

Hidroituango Hydro: Colombia's biggest infrastructure project at risk

TEACHING NOTE

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Synopsis

Hidroituango Hydropower Station, the biggest dam and most ambitious infrastructure project ever built in Colombia, faced a major crisis during the second quarter of 2018. Such crisis finally settled down after major technical and financial efforts that resulted in a 4 COP BN CAPEX and other expenses increase, modifying substantially the financial optics of the project. Additionally, the contingency postponed the launch of the first MW of energy from 2018 to 2021, and the completion of the hydropower station is expected to be delayed three years, until 2024. Having into account that more investments are needed and less income is going to be generated, EPM's board asked EPM's CEO and CFO, Javier Londoño de la Cuesta and Jorge Tabares, respectively, if they recommended to continue with the project or not. At that point, three questions arose: how much does the asset and the equity of the project value now? Which is the feasible Internal Rate of Return of the project after the contingency? And, does it still have Net Present Value?

It must be noted that in order to understand the financial effects of the contingency, the way the project was financed played a major role. Initially, it was conceived to be developed using a project finance approach, but, at the end, the decision was to carry it out using a corporate finance approach.

Pedagogical Objectives

This course was written as a comprehensive review for the introductory graduate Corporate Finance course at Universidad EAFIT. Because it contains topics much related to basic finance, it is plausible to be also used in an undergraduate corporate finance course. In consideration of the authors, the most complex issue in the case is that related to the probabilistic modelling. However, the case is resolved in such a way that Excel or any calculus sheet is more than suitable to give an answer.

This Teaching Note provides a plan focused on the trade-off between the project and corporate finance, the initial state of the project and how the contingency impacted it, and how to decide, in probabilistic terms, whether or not to continue with the project.

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The case has three teaching or pedagogical objectives:

1. **Skill objectives:** To solve the case, students will have to be able to build reasonable financial models with information constraints. DCF Valuation, valuation multiples and NPV and IRR calculations make most of the case. Prior to valuation, a correct assessing of the capital risk needs to be done. Finally, the case will allow students to familiarize with multiple scenarios and conditional or Bayesian probability; as result, the main goal of the case is to come with an answer expressed in probabilistic rather than in deterministic terms.
2. **Knowledge objectives:** To come with an answer to the case, students will have to be firstly able to describe the relation between risk and interest rates and how they impact WACC. Secondly, they will have to be capable of understanding the differences between asset valuation, using DCF and valuation multiples. Additionally, they will have to properly assess the impact of changes in the state of results in the valuation of a company or project. Ultimately, in order to define how the project could be developed, the choice of the partial probability of the nine scenarios proposed will become critical,
3. **Attitudinal objectives:** At the end of the case, students will be aware of the differences between project and corporate finance and the trade-off underlying when choosing one or the other approach to develop the project. Finally, they will understand that asset valuation is better expressed in probabilistic rather than in deterministic terms. Even when it is easier to think that companies or projects possess a specific value, it is more reasonable, and somehow harder, to comprehend that value varies in a reasonable range that implies uncertainty.

To assist students in analysing the case, there is an Excel workbook containing the case Tables in electronic format (Hidroituango Teaching Case. Figures and Tables). Additional material to comprehend the case will be found in the bibliography.

Substantive Analysis

Class discussion is broken into four sections. In the first one, students briefly discuss the key elements of an investment decision and how to differ project from corporate finance. The purpose of this talk is to develop a common understanding of how a project is financed and to identify why a company, in this case EPM, decides to develop the project using corporate finance

In the second section, students determine who owns and develops Hidroituango Project, why is it being developed using corporate finance and why such choice was a good or a bad decision. Additionally, they discuss which role COP/USD exchange rates and the energy prices play in determining the project's valuation and how they impact it. Finally, students will have to explain which probability should be assigned to each scenario and how they weigh the final result. Questions related to NPV, IRR and Equity Value are established assuming a Base or initial scenario. In fact, more questions arise:

How probable is to have $NPV > 0$? How probable is IRR being smaller than WACC?
How probable is Equity Value to be smaller than 12,000 COP BN?

In the third section, the impact of the contingency is evaluated. ¿How did the contingency changed the project? ¿Does the project value more or less after the contingency? ¿Did WACC changed? ¿How different would have been the impact of the contingency for EPM if the project had been developed using project finance? More CAPEX means loses? Is still Hidroituango a good investment? How do NPV, IRR and Equity Value calculations change in the Contingency case scenario? How probable is now to have a $NPV > 0$? Which are the current odds for having IRR smaller than WACC? Which is the probability of having the Equity Value smaller than 15,000 COP BN? If EPM projected EBITDA generation by 2025 at around 12,500 COP BN, is it going to change now due to the contingency? How does the contingency impact BHAG?^c

The fourth section finishes by asking the students what would have they advised to the board. Would they advise to continue or not to continue with the project? Why? How did they elaborate their thinking process? Did they realize that the answer, even if it were binary (yes or no), has a probabilistic nature? The class finishes with a brief discussion of what actually happened and a debate of the lessons of the case.

Section 1: Introduction – Corporate Finance vs. Project Finance

Initially, project finance was the scheme that EPM established to develop Hidroituango Project. In fact, a SPV (Special Purpose Vehicle) called EPM Ituango was created at the beginning of 2010 to build it. However, as it is mentioned in the Case Note, EPM decided to use corporate finance rather than project finance, because the Holding possessed an especial status which, if used, prevented the company to pay an additional 370 USD M in taxes; this, ultimately, gave the Board the clue to use a corporate finance approach. Nevertheless, to use DCF as the only measure in financial decisions assigns the risks a minor role. Which role do risks play in asset valuation? Does WACC capture all the risks involved? The view of the authors is that WACC captures a substantial piece of the risks but not all of it. Even if WACC were calculated perfectly, how does one capture changes in other variables such as income or expenses? Is in that question where probability analysis becomes useful. If multiple scenarios may occur, it is reasonable to value the projects taking them into account.

Usually, financial consultants advise against corporate finance when at least three conditions appear: i) the project is too big, meaning that if it goes wrong, it contaminates the company; ii) the project is in the same business line of the company, meaning that if it goes wrong, more businesses of the company are likely to tangle up; and iii) the project is developed in the long term, meaning that it is difficult to

^c BHAG stands for Big Hairy Audacious Goal.

accurately quantify the risks over time. As the reader may have noticed, Hidroituango fulfils the three conditions, meaning that using the corporate finance approach increased the risk of the company. Finally, it must be noted that the increase in risks was not captured by WACC. In fact, WACC diminished when Hidroituango was decided to be developed inside EPM's balance. These considerations, in a theoretical perspective, may be read more broadly in Chapter 4 of *The Economics of Public Private Partnerships*.^[1]

Section 2: Base case scenario – Hidroituango prior to the contingency

In the Teaching Case, it is clear that EPM develops Hidroituango Project, but the owner of the project, Hidroituango S.A., is a totally different company. In order to solve the case, to understand the politics behind the project is not mandatory, but it helps to comprehend the context in which Hidroituango decided to carry it out. Initially, EPM intended to control Hidroituango S.A., but IDEA, the second floor bank mentioned in the Teaching Case, gained the control of the Society. However, IDEA is a much smaller and poorer company, and definitely did not have the resources or experience to develop a project the size and cost of Hidroituango. Just from the beginning, IDEA intentions were to concession the project using a bid process. Nevertheless, that process never took place, because, as it was explained, politicians and the civilian society pushed Hidroituango S.A. to deliver the project to EPM directly. Ultimately, it is probable that by not assigning a developer of the project by means of a public bid caused that the royalties from the developer to Hidroituango S.A. were not as high as expected. This situation can only be explained by politics.

Prior to make any calculations, students must understand the quantity of scenarios that were configured in the Base case scenario: three CAPEX scenarios, given the fact that COP/USD exchange rates (low, average and high) impact CAPEX in COP terms; and three Income scenarios, given the fact that there are at least three energy prices (low, average and high). Combined, they make nine (9) COP/USD CAPEX and Income scenarios (see TN Table A).

TN Table A. CAPEX and Income scenarios

		Income		
		Low Energy Prices	Average Energy Prices	High Energy Prices
CAPEX	Low COP/USD exchange rate	(1) Low COP/USD exchange rates and low energy prices	(2) Low COP/USD exchange rates and average energy prices	(3) Low COP/USD exchange rates and high energy prices
	Average COP/USD exchange rate	(4) Average COP/USD exchange rates and low energy prices	(5) Average COP/USD exchange rates and average energy prices	(6) Average COP/USD exchange rates and high energy prices
	High COP/USD exchange rate	(7) High COP/USD exchange rates and low energy prices	(8) High COP/USD exchange rates and average energy prices	(9) High COP/USD exchange rates and high energy prices

Source: Authors' elaboration.

The most favourable scenario is the low COP/USD exchange rate, meaning that CAPEX is minimized in COP terms alongside with the high energy prices when the income is maximized (scenario 3). Conversely, the least favourable scenario is the high COP/USD exchange rate, meaning that CAPEX is maximized in COP terms alongside with the low energy prices, which in turn means that the income is minimized (scenario 7). However, both scenarios are not the most probable, given the fact that if the energy prices are high, there is inflation, and if there is inflation, COP/USD exchange rate increases; conversely, if the energy prices are low, there is low inflation, and if there is low inflation, COP/USD exchange rate decreases. This analysis leads to the conclusion that the most probable scenarios are comprised in the remaining seven. In Table 4 of the Teaching Case it is suggested a probability matrix; however, any probability matrix generated by the students or teachers is suitable only if it is properly explained. Last but not least, it must be taken into account that CAPEX scenarios impact debt and depreciation as well (as it is shown in Figure 3 and Table 10 of the Teaching Case).

Prior to make any calculations, it is important to understand that it is possible to assess probability using Excel or any other calculation sheet; there is no need for an additional or a more complex software, even when is possible to use it. Once the financial model is completed, authors recommend using the *Data Table* function in Excel to generate NPV, IRR, Equity Value, etc. values for each scenario. Working with this function saves time to the students and makes the modelling task simpler.

In order to obtain NPV, it is necessary to find Free Cash Flow (FCF) and WACC.

TN Equation A. Weighted Average Cost of Capital (WACC) calculation

$$WACC = K_d \times (1 - t) \times \frac{D}{D + E} + K_e \times \frac{E}{D + E}$$

Where:

K_d: Cost of Colombian debt in COP. The *K_d* is calculated by adding a long-term COP/USD devaluation to the *K_d* in USD. The long-term devaluation is calculated by using the differences between the long-term inflation and the long-term nominal per capital GDP growth between Colombia and the United States. Authors calculated the long-term devaluation in 2.42% using the information shown in Table 5 of the Teaching Case. Cost of Colombian debt (*K_d*) in USD is taken from BBB debt shown in Figure 8 = 5.90% of the Teaching Case. *K_d* in COP = 8.46% is almost same actual cost of debt of EPM. According to Table 5 in Teaching Case, EPM's interest coverage ratio = 2.7, means debt rating is BBB, according to the interest coverage ratios shown in Table 7 of the Teaching Case.

t: Income tax rate. Tax rate = 25% (Table 12 of the Teaching Case).

D: Debt participation = 55% (Table 5 of the Teaching Case). Given the fact that corporate finance is the approach chosen by EPM to raise capital, the debt participation ratio to be used is the one coming from the operation of the whole company, not only from the project (project finance). In Table 12 of the Teaching Case there is a Debt/Project CAPEX ratio = 51.60%, which intends to distract students. In fact, this ratio belongs to the project, not to the company. %E equals to $1 - \%D$.

Ke: Cost of equity in COP. *Ke* is calculated by adding the long-term COP/USD devaluation to *Ke* in USD for comparable projects. *Ke* must reflect the risk of the project, not the risk of the company (even when using a corporate finance approach). Table 6 in Teaching Note shows β_e for both comparable companies and projects (those with marks); this situation intends to distract students. Proper *Ke* must be calculated using β_e from comparable projects, not from comparable companies. Authors calculated long-term devaluation in 2.42% using the information shown in the Table 5 of the Teaching Case. *Ke* in USD for comparable public companies is calculated as follows:

TN Equation B. Cost of equity in USD

$$K_{e_USD} = K_{u_USD} + \left\{ (K_{u_USD} - K_{d_USD}) \times \frac{D}{E} \right\}$$

Where:

Ku: Unleveraged cost of capital in USD. The *Ku* in USD is calculated as follows:

TN Equation C. Unleveraged Cost of Capital in USD

$$K_{u_USD} = \text{yield}_{10\text{-yr bond}} + CRP + ERP \times \beta_u$$

Where:

Yield: 10-year Treasury bond yield = 2.01% (Table 5 of the Teaching Case).

CRP: Country risk premium = 1.99% (Figure 6 of the Teaching Case).

ERP: Equity risk premium = 5.62% (Figure 7 of the Teaching Case).

β_u : The unlevered beta (or asset beta) measures the market risk of the company without the impact of debt. β_u is obtained for each one of the four comparable projects companies listed with marks in Table 6 in Teaching Case. %E and %D should be calculated using information for each company shown in Table 6 as well. For example, in EIX stock case, with $\beta_u = 0.48$, it is calculated as follows:

TN Equation D. Unlevered beta

$$\beta_u = \beta_{e-adjusted} \times \%E + \beta_d \times \%D$$

Where:

β_{e-adj} : Adjusted equity beta measures equity risk compared to market risk. $\beta_{e-adjusted}$ is calculated by using two-thirds of historical equity beta (Table 6 in Teaching Case) and one-third of a unity. For example, in the case of EIX stock, $\beta_e = 0.41$ and $\beta_{e-adjusted} = 0.61$.

β_d : Debt beta measures debt risk compared to market risk. It is calculated as follows:

TN Equation E. Debt beta

$$\beta_d = \frac{K_{d_USD} - yield_{10-yr\ bond} - CRP}{ERP} = \frac{5.90\% - 2.01\% - 1.99\%}{5.62\%} = 0.337$$

TN Table B. WACC calculation

Debt	55%
Equity	45%
Ku_USD	6.75%
Ke_USD	7.80%
Kd_COP	8.46%
Ke_COP	10.40%
t	25%
WACC	8.17%

Source: Authors' elaboration.

WACC is not supposed to change in the Contingency case scenario, due to the fact that authors know that additional CAPEX for the project has been raised by EPM by selling minor assets; that means D/E ratio remains unchangeable. However, this is not clear to students, so they could suggest different WACC values in the Contingency case scenario.

Free Cash Flow (FCF) is calculated according to this equation:

TN Equation F. FCF calculation

$$FCF = Depreciation + NOPLAT - CAPEX - \Delta NWC$$

Where:

Depreciation: To be obtained from Table 10 of the Teaching Case.

CAPEX: To be obtained from Table 9 of the Teaching Case.

Interests: To be obtained by multiplying the annual debt (Figure 3 and Table 12 of the Teaching Case) by Kd .

ΔNWC : Yearly changes in Net Working Capital. To be constructed by using cash, Accounts Payable (AP) and accounts receivable assumptions shown in Table 12 of the Teaching Case.

TN Equation G. ΔNWC calculation

$$\Delta NWC = (AR_{t+1} + Cash_{t+1} - AP_{t+1}) - (AR_t + Cash_t - AP_t)$$

NOPLAT: Net Operating Profit Less Adjusted Taxes. Equals to EBIT (Table 11 of the Teaching Case) affected by the tax shield.

For each year of investment, not only of operation, one FCF is generated. FCF in present terms (both 2009 and 2018 are suggested) is calculated discounting the annual FCF from WACC rate, as follows:

TN Equation H. FCF in present terms calculation

$$FCF_{present\ terms} = \frac{FCF_1}{(1 + WACC)^1} + \frac{FCF_2}{(1 + WACC)^2} + \dots + \frac{FCF_n}{(1 + WACC)^n}$$

However, authors recommend not projecting FCF for more than 10 years departing from the present time. From 2028 and forward, it is advised to use terminal value (TV), which is calculated as follows:

TN Equation I. Terminal Value calculation

$$TV_t = \frac{NOPLAT_{t+1} \times \left(1 - \frac{g}{ROIC}\right)}{WACC - g}$$

Where:

g : Long term nominal growth = 3%

ROIC: Return On Invested Capital. To calculate it properly, it must be consistent with long-term growth (3%), net investments and NOPLAT (Table 12). ROIC calculation depends on CAPEX and NOPLAT; thus, income, meaning ROIC, is sensitive to CAPEX and Income scenarios. According to authors' calculations, in Base case scenario ROIC varies from 9.95% (scenario 7 in TN Table A) to 27.80% (scenario 3 in TN Table A).

TN Equation J. ROIC calculation

$$ROIC = \frac{g}{\text{Net Investments}/NOPLAT} = \frac{g}{(\text{CAPEX} - \text{Depreciation})/NOPLAT}$$

TN Table C. ROIC sensitivity (Base case scenario, calculated in 2027)

		Income scenario		
		Low Prices	Average Prices	High Prices
CAPEX Scenario	TRM Minimum	14.426%	21.113%	27.801%
	TRM Average	12.151%	17.863%	23.576%
	TRM Maximum	9.955%	14.727%	19.499%

Source: Authors' elaboration.

TRM: stands for *Tasa Representativa del Mercado*, the Spanish word for COP/USD exchange rate. TRM Minimum means the lowest COP/USD exchange rate, i.e., more USD per COP; and TRM Maximum means the highest COP/USD exchange rate, i.e. less USD per COP.

Terminal value must be discounted at WACC rate to be obtained in present terms. Total Free Cash Flow (FCF), or Net Present Value (NPV), equals to FCF calculated during construction phase, plus first 10 years of operation in present terms, plus terminal value in present terms. NPV indicates if the investment creates or destroys value: If NPV > 0, the investment is projected to create value; if NPV < 0, the investment is projected to destroy value. The TN Table D shows NPV sensitivity according to CAPEX and Income scenarios.

TN Table D. NPV sensitivity (Base case scenario) in 2009 COP M

		Income scenario		
		Low Prices	Average Prices	High Prices
CAPEX Scenario	TRM Minimum	4,566,384	9,610,374	14,654,364
	TRM Average	3,338,484	8,382,474	13,426,464
	TRM Maximum	1,677,864	6,721,854	11,765,844

Source: Authors' elaboration.

TN Table D shows that in any case NPV < 0, meaning Hidroituango Project does not destroy value for the EPM Group. In 9 out of 9 cases NPV > 0, meaning that in all scenarios Hidroituango Project creates value for the EPM Group. As predicted, the most favourable case is when Low COP/USD exchange rate is combined with high energy prices (scenario 3 in TN Table A). The least favourable case is when High COP/USD exchange rate is combined with low energy prices (scenario 7 in TN Table A).

Internal Rate of Return (IRR) is the interest rate at which Net Present Value (NPV) of all cash flows (both positive and negative) coming from the project equal to zero. If IRR > 0 WACC, means investment is attractive and, thus, return is higher than opportunity

cost. If $IRR < WACC$, means that cash generation does not match opportunity cost and investment is not desirable. TN Table E shows that in all scenarios IRR is higher than WACC, thus investment in Hidroituango generates value form EPM.

TN Table E. IRR sensitivity (Base case scenario)

		Income scenario		
		Low Prices	Average Prices	High Prices
CAPEX Scenario	TRM Minimum	17.081%	22.950%	27.168%
	TRM Average	14.380%	20.393%	24.644%
	TRM Maximum	11.140%	17.414%	21.742%

Source: Authors' elaboration.

Equity Valuation is achieved by using valuation multiples from comparable multi-utility public companies shown in Table 8 of the Teaching Case. This valuation is built by extrapolating average public companies behaviour to the asset which is being analysed. Table 8 in Teaching Case presents weighted average Income and EBITDA valuation multiples for 10 multi-utility public companies. Authors recommend valuing equity using EBITDA rather than Income, because the former captures how efficiently a company is managing income. Equity Valuation is calculated as follows:

TN Equation K. Equity Valuation

$$Equity\ Valuation = \frac{EV}{EBITDA} \times EBITDA - Debt$$

EV/EBITDA: Valuation multiples = 13.27 (Table 8).

Equity Valuation must be discounted at a Ke rate = 10.40% (TN Table B). Additionally, must be noted that yearly EBITDA to be used corresponds to the first one when the hydropower station is in full capacity. In the Base case scenario, that year is 2021.

TN Table F. Equity Value Sensitivity (Base case scenario) in 2018 COP M

		Income Scenario		
		Low Prices	Average Prices	High Prices
CAPEX Scenario	TRM Minimum	15,566,035	23,960,965	32,355,895
	TRM Average	15,257,755	23,652,684	32,047,614
	TRM Maximum	14,712,848	23,107,778	31,502,707

Source: Authors' elaboration.

As mentioned in the subsequent explanation of TN Table A, not all scenarios are equal in probability, meaning that some are considered to be more likely to occur than others. Moreover, to comprehend which scenarios are the ones more likely to occur is both art and science. For instance, understanding macroeconomic theory helped to realize that scenarios 3 and 7 are less likely to occur than the others, because COP/USD exchange rate is inversely proportional to increase in prices. Nevertheless, that is something hard

to put in numbers. The best assignment of probability that authors feel able to give is the one shown in Table 4 of the Teaching Case.

Having into account different CAPEX and Income scenarios, it is possible to determine the probability of destroying value, expressed as (NPV < 0) or (IRR < 0); that requires assuming certain information like the one shown in probability matrix (Table 4 in Teaching Case). To obtain probabilities it's necessary to calculate average NPV and average IRR. Both averages correspond to the medium value of both statistics, having into account the probability of each individual NPV and IRR to happen. If NPV (TN Table D), IRR (TN Table E) and the probability matrix (Table 4 of the Teaching Case) are both 3x3 matrixes, the average NPV and the average IRR are calculated as follows:

TN Equation L. Average NPV and Average IRR calculation

$$\text{Average NPV} = NPV_{1,1} \times \text{probability}_{1,1} + NPV_{1,2} \times \text{prob}_{1,2} + \dots + NPV_{3,3} \times \text{prob}_{3,3}$$

$$\text{Average IRR} = IRR_{1,1} \times \text{probability}_{1,1} + IRR_{1,2} \times \text{prob}_{1,2} + \dots + IRR_{3,3} \times \text{prob}_{3,3}$$

Similarly, standard deviation of NPV and IRR could be calculated using equations as follows:

TN Equation M. NPV & IRR standard deviation calculation

$$SD\ NPV = \sqrt{\left((Average\ NPV - NPV_{1,1})^2 \times \text{prob}_{1,1} + \dots + (Average\ NPV - NPV_{3,3})^2 \times \text{prob}_{3,3} \right)}$$

$$SD\ IRR = \sqrt{\left((Average\ IRR - IRR_{1,1})^2 \times \text{prob}_{1,1} + \dots + (Average\ IRR - IRR_{3,3})^2 \times \text{prob}_{3,3} \right)}$$

In order to determine probability of NPV < 0 and IRR < WACC, it becomes handful to use a normal distribution given the fact that it is defined by only two parameters: μ = mean and σ = standard deviation. TN Equation L and TN Equation M show how to calculate statistics that describe samples and pretend to describe population. Probability is mathematically obtained by using Z-score, which describes the number of standard deviations (σ) from the mean (μ) a data point is. Z-score is calculated according to the following equation:

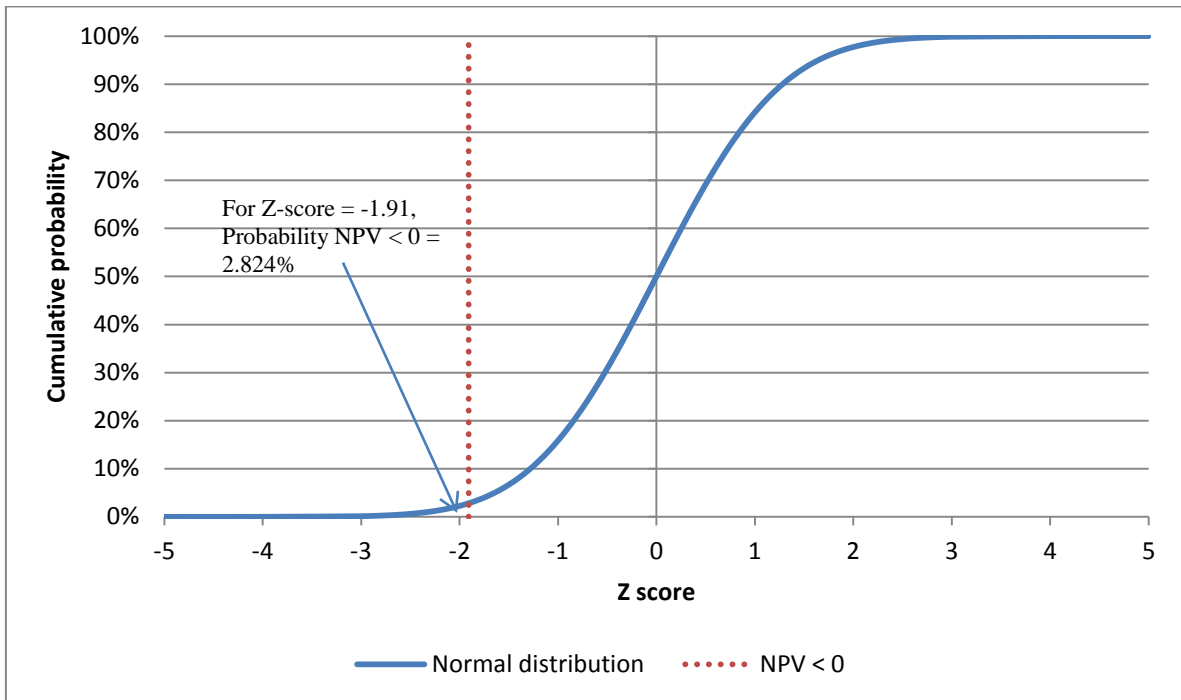
TN Equation N. Z-score calculation

$$Z - score_{NPV < 0} = \frac{0 - NPV\ average}{SD\ NPV} \quad Z - score_{IRR < WACC} = \frac{IRR - IRR\ average}{SD\ IRR}$$

TN Table G. Probability of NPV < 0 and WACC < IRR (Base case scenario)

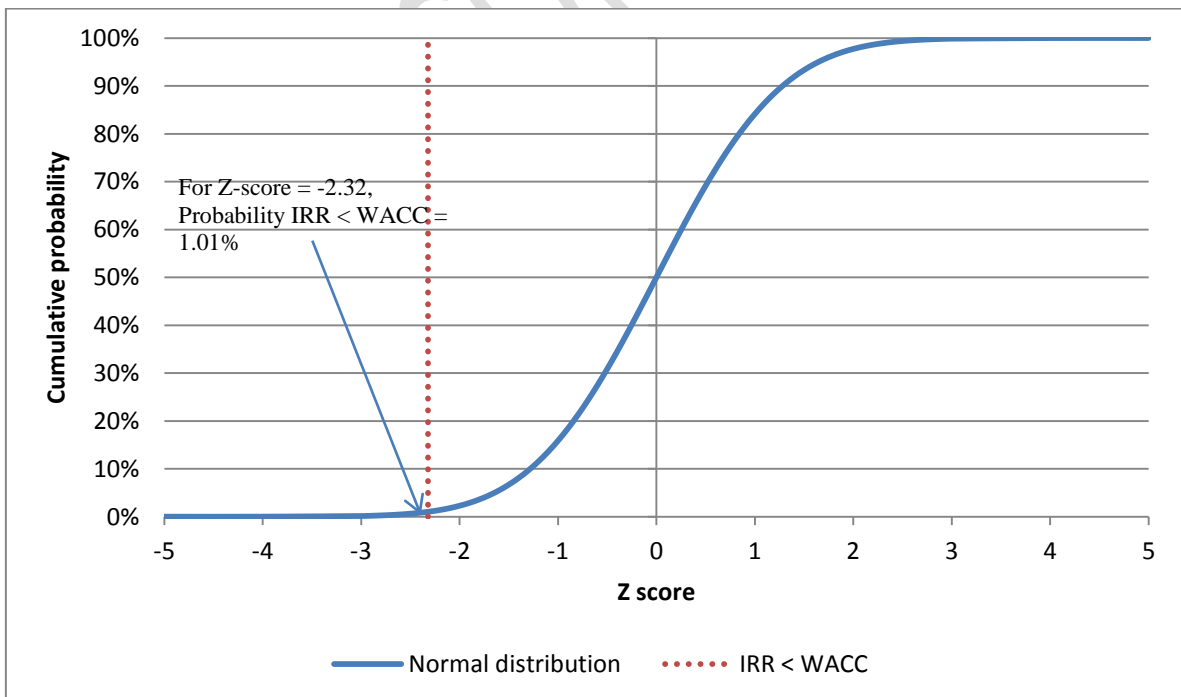
Average NPV	7,736,349	Average IRR	18.74%
SD NPV	4,056,182	SD IRR	4.55%
Z-score	- 1.91	Z-score	- 2.32
Probability NPV < 0	2.824%	Probability IRR < 8,19% (WACC)	1.017%

TN Figure A. Probability NPV < 0 (Base case scenario)



Source: Authors' elaboration.

TN Figure B. Probability IRR < WACC (Base case scenario)



Source: Authors' elaboration.

As may be seen in TN Figure A and TN Figure B, the probability of destroying value by investing in Hidroituango Project in the Base case scenario is around 1/50 to 1/100. This means that if EPM hypothetically develops Hidroituango one hundred times, there is a chance that at least in one of those times the project destroys value for the company.

Section 3: Scenario1 – Hidroituango after the contingency

The financial effects of the contingency on the project may be summarized as follows:

- CAPEX increased in 3,000 COP BN, to be expended between 2019 and 2023 (Figure 2 and Table 9 of the Teaching Case). More CAPEX means more depreciation, turning in less NOPAT and, ultimately, in less ROIC. This impacts both FCF and the terminal value.
- Additional expenses increased by 1,000 COP BN. It is expected to expend it between 2018 and 2020 (Figure 2 and Table 9 of the Teaching Case), and has the same effect than CAPEX.
- Income generation is expected to delay from 2019 to 2021. Just until 2024, Hidroituango will be working at full capacity. This makes FCF decrease.
- Three out of four insurances are plausible to be paid to EPM, as indicated in Figure 4 of the Teaching Case. Those insurances sum up around 2,800 COP BN. This partially increases FCF.
- WACC, growth and debt are supposed to remain unchangeable, as indicated in Teaching Case.

Construction of the Income and Cash Flow Statements in the contingency case scenario is a similar process than the one shown in the Base case scenario. The differences are associated to the effects of the contingency mentioned. Having that into account, ROIC, NPV and IRR sensibilities are shown as follows:

TN Table H. ROIC sensitivity (Contingency case scenario, calculated in 2027)

		Income scenario		
		Low Prices	Average Prices	High Prices
CAPEX scenario	TRM Minimum	10.151%	15.084%	20.016%
	TRM Average	9.018%	13.465%	17.913%
	TRM Maximum	7.815%	11.747%	15.678%

Source: Authors' elaboration.

TN Table H shows that minimum ROIC in the Contingency case scenario = 7.815% is more than 2 points (200 basic points) smaller than minimum ROIC in the Base case scenario (TN Table C).

TN Table I. NPV sensitivity (Contingency case scenario) in 2009 COP M

Income scenario		
Low Prices	Average Prices	High Prices

CAPEX Scenario	TRM Minimum	- 1,053,072	3,377,848	7,808,769
	TRM Average	435,743	4,866,663	9,297,583
	TRM Maximum	1,551,113	5,982,033	10,412,953

Source: Authors' elaboration.

TN Table I shows that minimum NPV in the Contingency case scenario = -1,053 COP BN is more than 2,500 COP BN higher than minimum NPV in the Base case scenario (TN Table D). In fact, in one out of nine cases $NPV < 0$, meaning value is destroyed at least in a 1/9 proportion.

TN Table J. IRR sensitivity (Contingency case scenario)

	Income scenario		
	Low Prices	Average Prices	High Prices
CAPEX Scenario			
TRM Minimum	11.257%	17.279%	21.327%
TRM Average	9.000%	15.230%	19.344%
TRM Maximum	6.247%	12.812%	17.036%

Source: Authors' elaboration.

TN Table J shows that minimum IRR in the Contingency case scenario = 6.247% is almost 5 points (500 basic points) smaller than minimum IRR in the Base case scenario (TN Table E). In fact, in one out of nine cases $IRR < WACC$, meaning value is destroyed at least in a 1/9 proportion.

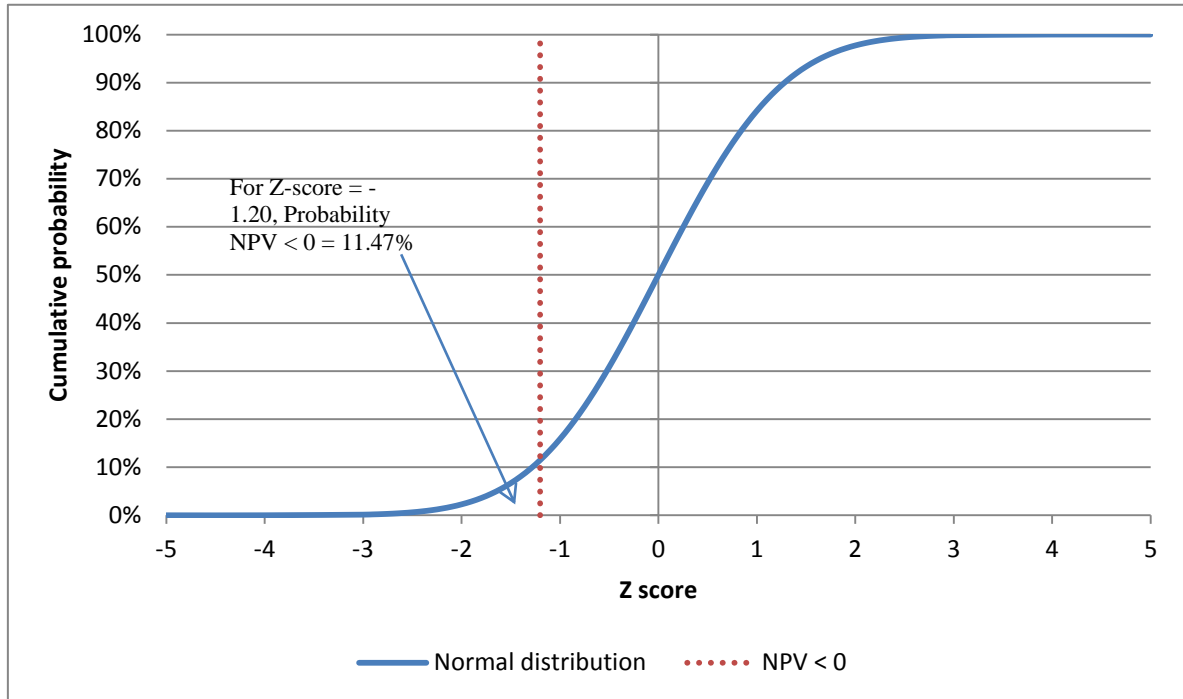
TN Table K. Probability of $NPV < 0$ and $WACC < IRR$ (Contingency case scenario)

Average	4,289,561	Average	13.67%
Desvest	3,569,549	Desvest	4.44%
Z-score	- 1.20	Z-score	- 1.24
Probability $NPV < 0$	11.474%	Probability $IRR < 8,17\%$ (WACC)	10.805%

Source: Authors' elaboration.

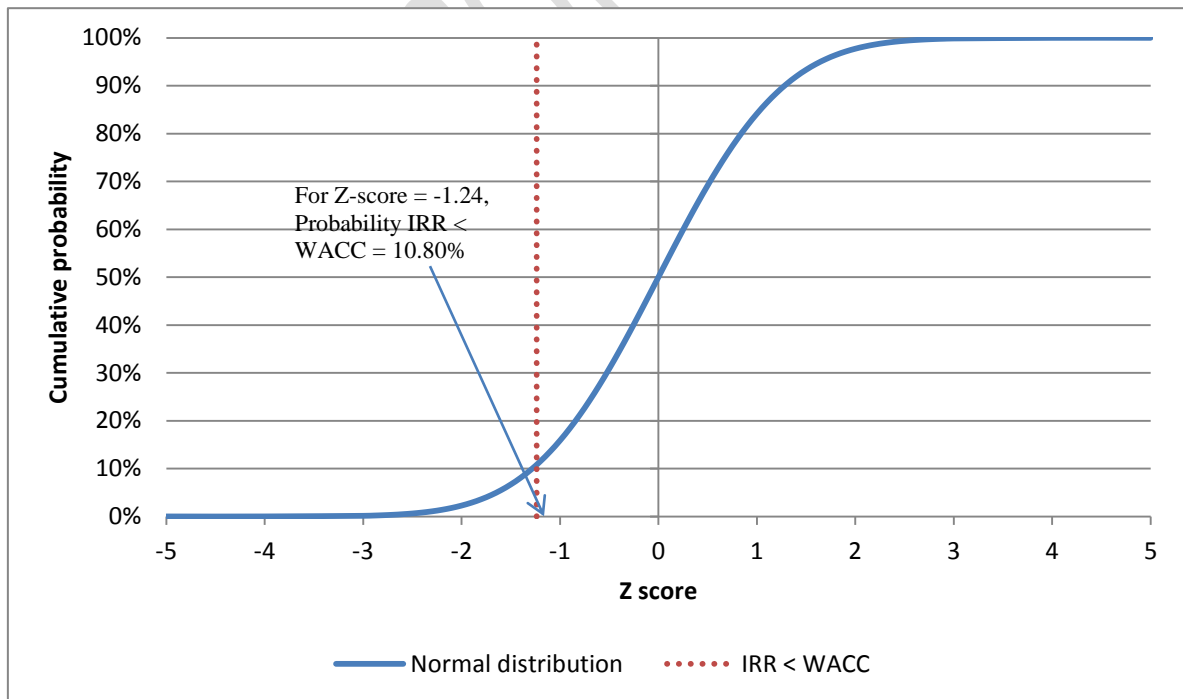
On average, NPV still has a positive value (more than 4,289 COP BN), and $IRR = 13.67\% > WACC$. However, the probability of destroying value in Hidroituango, failing the main goal of an investment, more than multiplied by five.

TN Figure C. Probability NPV < 0 (Contingency case scenario)



Source: Authors' elaboration.

TN Figure D. Probability IRR < WACC (Contingency case scenario)



Source: Authors' elaboration.

As may be seen in TN Figure C and TN Figure D, probability of destroying value investing in Hidroituango Project in the Contingency case scenario reached around 1/11 to 1/10. This means that if EPM hypothetically develops Hidroituango ten times in the Contingency case scenario, there is a chance that at least in one of those cases the project destroys value for the company. This is relatively similar to TN Table I and TN Table J, where in one out of nine cases value is destroyed for EPM. As a conclusion, due to the contingency the risk of this project destroying value for EPM multiplied by 5 compared to the Base case scenario.

Section 4: Conclusion, Epilogue and Decision

The first big issue related to the case is weighing the pros and cons of corporate and project finance. In order to complement previous analyses, it must be appointed that valuating assets do not consist just in determining a specific value, but also explaining which risk is associated to that value. In authors' view, one mistake was EPM deciding to use a corporate finance approach rather than a project finance approach to develop the project. Given as certain only the public information disclosed, the only concern for EPM appeared to be which approach saved more money to the company, not which approach save more money considering the risk associated to that decision. If project finance would have been the approach used by EPM in a first place, the effects of the contingency in the financial state of the EPM Group would have been much lesser. Balancing the trade-off between the value and the risks is a key element in financial analysis, but that is something that EPM appeared did not have into account.

Depending on the designer's view, his or her decisions might be biased. This means that financial models are sensitive to absorb bias coming from its designer's decisions, thus reflecting financial scenarios detached from reality. Given the fact that biasing is in most cases an unconscious decision, it is not easy to stop being biased. However, some decisions could be taken to minor biasing, as formulating a better, a worst or an average scenario, which introduces the case to probabilistic analyses. This decision makes statistics closer to *real* average and ultimately permits to diminish initial biases. At the end of the day, selecting key variables and the plausible ranges in which they vary improves the results of financial models or at least reduce the biases which induct to error. This is the explanation why nine scenarios were presented during this Hidroituango analysis. Imagine CFO selecting just the best scenario (number 3 in TN Table A); in his view, the project just would have changed from an exceptional situation (Base case scenario) to a very good situation (Contingency case scenario), meaning that the decision to be taken by the Board was a very easy one, and Hidroituango undoubtedly would have to continue. However, imagine the CFO selecting the worst scenario (number 7 in TN Table A); in that case, the project probably would have never started, preventing EPM to gain all the value which is forecasted to be produced.

Additionally, thinking in probabilistic terms is not a common attitude among most people, and certainly is not easy to handle when assessing finance problems. It is easier

to say that an asset possesses a specific value, but imagine someone which reasonable disagrees with one of your subjective assumptions like long-term tax rate, interest rate, GDP growth or inflation; that legitimate difference in one or some of the assumptions reflects a different asset value which is as probable as your asset value itself. To accept that many comparable and equally-likely good or bad decisions are possible to be taken is another argument to establish different scenarios, which finally allow developing probabilistic analyses rather than deterministic ones.

In Section 3 it was observed that due to contingency, the risk of $NPV < 0$ and $IRR < WACC$ more than multiplied by 5 and reached a probability of 1/10. Actually, 1/10 is almost as big as the probability of throwing three coins at a time and getting heads in those three (1/8). In some people's opinion, authors included, that is a big risk, because there are no guarantees that no more contingencies are going to come in the future, worsening the current scenario. However, the decision frame in which the Board had to take the decision was not between Base case scenario and Contingency case scenario, but between Contingency case scenario and cancelling the project scenario. In the Contingency case scenario, the worst case reflects a NPV around -1,000 COP BN. But if cancelled, no income is going to be generated and, thus, all the inverted CAPEX will be lost, around 9,000 COP BN, plus billionaire expenses related, at least, with dismantling the dam. If the alternatives are: i) maybe losing 1,000 COP BN; or ii) definitely losing more than 9,000 COP BN, authors believe that CEO and CFO should advise the Board to continue with the project.

Finally, it must be appointed that during 2018, EPM's decision was to complete the project once all permissions by the authorities were released after the contingency.

Endnotes

- [1] Engel, E., Fischer, R. y Galetovic, A. (2014). *The Economics of Public Private Partnerships* (1st ed.). New York City: Cambridge University Press.