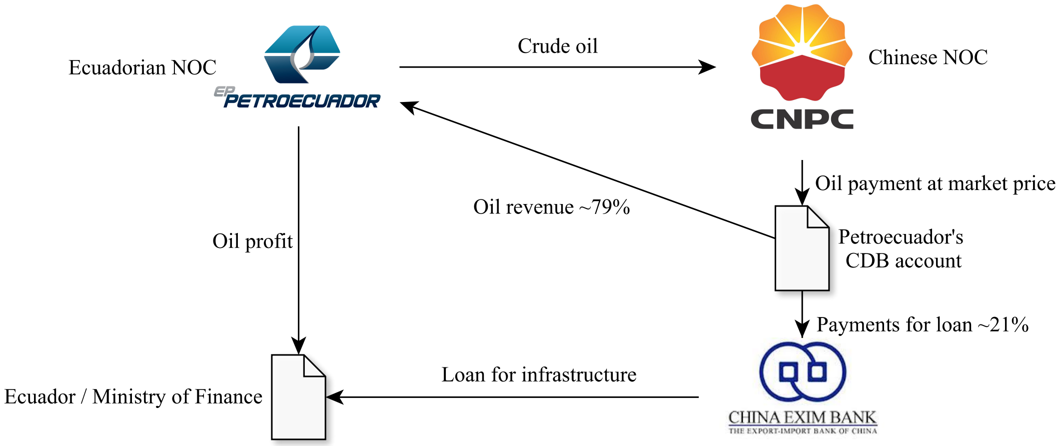


Fig. 2 Oil-backed-loan mechanics for Ecuador adapted from (Jiang & Sinton, 2011)

3. Materials and methods

The analysis is framed in the recent events of low-oil prices (2015-2016) and the need of the Ecuadorian government to obtain liquidity. The government's strategy is to concession the largest newly built state-owned hydropower stations, Coca Codo Sinclair and Sopladora, in exchange of a Power Purchase Agreement (PPA) with a potential buyer (EL UNIVERSO, 2016).

The methodology consists in developing short and long-term cash flows to assess the asset concession value and PPA tariff scheme. Short-term analysis is critical since politicians and governmental planners usually think in function of pre or post-election periods which usually last between 4 to 5 years (Masini & Menichetti, 2013). In Ecuador's case, the expected savings due to the shift from thermal generation towards hydropower is used in the country's technical expansion plans and political discourse (Andes, 2016); these expected savings are however dependant on oil prices, higher oil prices mean larger saving due to switching to hydropower. Short-term analysis will assess how the sudden inclusion of a PPA can impact the budget of the power sector.

The long-term analysis has a broader scope. Although hydropower stations have a long service life time of over 50 years, for project evaluation a useful life of 30 years is considered. The long-term analysis is based in a concession period of 30 years with projections in nominal terms, assuming an American inflation rate of 2%[4] for energy prices and for cost structures of both hydropower stations. In line with other countries in the region (BNEF, 2015), the PPA is two-tier: i) payments for capacity (US$ per kW-month) and ii) payments for dispatched energy (US$ per MWh). Payments for capacity have been considered in a range between US$ 40 to US$ 60 per kW-month (adjusted

[4] Standard inflation rate for the United States of America, (Tradingeconomics, 2016).

to inflation) and depending on firm power capacity[5], which was estimated using a dry hydrological scenario of 45% for each power station. A payment for dispatched energy was set at US$ 2 per MWh (adjusted to inflation), which is the current dispatch price paid to hydropower stations in Ecuador. Operation and maintenance costs have been provided by the grid operator CENACE (CENACE, 2015). Finally, the discount rate for the Net Present Value (NPV) calculation has been estimated between 15% and 17%[6].

Different perspectives will be assessed: i) state, regarding the impact of a PPA in annual power sector cash flow, ii) private, regarding the asset value and the necessary PPA value to be signed and iii) final consumer, the impact of a PPA for final user tariff. Table 1 details technical and financial information of both hydropower stations which was collected from the Ministry of Electricity and Renewable Energy (MEER) and the Ministry of Finance of Ecuador (MF).

Table 1 Characteristics of hydropower stations Coca Codo Sinclair and Sopladora

	Coca Codo Sinclair	Sopladora
	Technical Characteristics	
Installed capacity (MW)	1500	487
Average generation (GWh/yr)	8734	2800
Capacity factor	67%	66%
Design flow (m3/s)	220	150
Turbines	8 x 187.5 MW Pelton	3 x 165.24 MW Francis
Head	620m	363m
Construction start	2010	2011
Operation start	November 2016	May 2016
	Financial characteristics	
Project cost (US$)	2,850 million	900 million
Useful/Project lifetime (years)	50+/30	50+/30
Construction company	Sinohydro Corporation	China Three Gorges Corporation
Financing institution	China EXIM Bank	China EXIM Bank
Loan (US$)	1,683 million	571 million
Interest rate	7.29%	6.88%

4. Results and discussion

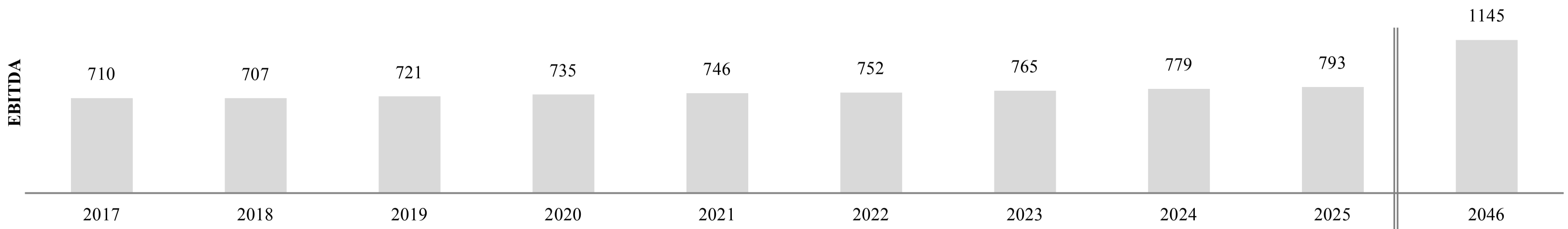
The sensitivity of short-term savings due to the switch from thermal generation to hydropower is assessed by comparing three consecutive years (2015, 2016 and 2017) and can be seen in Fig. 3. Total fossil fuel expenditure in 2015 reached US$ 699 million, which was covered by the Ministry of Finance (US$ 440 million) and MEER-CELEC (US$ 259 million) that buy fossil fuels at a subsidised price. With the additional capacity of Coca Codo Sinclair and Sopladora the expenditure in fossil fuel prices reduces to US$ 70 million/year, which represent savings for the State of US$ 630 million per year at 2015 oil prices. However, when 2016 oil prices are considered, the saving by the State reduce to US$ 472 million/year. This reduction is significant, since it is equivalent to the value for the amortization payment of the Chinese loan. Each percentage point of oil price change, impacts expected annual saving in US$ 4.5 million. Savings for 2017, are estimated to be slightly higher due to oil price recuperation, however they are still US$ 113 million lower than expected.

Low oil prices have two implications: i) Ecuador is a net oil exporter (~300kBPD), therefore oil-backed loans have been the driver to build hydropower capacity. Falling oil prices weakens Ecuador's debt service with China thus forcing the country to change loan conditions i.e. increase repayment period or alter the proceed/debt service ratio (79%/21%) (see Fig. 2), ii) low oil prices and reduction of expected savings lowers income that government needs for other expenditures, therefore causing fiscal deficit. This creates pressure to transfer sunk assets of State owned companies to raise capital in exchange of PPA that will be paid to the buyer (and operator) of infrastructure. In this sense, Table 2 and Table 3 present a detailed long-term cash flow for a private investor willing to pay a concession equal to the construction cost of each project (Coca Codo Sinclair for US$ 2850 million and Sopladora US$ 900 million).

[5] Firm power capacity is the amount of energy available for production or transmission, which can be (and in many cases, must be) guaranteed to be available at a given time. Firm energy refers to the actual energy guaranteed to be available. For the case of hydropower firm capacity would be the available capacity at worst hydrology conditions.

[6] CAPM (Capital Asset Pricing Model) was used to calculate the appropriate discount rate.

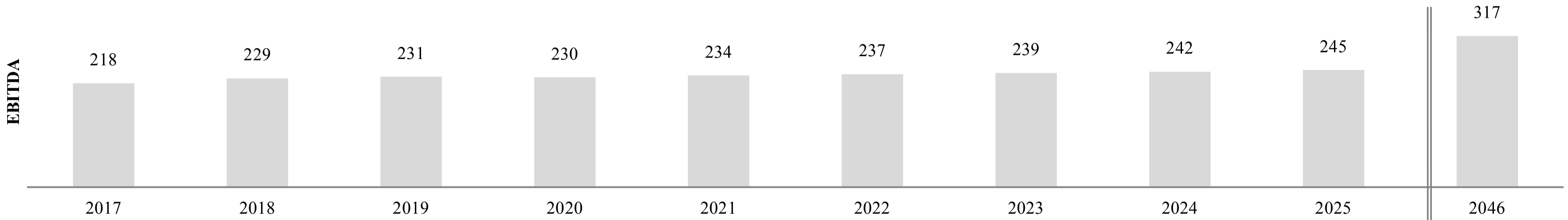
Table 2 Cash flow for Coca Codo Sinclair hydropower project



COCA CODO SINCLAIR

US$ million, except technical data	2017	2018	2019	2020	2021	2022	2023	2024	2046
Installed capacity (MW)	1500	1500	1500	1500	1500	1500	1500	1500	1500
Firm capacity (MW)	675	675	675	675	675	675	675	675	675
Capacity factor - average (%)	67.1%	66.0%	66.0%	66.3%	65.8%	65.4%	65.2%	66.0%	66.0%
Availability factor - average (%)	99.0%	97.2%	97.4%	97.6%	97.4%	96.5%	96.5%	96.5%	97%
Available capacity (MW)	1485	1458	1461	1464	1461	1448	1448	1448	1448
Generation (GWh)	8817	8672	8672	8712	8646	8594	8567	8672	8672
Payment for capacity (US$/kW-month)	40.5	41.2	42.0	42.7	43.5	44.3	45.1	45.9	67.9
Payment for energy (US$/MWh)	2	2	2	2	2	2	2	2	2
P&L									
Consolidated income (Annual PPA)	739.3	738.7	753.2	768.0	779.9	786.3	800.1	814.4	1197.5
Payment for capacity	721.7	721.3	735.8	750.6	762.6	769.1	783.0	797.1	1,180.2
Payment for energy	17.6	17.3	17.3	17.4	17.3	17.2	17.1	17.3	17.3
O&M costs	(23.0)	(23.4)	(23.8)	(24.3)	(24.7)	(25.1)	(25.6)	(26.1)	(38.6)
Overhead	(4.7)	(4.8)	(4.9)	(5.0)	(5.0)	(5.1)	(5.2)	(5.3)	(7.9)
Others	(1.2)	(3.5)	(3.6)	(3.7)	(3.7)	(3.8)	(3.9)	(3.9)	(5.8)
Total costs	(28.9)	(31.7)	(32.3)	(32.9)	(33.5)	(34.1)	(34.7)	(35.3)	(52.3)
EBITDA	710	707	721	735	746	752	765	779	1145
Depreciation and amortization	(142.1)	(141.4)	(144.2)	(147.0)	(149.3)	(150.4)	(153.1)	(155.8)	(229.0)
Taxes	(191.5)	(190.6)	(194.4)	(198.2)	(201.2)	(202.8)	(206.4)	(210.0)	(308.7)
Net profit	377	375	382	390	396	399	406	413	607
Energy price (US¢/kWh)									
Energy selling price per kWh (US¢/kWh)	8.39	8.52	8.68	8.82	9.02	9.15	9.34	9.39	13.81

Table 3 Cash flow for Sopladora hydropower project



SOPLADORA

US$ million, except technical data

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2046
Installed capacity (MW)	487	487	487	487	487	487	487	487	487	487
Firm capacity (MW)	219.15	219.15	219.15	219.15	219.15	219.15	219.15	219.15	219.15	219.15
Capacity factor - average (%)	60.1%	57.7%	59.2%	62.0%	61.6%	61.6%	55.2%	5 5.7%	56.4%	58.8%
Availability factor - average (%)	93.4%	97.7%	97.7%	95.9%	96.3%	96.5%	96.5%	96.5%	96.5%	97%
Available capacity (MW)	455	476	476	467	469	470	470	470	470	470
Generation (GWh)	2563	2460	2525	2646	2629	2629	2354	2376	2405	2508
Payment for capacity (US$/kW-month)	40.5	41.0	41.5	42.0	42.6	43.1	43.6	44.2	44.7	58.1
Payment for energy (US$/MWh)	2	2	2	2	2	2	2	2	2	2
P&L										
Consolidated income (Annual PPA)	226.2	239.0	242.1	240.9	244.8	248.3	250.8	253.9	257.1	332.5
Payment for capacity	221.1	234.1	237.1	235.6	239.5	243.0	246.1	249.1	252.3	327.5
Payment for energy	5.1	4.9	5.0	5.3	5.3	5.3	4.7	4.8	4.8	5.0
O&M costs	(5.2)	(5.3)	(5.3)	(5.4)	(5.5)	(5.5)	(5.6)	(5.7)	(5.7)	(7.5)
Overhead	(1.7)	(1.7)	(1.7)	(1.8)	(1.8)	(1.8)	(1.8)	(1.9)	(1.9)	(2.4)
Others	(1.4)	(3.5)	(3.6)	(3.7)	(3.7)	(3.8)	(3.9)	(3.9)	(4.0)	(5.2)
Total costs	(8.3)	(10.5)	(10.7)	(10.8)	(11.0)	(11.1)	(11.3)	(11.5)	(11.6)	(15.1)
EBITDA	218	229	231	230	234	237	239	242	245	317
Depreciation and amortization	(43.6)	(45.7)	(46.3)	(46.0)	(46.8)	(47.4)	(47.9)	(48.5)	(49.1)	(63.5)
Taxes	(58.7)	(61.6)	(62.4)	(62.0)	(63.0)	(63.9)	(64.6)	(65.4)	(66.2)	(85.6)
Net profit	115.6	121.2	122.8	122.0	124.0	125.8	127.0	128.6	130.2	168.3
Energy price (US¢/kWh)										
Energy selling price per kWh (US¢/kWh)	8.82	9.72	9.59	9.10	9.31	9.45	10.65	10.69	10.69	13.25

For Coca Codo Sinclair, assuming a power availability payment of US$ 41 per kW-month, energy dispatch tariff of US$ 2 per MWh and a WACC of 14%; a US$ 2850 million concession would mean a US$ 793.3 million PPA (on the first year), which is equivalent to an energy price of US¢ 8.39 per kWh. This price is the value that the power grid would need to pay when electricity from Coca Codo Sinclair is dispatched (it is significantly higher than the current average system generation cost (US¢ 4.2 per kWh in 2016). Sensitivity analysis for energy price is performed for variations in the concession value (US$ 800, 900 and 1000 million) and WACC (12%, 14% and 16%) and are presented in Table 4. Sopladora's case presents similar values. assuming a power availability payment of US$ 41 per kW-month, energy dispatch tariff of US$ 2 per MWh and a WACC of 14%; a US$ 900 million concession would mean a US$ 227 million PPA (on the first year), which is equivalent to an energy price of US¢ 8.82 per kWh. Therefore, a concession system would deliver a total value of US$ 3750 million to the State (CCS + Sopladora), but the PPA payment for the first year would be US$ 1020 million, and would continue for the following 30 years (until 2046, see Table 2 and Table 3).

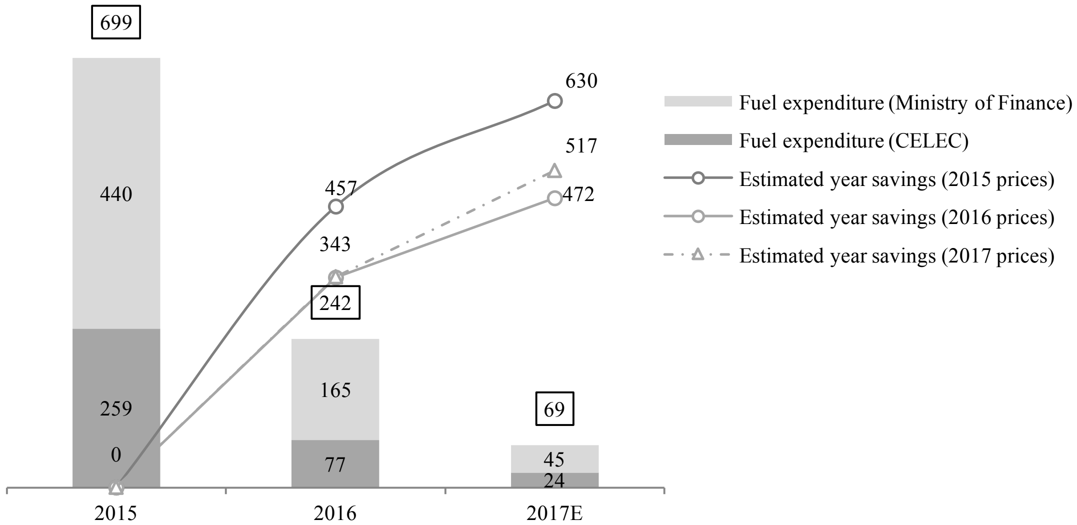


Fig. 3 Expected short-term savings in US$ million due to hydropower entry and sensibility to oil price in Ecuador

Table 4 PPA electricity selling price sensitivity to concession value and WACC

	Coca Codo Sinclair			Sopladora		
	Concession value (US$ million)					
WACC	$2,700	$2,850	$3,000	$800	$900	$1000
12%	6.76	7.11	7.46	6.86	7.66	8,47
14%	7.90	8.23	8.64	7.90	8.84	9.77
16%	8.90	9.38	9.85	8.97	10.04	11.11

This increase in electricity dispatch price of these two large hydro stations that can approximately supply almost half of Ecuador's energy demand would to be absorbed by the power system and ultimately be transferred to final users (unless the state wishes to sink the PPA annual value). Fig. 4 presents change of average generation system cost, there is first a reduction of cost due to hydropower and international oil price reduction, but later an increase due to a concession scheme that introduces a PPA. System average generation cost reduces from US¢ 8.17 per kWh to US¢ 4.54 per kWh (considering system cost plus the subsidy shown in light grey). The introduction of a PPA would make average generation cost reach US¢ 8.08 per kWh, which means an 84% increase when comparing to the projected generation cost for 2017, which is estimated in ¢US 4.24 per kWh with no PPA. The analysis incorporates the expected savings that hydropower achieves by displacing fossil fuels for generation (US$ 457 million per year). However, the annual deficit created with the PPA is around US$ 967 million, meaning that the accomplished savings by the operation of hydropower stations are overshadowed by the deficit created by the PPA (see Fig. 4). Translating this to final user (Generation + transmission + distribution), Fig. 5 presents the increase on the average electricity prices for final user, which rises from ¢US 8.75 per kWh in 2014 to ¢US 13.26 per kWh expected for 2017 when including the PPA. This steep 51% increase in prices could probably cause a social shock and possible political unrest, unless the State is willing to absorb the deficit by 'reducing' budget to other governmental sectors.

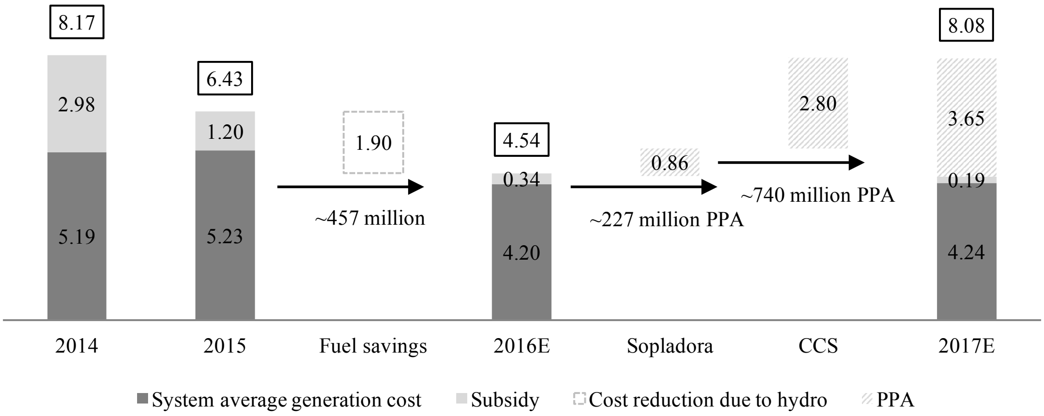


Fig. 4 Expected increase in average generation system cost in US¢ per kWh if the concession of hydropower stations Sopladora (487MW) and Coca Codo Sinclair (1500MW) take place through a two-tier PPA scheme.

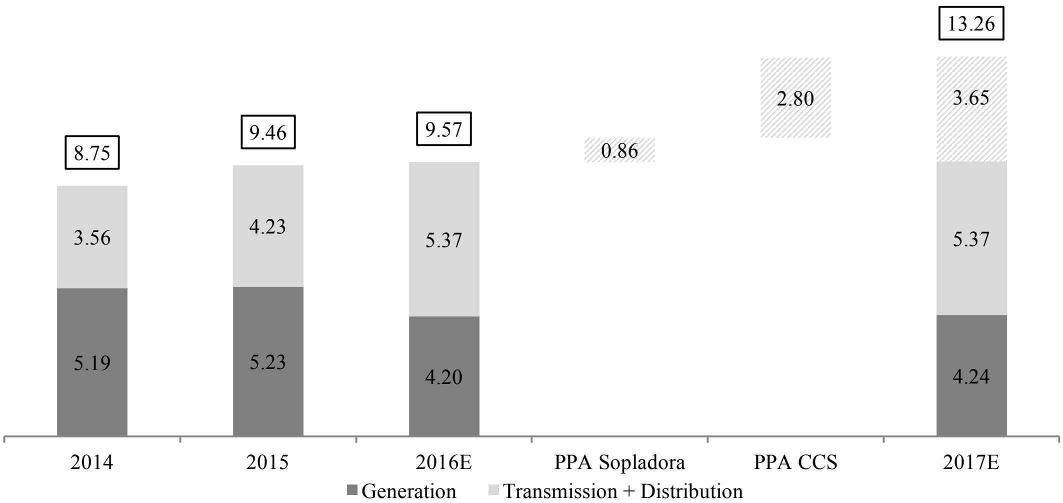


Fig. 5 Expected increase in average final user cost in US¢ per kWh if the concession of hydropower stations Sopladora (487MW) and Coca Codo Sinclair (1500MW) take place through a two-tier PPA scheme.

5. Conclusions

The Ecuadorian government has invested in large hydro infrastructure, sunken capital costs and investor risks, with the purpose to shift away from thermal generation. A season of low oil prices has coincided with the commissioning of large hydropower stations Coca Codo Sinclair (1500mW) and Sopladora (487MW), therefore a strategy to concession them has been proposed by the government. Results show that when the time to reap the benefits of the introduction of hydropower in the system has come, a concession agreement annuls the expected savings and could even increase generation cost and final user tariffs. Financing schemes of capital-intensive projects should be addressed in terms of their repayment structures and on their dependence on revenues from highly volatile raw material exports. Sudden emergency measure such as concession schemes under pressure can lead to unbeneficial auction procedures or even worse, direct negotiations with only one bidder. It is anticipated that the results of this study will assist energy planners in developing countries to make more objective and informed decisions regarding new large-scale hydropower projects and their financing schemes with commodity-backed loans, as well as challenging the paradigm of intensive investments in large-hydropower instead of diversified modular non-conventional renewable energy sources such as solar photovoltaic and wind.

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