



Cost of Equity: Eolic Projects in Emerging Countries (Argentinean case)

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Introduction

During the last decade, Non-Conventional Renewable Energy (NCRE)¹ has shown an unprecedented growth. Between 2005 – 2015 Wind and Solar Photovoltaic (PV) power capacity, the most representatives within NCRE group, increased 634% (22% annual average) and 4351% (46% annual average) respectively.

Thus, at the end of 2015 wind power totaled 433 GW worldwide, while PV summed up 227 GW. It is important to remark that the last one has grown at a higher rate in the last decade, therefore the gap between them has continuously been decreasing (REN 21, 2016; EIA, 2016).

On the other hand, growth share worldwide varies notably during the analyzed period.

During 2005, growth leaders were Germany, Spain and India, and only two developing countries, China and India, were in the Installed Top-10 Capacity (~50 GW). Also, the global PV capacity was insignificant (<2 GW worldwide) (REN 21, 2006).

Six years later, Wind and PV installed capacity increased up to 238 GW and 70 GW respectively, being China and Germany the leaders in capacity growth, followed by the United States playing a key role in both technologies as well (REN 21, 2012).

In 2015, China takes the lead in capacity growth for both technologies, and jointly with the United States, relegates the European countries. In addition, a variety of developing countries such as Brasil, Chile and Pakistan have augmented their share in both wind and PV technologies (REN 21, 2016).

Although South America is still far away from Europe, China and US levels, it is certainly going through its own “green energy boom.” Nowadays this region is having a sustained growth, above world average, caused mainly by international credit availability, unbeatable natural resources (Tissot, 2012) and a growing demand (EIA, 2016).

In this region, wind energy capacity has been tripling since 2012, and PV grew from almost non-existing capacity in 2012 to 1 GW by the end of 2015. 2016 was also a stunning year for NCRE, with results for tenders and auctions forecasting more than 5 GW in new capacity, just between Chile, Perú, Brasil and Argentina (IRENA, 2016). Furthermore, prices were lower than expected, in a range of 30-60 U\$S/MWh, showing a huge gap between countries, technologies and companies.

This scenario demands the adjustment of financial assessments to the local conditions, considering that calculation of the cost of equity and debt are substantially different between South America, US and Europe.

The information provided in the previous paragraph is particularly relevant in NCRE projects, usually strongly leveraged, with 60% to 90% of total investment covered by debt. Then, a correct pricing of energy produced requires new assessment tools, contemplating local issues.

Finally, A. Damodaran on his personal website maintains an updated database with a list of Betas classified both by industrial sector and regional datasets. On its Global analysis, the "Green & Renewable Energy" sector is composed of 179 firms which have been used to estimate the industry's

¹ It excludes Hydroelectric, considered conventional.

leveraged and unlevered Global betas. Thus, to get to his result A. Damodaran needs to bear 179 regressions plus further adjustments.

Objective

The main objective of this paper is to develop a calculation method of the cost of equity (determined by the CAPM²) for wind energy projects in Argentina, also as a useful framework to be employed in emerging countries. Although PV energy is still underdeveloped compared to wind energy, and thus there is not enough market data yet, the proposed framework is valid for PV projects as well, as wind and PV share economic features.

For that purpose, these main steps will be followed:

- a) Estimating a specific *Beta*³ for wind projects, using global indexes.
- b) Calculating the Unlevered *Beta* of previous result.
- c) Re-levering the obtained *Beta*, based both in expected local debt and effective taxes ratios.
- d) Calculating the CAPM for wind energy projects in Argentina.
- e) Using this methodology to calculate CAPM for Emerging Countries and finally compare them.

Methodology and Estimation

In greenfield projects, the cost of equity is the return that an investor requires to decide its participation (or not) in an investment project, ex-ante. The most common methodology to estimate it is the Capital Asset Pricing Model (CAPM), detailed in later paragraphs.

However, in our way of searching the local CAPM for the studied projects, first we must calculate the Beta for wind energy projects (we will discuss the reason for this need in the CAPM section).

Beta is a measure of the volatility, of an individual stock or a portfolio, in comparison to the whole market. In this case, we analyze the volatility of wind energy companies.

Beta Estimation

As a first step, we specify the mathematical definition of the beta of an industry. In that sense, we decided to lean on the one provided by A. Damodaran⁴:

² Refer to the section “Capital Asset Pricing Model” for further explanations.

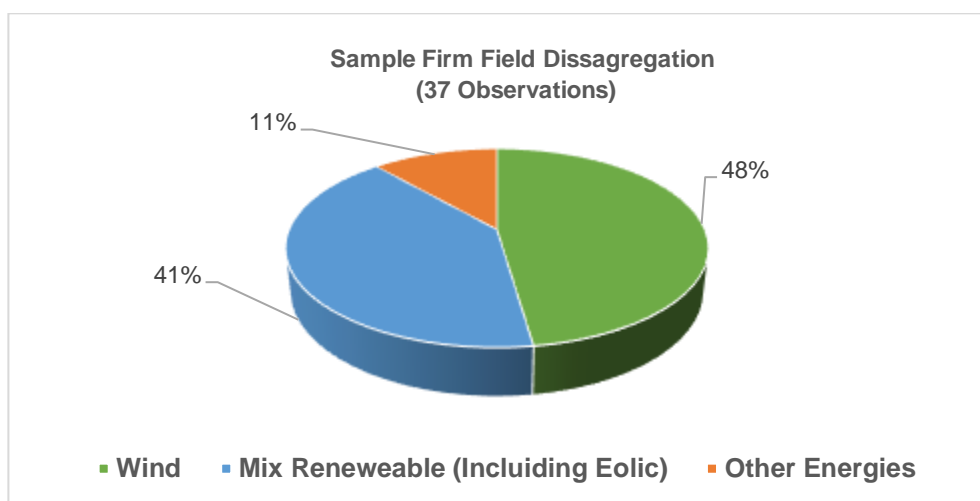
³ Refer to the next section for a detailed definition of the Beta of an asset.

⁴ Aswath Damodaran, “Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Second Edition”, chapter 4, page 17.

$$\text{Beta of an asset } i = \frac{\text{Covariance of asset } i \text{ with Market Portfolio}}{\text{Variance of the Market Portfolio}} = \frac{\text{Cov}_{im}}{\sigma_m^2}$$

In the case of a simple linear regression, its slope is the beta of the asset⁵. In this regard, “[...] *the conventional approach for estimating the beta of an investment is a regression of the historical returns on the investment against the historical returns on a market index*” (A. Damodaran, 2002, c.8 – p.2).

Per the procedure described above, our first duty was to search for ***an appropriate financial asset*** to play the role ***as a representative wind company stock*** and another one to play the role as the market. We came to select the First Trust ISE Global Wind Energy Index Fund (FAN) to play the first role described because of its financial structure: 48% of them have as only purpose the wind energy market, 41% of them the renewable energy market and 11% other energy markets. We also verified that 60% of the companies of our sample are wind farm operators concluding that for our purposes its structure reflects a fair picture of the Wind market.



Source: Own estimations.

As performing the second role, we selected the S&P 700⁶ following the recommendations provided by A. Damodaran when he emphasizes the preference to use an index that is composed of stocks from different global markets (in the case of an international or cross-border investor). Furthermore, because the FAN index has a noticeable ponderation of European companies (meaning that 67% of the FAN conformation corresponds firms from that origin) we opted to choose an index without US influence.⁷

Our second duty was to regress the FAN against the The S&P 700. For that purpose, we used the monthly market rates corresponding to a three-year (from Aug-13 to Jul-16) period of both assets⁸.

⁵ Aswath Damodaran, "Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Second Edition", chapter 8, page 3.

⁶ For more information about the specifics about the index refer to <http://www.us.spindices.com/indices/equity/sp-international-700>

⁷ The Indexes on which we base in order to estimate our regression had been taken from the report: "The impact of risks in renewable energy investments and the role of smart policies" by the DIA-CORE Project. For further information please refer to the original work.

⁸ We used <http://www.morningstar.com/historical data for our calculations>

Later we obtained the historical monthly return of each index using the following calculation⁹:

$$\text{Market Return}_j = \frac{\text{Index}_j - \text{Index}_{j-1} + \text{Dividends}_t}{\text{Index}_{j-1}}$$

where,

Market Return_j = returns of the index in month *j*

Index_j = the level of the index at the end of month *j*

Index_{j-1} = the level of the index at the end of month (*j - 1*) (the previous month)

Dividend_j = the dividends paid on the index in month *j*

Finally, we regressed the FAN against the S&P 700 using Eviews 7.1 software obtaining the following statistical output:

Dependent Variable: FAN				
Method: Least Squares				
Date: 02/26/17 Time: 16:16				
Sample: 2013M08 2016M07				
Included observations: 36				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.008958	0.00471	-1.901956	0.0657
S_P_700	0.998109	0.125628	7.944948	0
				-
R-squared	0.649926	Mean dependent var		0.030476
Adjusted R-squared	0.639629	S.D. dependent var		0.038516
S.E. of regression	0.023122	Akaike info criterion		-4.64214
Sum squared resid	0.018177	Schwarz criterion		4.554166
Log likelihood	85.55851	Hannan-Quinn criter.		4.611435
F-statistic	63.12221	Durbin-Watson stat		1.412612
Prob(F-statistic)	0			

⁹ Aswath Damodaran, "Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Second Edition", chapter 8, page 5.

As we can see in our summary output, from our sample of 36 months' observations we arrived to a beta value equal to $\beta = 0.9981$

For further analysis on the overall robustness of the obtained regression, please refer to Annex I.

However, this result belongs to the levered beta. That is, it has incorporated the capital structure of the companies that compose the ISE Global Wind Energy Index Fund and, therefore, we must unlevered it to erase that distortion.

Unlevered Beta

Before venturing into the heart of this section, we will modify the estimated beta using the adjustment proposed by Blume¹⁰ (for predictive purposes).

The formula is usually used:

$$\beta_{adjusted} = 1/3 + 2/3 * (\beta_{unlevered})$$

Obtaining:

$$\beta_{adjusted} = 0.9987$$

To find the unlevered beta, we relied again over the methodology followed by A. Damodaran; who defined the unlevered beta equation as:

$$Unlevered\ Beta_{Business} = \frac{Beta_{comparable\ firms}}{1 + (1 - t) \frac{D}{E}_{comparable\ firms}}$$

Therefore, we searched for the *debt to equity ratio* ($\frac{D}{E}$) of the ISE Global Wind Energy Index Fund. To do this we started by looking for the last 7 years ($\frac{D}{E}$) ratio (between 2010 and 2016) for each company composing the FAN index. Once we finished our investigation we ended reaching a representativeness of 93% over the complete population; that is, 37 observations over a 44 (being the last amount one the full population). After that, we computed the weighted average of each one of the 37 firms ($\frac{D}{E}$) from

¹⁰For more information about how to calculate the Blume's adjusted beta and understand the concept behind it please refer to M. Blume, March 1971, "On The Assessment of Risk", The Journal Of Finance, 1-10. and M. Blume, June 1975, "Betas and Their Regression Tendencies", Journal of Finance, X, No. 3, 785-795.

2010 to 2016. Lastly, to obtain the debt to equity ratio of the FAN index, we proceeded to sum each one of the weighted average ratios, reaching a $\frac{D}{E} = 0.79$.

An analogous procedure was applied to calculate the index's effective tax rate; this time reaching a representativeness level of 89% (36 observations over full population). It is important to remark that the temporal frame used to calculate the effective tax rate was the same as the one used to calculate the debt to equity ratio; that is, from 2010 to 2016. The effective tax rate of the ISE Global Wind Energy Index Fund resulted to be equal to $t = 0.3444$.

Calculation:

$$\beta_{adjusted} = 0.9987$$

$$\frac{D}{E} = 0.79$$

$$t = 0.3444$$

$$Unlevered \beta_{wind \ market} = 0.6575$$

Re-levered Beta

Finally, we computed a new beta by leveraging it with the $\frac{D}{E}$ corresponding to the capital structure of the project to be evaluated. In our case, we opted for a target debt to equity ratio of 70/30 following the results obtained with the DiaCore team¹¹.

We calculate the value of the levered beta through the Hamada equation¹²:

$$\beta_L = \beta_U \left(1 + (1 - t) \left(\frac{D}{E} \right) \right)$$

Calculation:

$$\beta_U = Unlevered \beta_{wind \ market} = 0.6575$$

$$\frac{D}{E} = 2,33$$

$$t = 0.35^{13}$$

¹¹ DIA-CORE, "The impact of risks in renewable energy investments and the role of smart policies", page 164, February 2016.

¹² For more information please refer to Aswath Damodaran, "Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Second Edition", chapter 8, page 20.

¹³ Corresponds to the effective tax rate applicable in Argentina.

$$\beta_L = \text{Levered } \beta_{\text{target}} \frac{D}{E} = 1.6547$$

Capital Asset Pricing Model (CAPM)

Having estimated our wind energy beta, all the information we needed to obtain the wind energy cost of equity is: the US risk-free rate, the US risk-premium and the Country Risk Premium. That is, all the remaining information needed to compute our beta result in the modified version of CAPM¹⁴ model suggested by A. Damodaran¹⁵:

$$\text{Cost of equity} = \text{Riskfree rate} + \text{Beta} * (\text{U. S. Risk premium}) + \text{Country Risk Premium}$$

As an example, we proceeded to calculate the cost of equity for Argentina.

$$\text{Free rate} = \text{US Treasury Bonds 10 Yr} = 1.84\%^{16}$$

$$\text{US risk} - \text{free rate} = \text{Risk Premium} = 4.81\%^{17}$$

$$\text{EMBI} + (\text{Average 2016}) = \text{Country Risk Premium} = 4.75\%^{18}$$

$$\beta_L = \text{Levered } \beta_{\text{target}} \frac{D}{E} = 1.6537$$

¹⁴ For original author reference please refer to: Sharpe. William F, 1964, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk.", Journal of Finance, 19:3, pp. 425–42. and Lintner. John, 1965. "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets.", Review of Economics and Statistics, 47:1, pp. 13–37.

¹⁵ For more information please refer to Aswath Damodaran, "Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, Second Edition", chapter 7, pages 14 – 19.

¹⁶ US Treasury Bonds 10 Yr (Average 2016). Source: <https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield>

¹⁷ For our estimation, we computed the difference between the returns on US long-term bonds and the ones from the S&P500 for the 25-year period from 1991 to 2016.

The arithmetic average performance of the stocks during mentioned period is 11.32%, while that of the US long-term bonds is 6.51%; resulting in a difference of 4.81% that will be risk premium.

Source: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html, Aswath Damodaran, January 5, 2017.

¹⁸ JP Morgan Emerging Market Bond Index (EMBI) is considered a good indicator of country risk. Composed by a portfolio of bonds denominated in United States dollars (of different average life) resulting in a good indicator of national financial risk.

Due to Argentina's departure from default risk after paying off 'holdout' bondholders on April 2016, we decided to take as a reference Country Risk Premium the average country risk rates from the year 2016. Potential changing expectations should be considered regarding the Argentine economy. The resulting value of the average daily EMBI + Argentina for 2016 is 4.75%.

ARG Wind Energy Cost of Equity = 1.84% + 1,65 * (4.81%) + 4.75%

ARG Wind Energy Equity Cost = 14,55%

Wind Energy Cost of Equity per Country

In this section, we continued our analysis by performing the same operation described above but for every LATAM Emerging Country accounted in the EMBI+ index list. In that sense, we chose to calculate each of our country risk premiums by averaging the daily historical quotes for every EMBI+ from Oct-2007 to Jan-2017.

Here is a short summary of the data source we used for our estimations:

EMBI+	Average 10Y (Oct-2007 to Jan-2017)
Brasil	2.65
Colombia	2.21
Ecuador	10.12
Argentina	4.75 ¹⁹
México	2.26
Perú	2.00
Panamá	2.08
Venezuela	27.49 ²⁰
Uruguay	2.53
Chile	1.56 ²¹
El Salvador	4.30 ²²

Source: Own estimations.

¹⁹ Idem footnote n° 18.

²⁰ In Venezuela's case, due to a difference above 12 percentage points between the 10-year average (Oct-2007 to Jan-2017) and the 2016 average for the EMBI+ Venezuela; we used the latter average as we believe is a better reflection of the current risk perceived by investors.

²¹ In Chile's case, we averaged the daily historical quotes from Jul-2009 to Jan-2017 (8-year period approximately) due to information availability in our consulted database.

²² In El Salvador's case, we averaged the daily historical quotes from Jul-2009 to Jan-2017 (8-year period approximately) due to information availability in our consulted database.

It is important to remark that we supposed a 35% effective tax rate when we calculated our beta. Therefore, a more accurate way of determining every cost of equity for each country would be to compute its own effective country tax rate during its beta estimation. With the only purpose of keeping this article as short as possible we chose to use 35% as a fixed effective tax rate for all our population countries.

Our estimations results are shown in the next table:

Country	Cost of Equity Per Country
Brasil	12.44%
Colombia	12.00%
Ecuador	19.91%
Argentina	14.55%
México	12.06%
Perú	11.79%
Panamá	11.87%
Venezuela	37.28%
Uruguay	12.33%
Chile	11.35%
El Salvador	14.09%

Source: Own estimations.

Conclusions

As we have seen, NCRE are becoming a solid industry worldwide, as they compete both in price and performance with conventional thermal energy; collaborating, at the same time, with environmental sustainability.

As this industry moves forward, also the amount of companies and available financial information do so. We can notice it in the creation of wind energy indexes that didn't exist few years ago. This type of information is crucial for projects assessment, usually high leveraged.

Despite its great natural resources, Latin America is just in the beginning of the renewable path. Emerging markets hold a huge amount of papers written about external debt, their interest rate and how it should be calculated; but just a few have explored, from a theoretical-economic point of view, NCRE projects. That is, at this moment, there is lack of information in terms of the opportunity cost for renewable projects in Latin America.

As we explained, knowing this information is crucial for correct project assessments. Given the mentioned relevance of the matter, we decided to dedicate this work to estimate the cost of equity for wind projects in Argentina. To accomplish this task, we used: the CAPM theory, an own Beta estimation, and Damodaran's statistic equations for the Country Risk Premium assessment.

We believe that the greatest value of this work takes place in the choice of the indexes to obtain the Wind Energy Beta. Since Beta is the only risk parameter of the CAPM model that measures the target industry risk (in our case the Wind Industry), we thoroughly investigated the composition of the potential indexes to use in our regression. In that sense, we decided that the FAN could be used as fair representation of the Wind Industry and, consequently, the S & P 700 as the Market representation (taking into consideration the countries that compose the latter in comparison to the FAN).

From what is described in the previous paragraph, we found in the proposed methodology a simpler way to get the wind industry beta, and to adjust it to local variables. Firstly, due to the least amount of observations necessary to achieve similar results to those obtained by A. Damodaran (in Jan-2017 his "Green & Renewable Energy" unlevered beta was equal to 0.5723)²³; and secondly, because data surveyed is significantly less in this single regression than in the 179 regressions calculated by Damodaran. Therefore, we concluded that it is possible to obtain the wind industry beta from a single asset, without resigning significant explanatory power or statistical rigor.

Furthermore, the obtained results are consistent with Argentina's last tender prices and informal comments from key players. It is important to point out that we extended the calculation to other Latin American countries, although data absence preclude us from checking their consistency.

Beyond the considerations and limitations of the preceding paragraph, the main intended reason of our findings is to be used as a reference tool; that is, as an elementary benchmark rate for wind projects assessment in emerging countries (which also could be easily extended to PV projects)

As pending, there is the duty to collect data about investment cost, debt cost, leverage and corporate taxes for every studied country, towards to develop more specific and detailed rates, that could be used not just as a reference, but as a real discount rate for the NCRE projects in each country.

²³Source: <http://www.stern.nyu.edu/~adamodar/pc/datasets/betaGlobal.xls>, Aswath Damodaran, January 5, 2017.

ANNEX I

Sample: Statistical Regression Basics

$$n = 26$$

$$k = 2$$

Student's t-test

$$t_1 = - 1.9019$$

$$t_2 = 7.9449$$

Since the test t has the following form $t < n - k, 1 - \alpha/2 >$, our t_{cr} will be:

$$t_{cr} = |2.0281|$$

That is, if $-2.0281 < \text{empirical } t < 2.0281$ then we don't reject null hypothesis. In the opposite case, we will reject the null hypothesis that both parameters of the obtained regression are individually equal to zero.

As can be seen that t_2 test is in the rejection zone, therefore we conclude that this variable is significant for the considered model. Being the t_1 test in in the acceptance zone doesn't imply major consequences because it is the intercept.

R Square and Adjusted R Square

$$R \text{ Square} = 0.6499$$

$$\text{Adjusted } R \text{ Square} = 0.6396$$

Although both the R^2 and the adjusted R^2 do not yield values close to 1, they have an acceptable explanatory power.

F-test

$$F = 63.1222$$

Considering that F - test has the following form $t < k - 1, n - k, 1 - a >$, our F_{cr} with a significance of 5% will be:

$$F_{cr} = 4.1709$$

That is if *empirical* $F < 4.1709$, then we don't reject. In the opposite case, we will reject the null hypothesis that both parameters of the obtained regression are jointly equal to zero.

Durbin-Watson Test

$$d = 1.4126$$

$$4 - d = 2.5874$$

Null Hypothesis:

H0: The errors are uncorrelated

For $n = 36$ and 2 explanatory variables we have that our critical values are $d_l = 1.411$ and $d_u = 1.525$. Having that in consideration we conclude that there is no statistical evidence that the error terms are negatively autocorrelated; and, also that the test is inconclusive regarding the possibility that the error terms are positively autocorrelated.

Will remain for future investigations to explore the recommendations made by Roger G. Ibbotson, Paul D. Kaplan, and James D. Peterson when they encourage to incorporate the information contained in prior market returns²⁴. That is, to address the possibility of dealing with autocorrelation by adding lagged market returns into the estimation process.

²⁴ Please refer to Ibbotson, Roger G., Paul D. Kaplan, and James D. Peterson, 1997, "Estimates of Small-Stock Betas Are Much Too Low," Journal of Portfolio Management.

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