Financial Leverage in Renewable Energy and its Future Investment

Asghar Sabbaghi and Drew Ritter*

Abstract

This study will examine the impact of financial leverage on renewable energy sector and the factors that influence leverage, as well as the new financial risks, in today's global environment. We will develop a number of analytical models to analyze the trends and risk factors in renewable energy sector when compared with SPX Index. We will demonstrate that clean energy can be an attractive long-term investment if some financial risks arising from the debt and capital structure can be diversified away, Moreover, we argue that there are high amounts of debt in the capital structure of clean energy, but time will tell how much risk is associated with financial leverage regarding this debt.

Keywords: Financial Leverage, Renewable Energy Investment, Renewable Energy Investment models,

I Introduction

The purpose of this study is to examine the effects of financial leverage on clean sources of energy and the factors that influence leverage, as well as the new risks, in today's financial market and the factors that influence leverage, as well as the new risks, in today's global environment.

The concept of financial leverage, in general, is defined as the ratio of equity and financial debt of a company, and is viewed as an important element of a firm's financial policy. Higher financial leverage implies that there is higher financial debt for a fixed equity. This would allow the company to use more debt to finance assets acquisitions, and to potentially boost the returns on equity capital of a company, especially when the business is unable to increase its operating efficiency and returns on total investment. Due to the assumption that earning on borrowing is higher than interest payable on debt, the company's total earnings will increase, ultimately boosting the earnings of stockholders. Therefore, leverage is often viewed as an essential tool a company's management can use to make the best financing and investment decisions, as it provides a variety of financing sources by which the firm can achieve its target earnings. Leverage is also viewed an important technique in investing as it would help companies to set a threshold for the expansion of business operations. For example, it can be used to recommend restrictions on business expansion once projected return on additional investment is lower than cost of debt.

Leverage is also used by investors to significantly increase the returns that can be provided on an investment. They lever their investments by using various instruments, including options, futures, and margin accounts. Companies also use leverage to finance their assets, and thus, instead of issuing stock to raise capital, companies can use debt to invest in business operations in an attempt to increase shareholder value. However, as financial leverage increases, the cash flow requirements necessary to service additional debt also increases. Therefore, the risk of inadequate cash flow can be a concern in strategic decisions regarding financial structure**.** This suggests that liquidity and leverage are intricately intertwined in these financial decisions.

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Financial risk may also arise from variation in earnings per share (EPS) due to the use of debt capital as well as the risk of insolvency of the common stock shareholders. Moreover, financial risk may be associated with the consequences on uncertainty of firm's financial policy regarding the debt-equity mix and fixed interest charge associated with debt. Introduction of debt capital into a firm's capital structure intensifies the volatility of earnings per share (EPS). Therefore, additional earnings are vital to compensate for the financial cost arising from the debt capital, otherwise, the employed debt capital will increase the firm's financial risk.

According to Ahmed Sheikh and Wang (2011), inappropriate selection of securities such as debts or preferred stock creates a financial distress and ultimately to bankruptcy of the firm. Furthermore, as Luoma and Spiller (2002) state, a particular usage of preferred stock and debt in financing the firm's assets creates financial risk which is directly associated with firm's financial leverage. The impact of financial leverage would depend on economic conditions. Levy and Sarnat (1994) have argued that this impact would likely be positive under good economic condition while it is negative under downturn economic condition. Therefore, capital structure and financial strategy that led to increasing the variability of firm's return may expand the financial risk of the firm.

In this study, we will examine the trends and risk factors to be considered for future investment in clean energy sector, and discuss the following questions: (1) what is the impact of financial leverage on renewable energy? (2) What are the factors that influence leverage? And (3) What are the new risks in today's global environment?

One may argue that a society with previous tendencies to depend upon fossil fuels must eventually switch to cleaner energy sources. Additionally, producers used to borrow without paying close attention to the implications of considerable potential risk due to the pandemic, and consequently deleveraged their finances. According to the International Energy Agency (IEA), renewable energy has shown reasonable resilience, when compared with alternative energy sources throughout 2020. Moreover, for the first time in over 130 years, the United States produced more renewable energy than coal (Francis, 2020). However, many issues associated with the pandemic have stalled progress within renewables, such as tax incentives, supplier issues, and lockdowns disrupting consumer spending. In this study, we will focus on the renewable energy sector and the effects of financial leverage on investment within this sector, and trends that contribute to the risk.

Given the dependency of renewable energy on new technology innovations and the potential for growth, the clean energy sector is becoming an attractive investment. Thus, renewable energy companies have the potential of constant improvement in reducing their cost through applied research and knowledge, similar to technology companies. However, the industry appeal is matched by uncertainty, because investors are repricing the risk in investment in renewable energy due to the current global environment as well as additional focus on clean energy contributors' capital structure. We will examine the leverage in clean energy sector in relation to the implied risk.

II Literature Review

According to the International Energy Agency's annual report (IEA, 2020) the performance of renewable energy has declined, much like the global economy over the same period. However, renewable energy has been more resilient than oil and other energy production subsectors (IEA, 2020). This annual report contains numerous depictions of performance, expectations, sector trends, and what is referred to as the Sustainable Development Scenario (SDS). The SDS is the baseline that has been developed to determine the sustainability measures within energy production compared to sustainable future goals. Hence, the SDS gives a baseline for what future expectations within clean energy sources should be for a healthy environment.

The history of renewable energy sector and its financial performance can help to better understand how financial leverage can determine the industry's value and future expectations. Nissim and Penman (2003) have examined operating, financial, and total leverage to speculate future returns. They also include the equations for calculating each type respectively. They used data from 1963 to 2000, and concluded that the firms with the highest leverage had lower operating income overall. However, they did find that leverage have contributed to future profitability in controllable amounts. They have examined the short-term effect of financial and operating leverage versus the long-term effects of liability and the issues that can arise within those markets due to long-term debt (Nissim and Penman, 2003, pp. 4,).

Baker (2001) has investigated the effect of financial leverage and the greater use of debt capital from a holistic approach. He has used economics and statistical analysis to examine the effect of leverage on profitability and risk (Baker, 2001). This study has used a two-way model for stock market conditions plus leverage and risk variables to explain the leverage's effect (Baker, 2001), and found that leverage is positively correlated to market structure areas, specifically cost stability (Baker, 2001, pp. 4). In this study, we will use the macroeconomic approach and examine if macroeconomic effects such as the leverage for a benchmark of the overall market affect clean energy leverage.

Ozdagli (2012) has developed a model to study the relationship between limited capital irreversibility and risk-free debt contracts to examine the effect of financial leverage on investment, book-to-market ratios, and stock returns. This model shows risk preferences as well as a "benefit from the tax shield of debt, as in the trade-off theory of capital structure" (Ozdagli, 2012, pp. 1034). This study describes how leverage can be irreversible, so that the user cost of capital increases and reduces capital stock, and how leveraging can explain that why expectations do not match reality. However, in his model, Ozdagali isolated external factors by focusing on firms with no operating cost that still had high amounts of financial leverage.

Johnson (2014) has explained the risk analysis methods in developing a diversified portfolio as well as the risk associated with different subsectors within renewable energy. This framework, compares a specific portfolio or individual stock to a diversified index, assuming the S&P 500 as a baseline for acceptable risk, the study shows the variance of risk for any stock, relative to the SPX Index. This framework would help to gauge a comparison between systematic risks of renewables.

Sadorsky (2010) has developed a beta statistical model to determine the drivers for risk within renewable energy, and found that oil price, sales growth, and macroeconomic factors were the three variables that catalyzed growth in returns for clean energy. The model has foundational concepts of a capital asset pricing model with oil and sales growth leading to the most significant contribution in returns. This study found that as the oil price increases, interest in clean energy investment rises, and as sales increase, the company will reduce its risk. Sadorsky (2010) also highlighted the implications of policy decisions, technology, and various factors that influence clean energy returns. In his study for the determinants of higher returns in clean energy. Sadorsky used the Wilderhill Clean Energy ETF as his baseline for clean energy. The analysis considers an assumption that clean energy will be transitioned as a more popular source of power in the future. Moreover, the factors that could facilitate that transition to clean energy could include taxation of fossil fuels and other incentives.

III Modeling Framework

In this section, we develop a model to better describe the financial leverage in renewable energy sector, particularly in relation with other variables such as the new risk factors and renewable energy trends, and to test volatility using beta values. We have selected the securities that would represent different subsectors within clean energy (wind and solar) in the US market and one company with a significant market capitalization in clean energy. In this model, we will focus on determining how returns between the different securities within clean energy compared to the market (SPX Index). We will use daily return data from two periods of high uncertainty: 2007-2009 and 2018-2020, to examine how the securities varied compared to the market and each other (Model I).

This model will show the risk factors associated with leveraged equity in the renewable energy sector compared to the SPX Index in low-demand environments. The beta value can indicate the risk of particular equity without the equilibrium that an investor would otherwise be able to diversify away (Johnson, 2014, Chapter 9). In this current environment, aggregate macroeconomic factors can be critical determinants of equity performance. Moreover, when considering an unprecedented drop in a demand for stock such as renewable energy or oil, new risk factors are considered.

We have selected three major equities from the renewable energy market, as the leading producer of renewable energy in their own areas and based on their market niche within the energy sector in the US market:

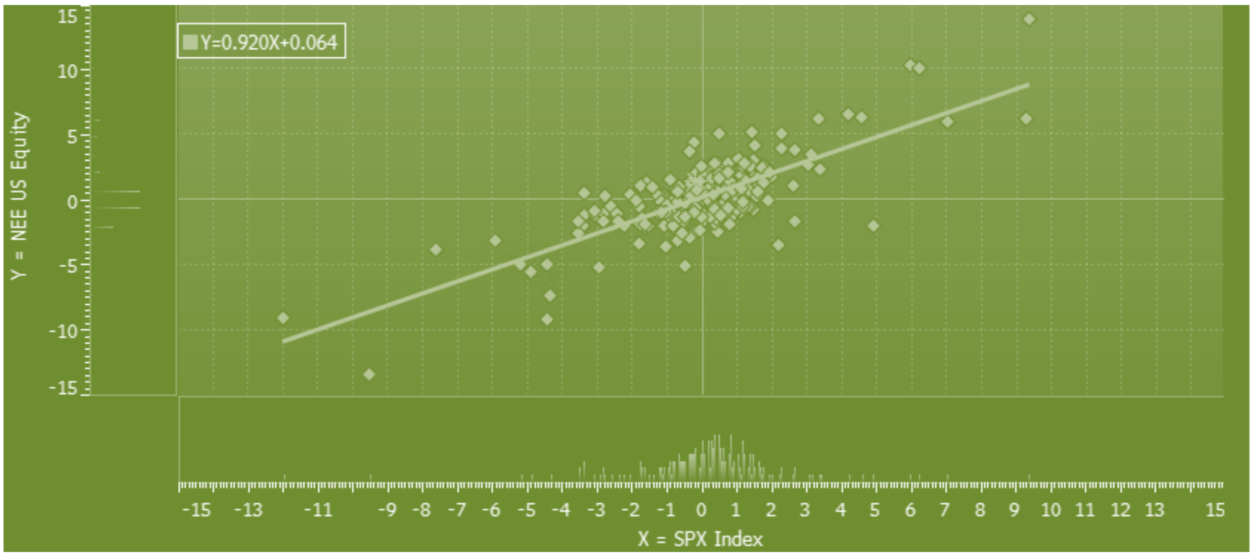
1. Next Era Energy (NEE), an American energy company that is the largest electric utility holding company by market capitalization with subsidiaries that include Florida Power & Light (FPL), NextEra Energy Resources (NEER) LLC. which, together with its affiliated entities, is the world's largest generator of renewable energy from the wind and sun and a world leader in battery storage.
2. Brookfield Renewable Partners, is one of the largest, public pure play renewable businesses globally that owns and operates renewable power assets. As of the end of 2017, Brookfield Renewable owned over 200 hydroelectric plants, 100 wind farms, over 550 solar facilities, and four storage facilities, with approximately 16,400 MW of installed capacity. (Brookfield Renewable Partners L.P. Annual Report" 31 December 2017. Retrieved 27 June 2018.)
3. First Solar Inc. is a leading American solar technology company and global provider of responsibly produced eco-efficient solar modules advancing the fight against climate change.

We have collected data about the equities of these companies, particularly during two low-demand periods from Bloomberg: (1) the periods of 2007-2009 and (2) 2018-2020. We included the time before and after the shock of unexpected risk to mitigate outliers of risk in each desired sample. As Johnson (Ch.9, 2014) argues, by regressing the equity returns against the market returns, one can determine the comparative risk, using the beta value (Johnson, 2014), that is centered around 1.0. When the beta value falls below 1.0, the dependent variable is considered less volatile than the market, and conversely, for beta value above 1.0 would indicate that the dependent variable is considered more volatile than the market (Johnson, 2014).

This model will examine three individual securities that contribute in different ways to clean energy market and their volatility, compares to the SPX Index. Under Bloomberg's default settings, a particular company's historical return data can be compared to the SPX Index over a selected period of time to find the beta. However, as many companies are not public or have not been public long, data is typically short-term. We use Durbin-Watson (DW) statistics to measure the autocorrelation in residuals from the model. In particular, DW would help us to measure the type of autocorrelation in residuals, if any, when each equity regressed on the SPX Index in any sample. While this value will range from 0.0 - 4.0, however, a value around to 2.0 means that there is no autocorrelation detected, a value lower than 2 indicates a positive autocorrelation and greater than 2 signifies a negative autocorrelation. The SPX Index is being used as the baseline for comparison in this analysis to determine the risk associated with leveraged equities in the energy sector.

First, we have compared data for Next Era Energy (NEE) equity from 2007-2009 with the market (SPX Index) in Figure 1. The value for beta=0.920, shows less volatile when compared with SPX during this period. However, according to the Durbin Watson value, NEE has very little autocorrelation but has a slightly negative relationship. The coefficient of determination for the data during 2007-09, is 0.583, indicating that the S&P Index describes 58.3% of variations in NEE.

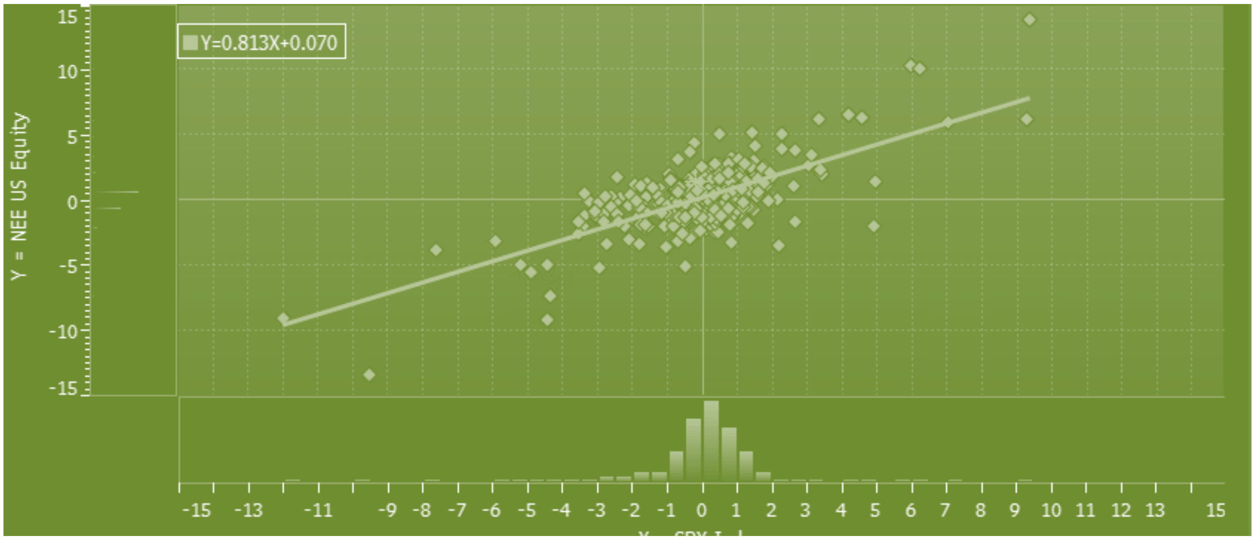
Figure 1: Next Era Energy (NEE 2007-2009)



Statistical Measures	Values
BETA	0.920
ALPHA (Intercept)	0.064
R^2 (Coefficient of Determination)	0.583
Durbin Watson	2.054
Standard Deviation of Error	1.699
Standard Error of ALPHA	0.108
Standard Error of BETA	0.049
Number of Data Points	250

The corresponding relationship for the data of 2018-2020, shown in Figure 2, with correlation coefficient of 0.763, shows a strong positive relationship between the variables. The data shows that, similar to the previous period, Next Era Energy during 2018-20 was less volatile than the SPX Index. The beta value of 0.813 indicates less movement than the more diversified SPX Index. The correlation coefficient in this sample is 0.688, and the coefficient of determination of 0.474 demonstrates that variations in NEE is not described by the variations in S&P Index as much as the previous period.

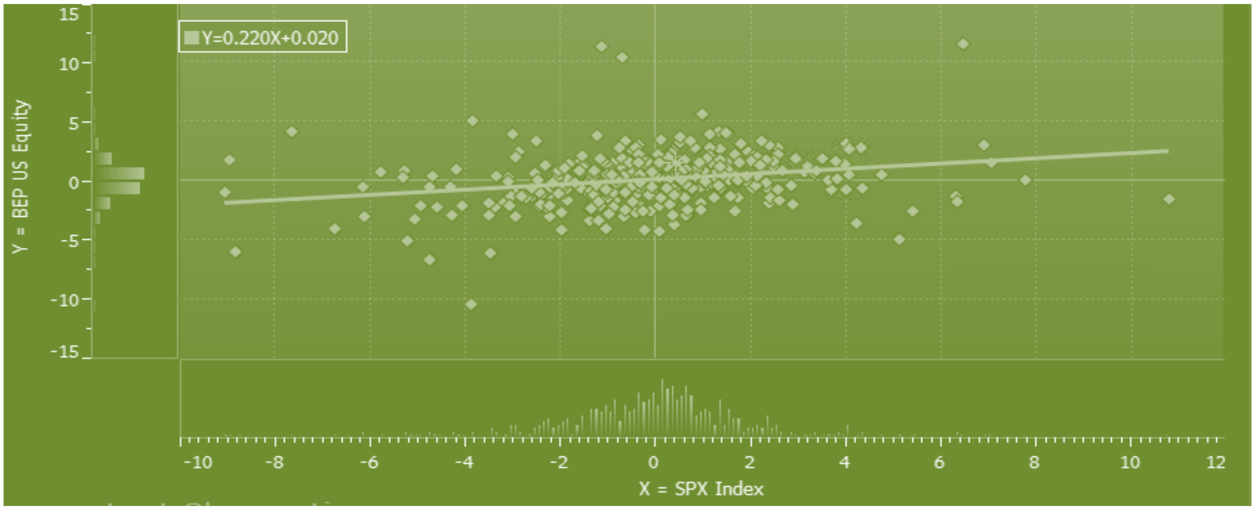
Figure 2: Next Era Energy (NEE 2018-2020)



Statistical Measures	Values
BETA	0.813
ALPHA (Intercept)	0.070
R^2 (Coefficient of Determination)	0.474
Durbin Watson	2.058
Standard Deviation of Error	1.434
Standard Error of ALPHA	0.064
Standard Error of BETA	0.038
Number of Data Points	501

Next, we have examined the data for Brookfield Renewable Partners (BEP) during 2007-2009, displayed in figure 3-1, and it shows that BEP had less market variation when compared with the SPX Index during that period. This sample's correlation coefficient for the data during 2007-2009 is very low (0.249), and the coefficient of determination indicated that the S&P Index variation can describes very little variations in the performance of BEP during this period.

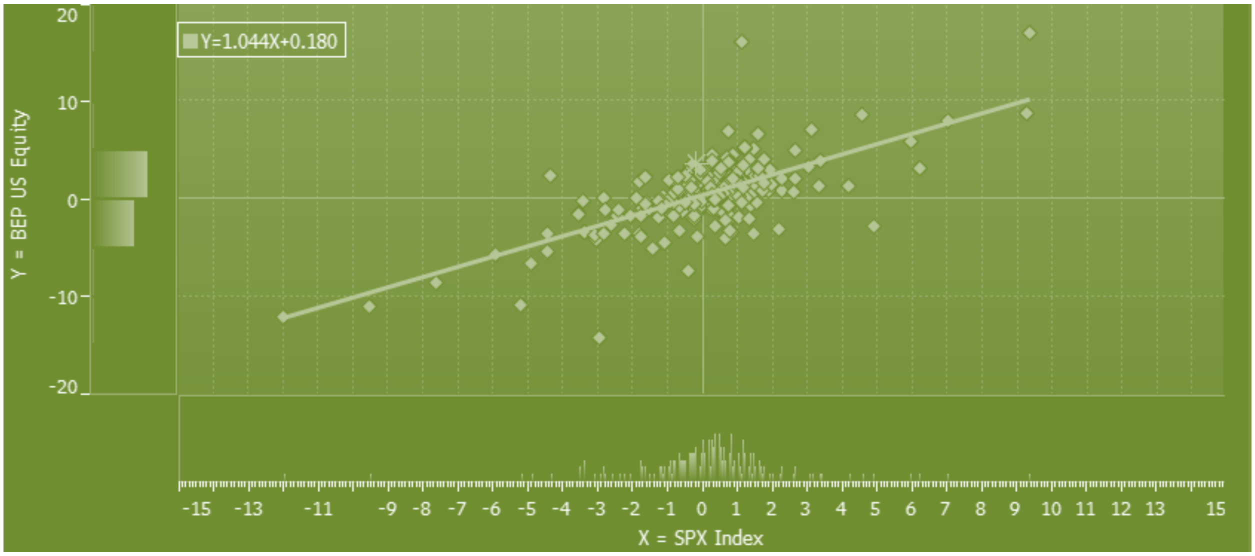
Figure 3: Brookfield Renewable Partners (BEP 2007-2009)



Statistical Measures	Values
BETA	0.220
ALPHA (Intercept)	0.020
R^2 (Coefficient of Determination)	0.062
Durbin Watson	2.195
Standard Deviation of Error	1.884
Standard Error of ALPHA	0.087
Standard Error of BETA	0.039
Number of Data Points	474

The data for the period of 2018-20 in figure 4 shows a significant correlation coefficient (.691) between BEP variations and SPX index, and coefficient of determination (.478). The beta value of 1.044 indicates slightly higher volatility of BEP when compared with SPX index during this period. However, the beta value is very close to 1.0, meaning the volatility associated with BEP during this period is very similar to the SPX Index during the same period. Therefore, these results are similar to the other figures in this model but drastically different from the data sample for BEP from 2007-2009.

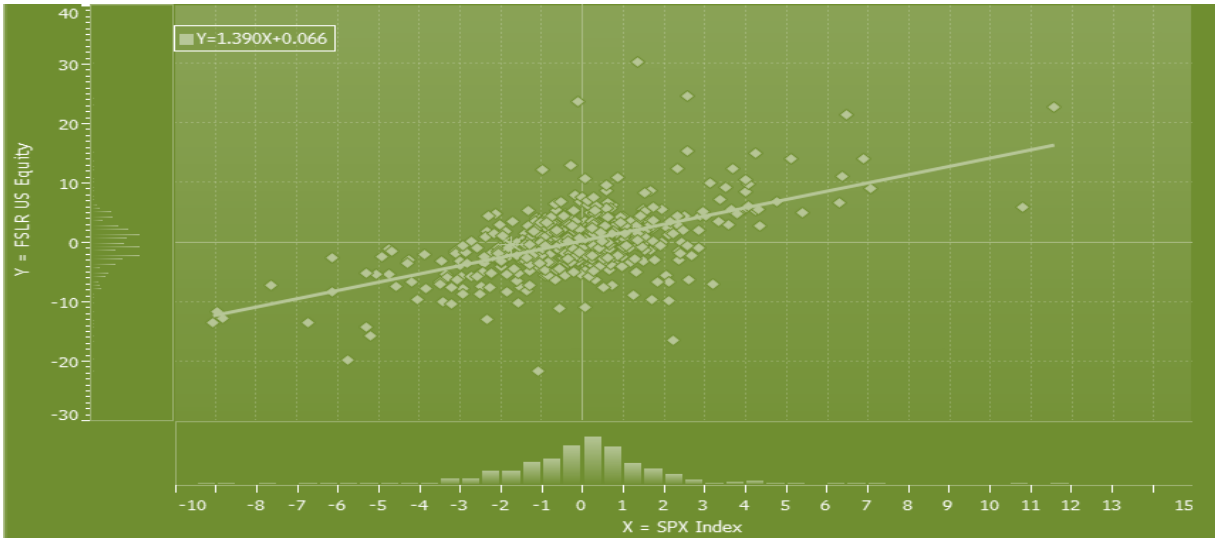
Figure 4: Brookfield Renewable Partners (BEP 2018-2020)



Statistical Measures	Values
BETA	1.044
ALPHA (Intercept)	0.180
R^2 (Coefficient of Determination)	0.478
Durbin Watson	2.163
Standard Deviation of Error	2.385
Standard Error of ALPHA	0.151
Standard Error of BETA	0.069
Number of Data Points	250

The data for First Solar Inc. (FSLR) from 2007-2009, displayed in figure 5 shows the volatility of this security during this period when compared with the SPX Index. This period was a high point of uncertainty for FSLR compared to the SPX Index. The correlation coefficient of 0.567, and the coefficient of determination 0.321 for FSLR shows less predictability of this security by the SPX Index during 2007-09.

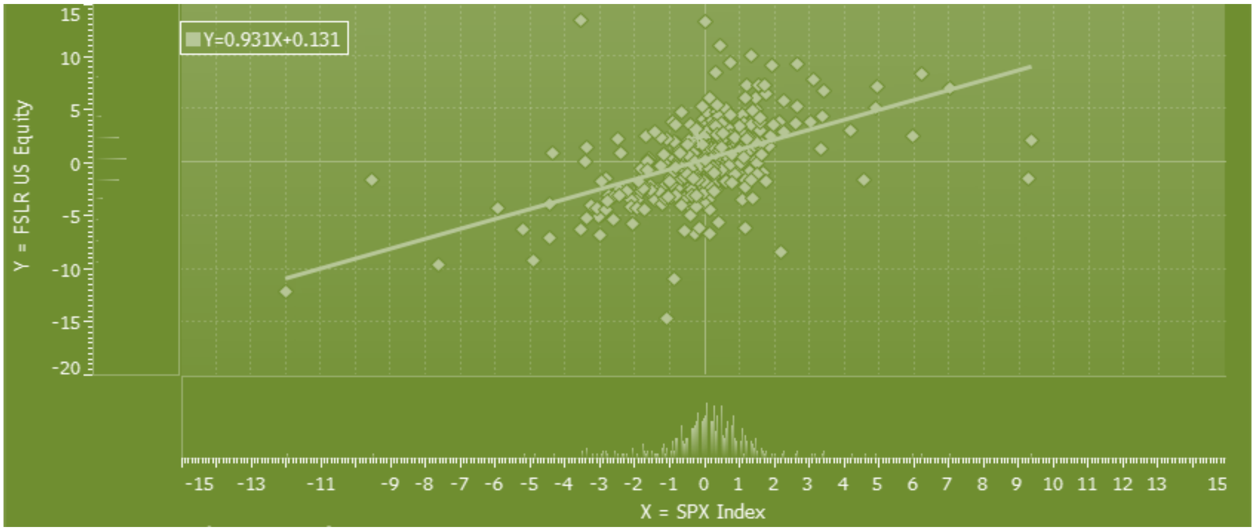
Figure 5: First Solar Inc. (FSLR 2007-2009)



Statistical Measures	Values
BETA	1.390
ALPHA (Intercept)	0.066
R^2 (Coefficient of Determination)	0.321
Durbin Watson	2.217
Standard Deviation of Error	4.478
Standard Error of ALPHA	0.200
Standard Error of BETA	0.091
Number of Points	501

However, the data during 2018-2020 for FSLR in figure 6 shows that the beta value, similar to most of the other samples, was below 1.0, while the coefficient of determination was 0.248, meaning only 24.8% of variations in FSLR could be described by the variations in S&P 500, and the correlation coefficient was 0.498. This relationship implies a moderately positive correlation.

Figure 6: First Solar Inc. (FSLR 2018-2020)



Statistical Measures	Values
BETA	0.931
ALPHA (Intercept)	0.131
R^2 (Coefficient of Determination)	0.248
Durbin Watson	2.352
Standard Deviation of Error	2.717
Standard Error of ALPHA	0.122
Standard Error of BETA	0.073
Number of Points	500

IV WilderHill® Index (ECO) to Measure Clean Energy Industry

In this section, we use the WilderHill® Index (ECO) as the representative index for clean energy industry. This index founded in 2004 by Wilderhill Clean Energy and it is the world's first and best known for climate change solutions to define and track the Clean Energy sector. The producers and publicly traded clean energy peers are the contributors to ECO index and it focuses on businesses that can gain from the transition to alternative energy. The weightings of stocks and sector within the ECO Index are based on their significance for clean energy, technological influence and relevance to preventing pollution.

In order to examine the industry-wide performance, we follow the beta modeling in Figures 1- 6, and use the same type of beta modeling with the WilderHill Clean Energy Index (ECO) as a function of the S&P 500 (SPX), as the industry model. The use of the ECO Index would allow us to effectively describe the industry beta as a whole. We use Bloomberg's data to find each index's quarterly price from 2005-2020, and use price data for ECO Index (y) and the SPX Index (x), to calculate each index's returns between 3-month periods and find the beta for all periods.

Data for debt/equity from 2005-2020 has been used to calculate the unlevered beta for the period. Therefore, we use the following formula for Returns and Beta:

$$Returns = \Delta Q = \frac{Q_2 - Q_1}{Q_1} \qquad (1)$$

$$SLOPE = \beta = \frac{\Delta y}{\Delta x} = \frac{\Delta ECO}{\Delta SPX} \qquad (2)$$

Where *Q1*=Old price, and *Q2*=New price*,*

We use the unlevered beta by using the tax rate and the debt/equity ratio of the firm to give a more accurate measure of leverage in clean energy with the beta value ignoring debt's influence. It worth noting that renewable energy companies received different tax incentives based on various metrics. However, it is challenging to compute a flat tax rate on renewable energy. For example, wind tax benefits vary from hydropower, etc. Thus, an average rate from 2005-2020 was determined based on the corporate tax rate during that period. Additionally, using the market beta (β) above, unlevered beta can be calculated according to formula (3), below*:*

$$Unlevered\ Beta = \frac{\beta}{1 + (1 - Tax\ Rate)(\frac{Debt}{Equity})} \qquad (3)$$

A high Debt-to-Equity ($\frac{Debt}{Equity}$) ratio generally indicates that a company has been aggressive in financing its growth with debt. This can result in volatile earnings as a result of the additional interest expense. If the company's interest expense grows too high, it may increase the company's chances of a default or bankruptcy.

Assuming that an industry such as renewables is becoming more reliant on technology, its stocks starting to display a tech stock's characteristics. Moreover, green investors are beginning to re-examine their portfolios to include cleaner sources of returns. Figure 9 shows the performance, based on price, between the market and variables such as oil price during 2003-2020. This figure displays the current uncertainty following the pandemic's height because renewable energy remained resilient despite low oil prices. The figure also compares a technology index, market indices, oil price, and the ECO Index. The analysis is intended to model the following relationships: (1) clean energy performance has dependent on oil price, (2) ECO performs similarly to a tech stock, (3) how ECO performs when compared to market benchmarks.

Lastly, the final regression model sought to find the variables that would influence financial leverage within the ECO Index. The variables affecting the firm's growth and size were highlighted and tested for correlation within the industry. The final regression consists of Research and Development (R&D) expenditure and market capitalization against the financial leverage for ECO and the SPX indices. The same regression will be examined on the SPX Index and to see how the market benchmark compares to the financial leverage clean energy benchmark.

We define the Financial Leverage as the changes in Earning Per Share (EPS) for each unit changes in operating income, also known as Earnings Before Interest and Tax *(EBIT)* as expressed in the following ratio:

$$Financial\ Leverage = \frac{\Delta(EPS)}{\Delta(EBIT)} \qquad (4),$$

Where

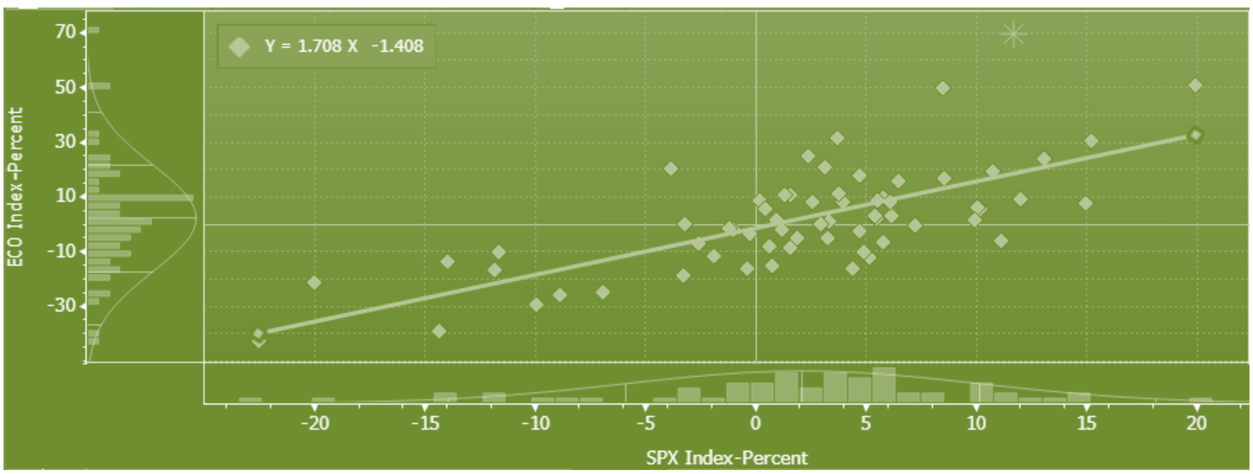
$$EPS = \frac{(EBIT - Interest\ Expense)}{Number\ of\ shares\ Outstanding}$$

The Financial Leverage indicates that the higher the degree of financial leverage, the earnings per share (EPS) will be more volatile. Since interest is a fixed expense, leverage magnifies returns and EPS, which is good when operating income is rising, however can be a problem during downturn economic times when operating income is under pressure

The unlevered beta gives a glimpse of the volatility without the assumption of debt. This modeling would help to better understand the relationship between leverage and implied risk for clean energy. Ambitious financing activities can harshly affect clean energy contributors with a low market cap and small production capacity. The purpose of this regression is to see how much risk is associated with leverage in clean energy. Also, not all variables tested are included in regression output; the final regression represents the highest correlation variables. Specifically, the regression model variables involve the index's size and growth to examine if they increased or decreased financial leverage within the SPX and ECO indices. In the final regression, we will test R&D Expenditure/share, Market capitalization, and financial leverage for ECO and SPX.

Model I Statistical Beta Risk Amongst SPX Index (Bloomberg)

Figure 7: Beta 2005-2020 (Quarterly Data Bloomberg_BETA)



Raw BETA	1.708
Adjusted BETA	1.472
ALPHA (Intercept)	-1.408
R^2 (Coefficient of Determination)	0.496
R (Correlation Coefficient)	0.704
Standard Deviation of Error	14.029
Standard Error of ALPHA	1.814
Standard Error of BETA	0.219
t-Test	7.811
Level of Significance	0.000
Last T-Value	3.581
Last P-Value	1.000
Number of data Points	64
Last Spread	3542.01
Last Ratio	0.057

This model has also used SPX index, to be comparable, and the Beta value for the ECO Index for this period was 1.708, which is higher than the beta values recorded for the three individual companies we examined earlier. The beta test accounted for a more considerable period than the previous samples. Moreover, the previous illustrations were intended to isolate the market during periods of high uncertainty, while this model captured both bullish market conditions and bearish market conditions from 2005-2020.

We have used Bloomberg quarterly return data, the market beta from 2005-2020, to regress the ECO Index on the SPX Index, and the results are shown in Figure 8.

Figure 8: Output for Beta ECO vs. SPX

Regression Statistics	
Multiple R	0.70426
R Square	0.49598
Adjusted R Square	0.48785
Standard Error	0.14029
Observations	64

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.201	1.201	61.011	0.000
Residual	62	1.220	0.020		
Total	63	2.421			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.014	0.018	-0.776	0.441	-0.050	0.022	-0.050	0.022
SPX Index Returns	1.708	0.219	7.811	0.000	1.271	2.145	1.271	2.145

The F value shows the significance of the model while the model is significant and the SPX Index returns explains about 49% of variations in the ECO Index return during this period. The market beta is also significant, as it can help to calculate the unlevered beta for ECO. Using formula (3), can help to calculate the unlevered beta, as it will also assess the risk expected without leveraging on returns. Simultaneously, the tax rate is based on the federal corporate tax rate from the years 2005-2020. We have used the average tax rate from 2005-2020 (0.32375) and the average Debt/Equity for ECO (91.42) to calculate the unlevered beta during this modeling period. Thus, *Unlevered Beta ECO:*

$$\text{Unlevered Beta ECO} = \frac{\beta}{1+(1-Tax\ Rate)\left(\frac{Debt}{Equity}\right)} = \frac{1.708}{1+(1-0.32375)(91.42)} = 0.027188$$

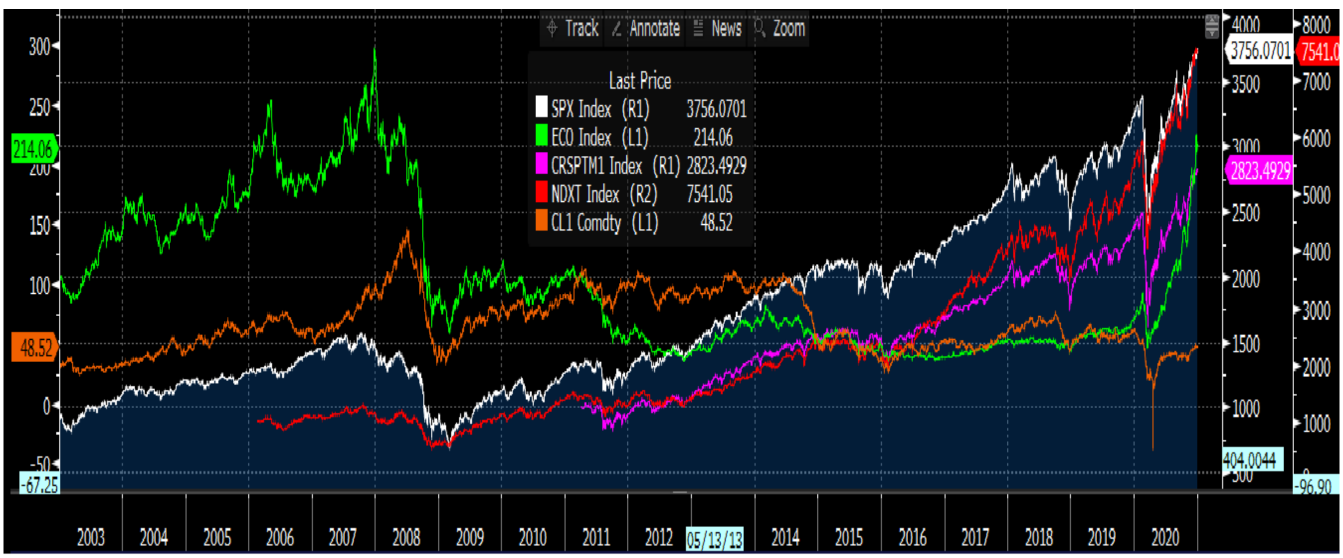
The unlevered beta shows the ECO Index's risk without debt, isolating the ECO Index risk. The significantly lower unlevered beta value demonstrates the riskiness of clean energy in its financing activities. This value is valuable in showing how the removal of leverage can isolate risk from company assets alone. Due to the low unlevered beta, it appears that the risk associated with

ECO is high compared to the SPX Index. According to this value, a high amount of risk can be attributed to the ECO Index's debt. When a stock raises its debt to equity to high levels, a more significant percentage of earnings will finance that debt. Hence, if the debt is high, it will increase investor uncertainty about future earnings.

Clean Energy Index against Market, Technology, and Oil

In order to assess the ECO Index performance when compared to technology, oil, and the general market, Figure 9, shows the price data, compared amongst benchmarks and oil. According to Sadorsky (Sadorsky, 2010, p.42), the relationship between oil price and clean energy sources is typically inverse. When oil prices are higher, there should be more interest in investment for clean and alternative energy sources. However, despite oil price being low renewable energy performed much like the market and technology, based on price. Much of this can be attributed to the low demand for petroleum-based activities from pandemic lockdowns, supplier struggles, and consumer spending. However, it shows the problem that investors have in this current environment, which is repricing clean energy and risks.

Figure 9: Price 2003-2020
(ECO Index, SPX Index, NDXT Index, CL1 Comdty, CRSPTM1 Index)
Graph created in Bloomberg.



Many renewable energy companies perform more like technology companies than energy companies (Sadorsky, p.42, 2010). This shift to more efficient processes through technology could partially explain the stock's behavior when compared to oil. This difference in behavior is due to the importance of technology in reducing their bottom line. As new and more efficient production systems for clean energy are developed , the cost of clean production will decrease. This decrease in cost will increase their profit per sales dollar. According to Sadorsky (2010), sales growth rates are known to be a determinant factor for reducing clean energy risk. With technology actively reducing cost, stakeholders within clean energy will be paying close attention to new production methods. Many investors seek green finance investments, and this concept is slowly gaining traction in the transition to clean energy. However, some investors are still left with uncertainty due to contributors' large debt issuance. The efficiency in new production systems may be counterintuitive if the debt remains high.

V Regression Model and Empirical Results

The focus of the regression model is to capture the variables that would influence financial leverage within the WilderHill Clean Energy Index (ECO) from 2005-2020. We use quarterly data, directly from Bloomberg, for the SPX Index and ECO Index. The model sought to find variables related to leverage in clean energy from the macro-level perspective. However, it is difficult to truly determine the holistic leverage percentage for clean energy producers and other affiliates macro-economically. This difficulty can partially be attributed to some significant contributors to the industry not having public data available to analyze. Hence, the ECO Index's leverage percentage was used as the benchmark to capture a glimpse of financial leverage in the sector.

Several variables were tested against financial leverage of the ECO Index and the SPX Index, but the highest correlation of these variables was R&D expenditure. The final multiple regression used financial leverage for ECO and SPX 2005-2020. The value for the sum of squares (SS) was extremely high as well in the regression. This high SS value indicates a high deviation from the mean value in the multiple regressions. Hence, the mean of the sum of squares (MS) was also heightened because of extreme variation in financial leverage. For example, the earnings before interest and taxes would be consistent in some periods, while the EPS suffered or grew exponentially, causing significant outliers from one quarter to the next. The change on a quarter-to-quarter basis largely contributed to the uncorrelated results. The significance F value indicated a minimal possibility that the model's null hypothesis is correlated with financial leverage. In Figures 10 and 11, the Multiple R output shows very little correlation between the indices' financial leverage and the variables tested. This output is similar to the inconclusive results of other variables tested against the same financial leverage measure within the ECO and SPX indices.

Figure 10: Regression Output ECO

Regression Statistics	
Multiple R	0.1530
R Square	0.0234
Adjusted R Square	-0.0086
Standard Error	19.0618
Observations	64

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	531.491	265.746	0.731	0.485
Residual	61	22164.597	363.354		
Total	63	22696.088			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.594	7.168	0.362	0.719	-11.740	16.928	-11.740	16.928
R&D Expense ECO	0.591	0.850	0.696	0.489	-1.109	2.291	-1.109	2.291
Market Capitalization	-0.001	0.001	-0.603	0.549	-0.003	0.001	-0.003	0.001

The average market capitalization for ECO and the SPX indices was used instead of total market capitalization because clean energy comprises small, mid, and large-cap contributors. The average market capitalization gives an average based on the index contributors. Hence, to gain more value from the benchmark, the average market capitalization was appropriate for comparing the SPX and ECO indices.

Figure 11: Regression Output SPX

Regression Statistics	
Multiple R	0.3256
R Square	0.1060
Adjusted R Square	0.0767
Standard Error	149.5192
Observations	64

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	161736.713	80868.356	3.617	0.033
Residual	61	1363715.220	22355.987		
Total	63	1525451.932			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-56.014	93.063	-0.602	0.549	-242.106	130.077	-242.106	130.077
R&D Expense SPX	8.901	4.145	2.147	0.036	0.613	17.189	0.613	17.189
Market Capitalization	-0.007	0.002	-2.682	0.009	-0.011	-0.002	-0.011	-0.002

The variables tested were to emulate prior findings during a financial crisis. In particular, Johnny Jermias and Faith Yigit found that firm size, growth opportunities, the tangibility of assets, and industry mean average to be the factors most influencing leverage during a financial crisis. Their research was based in Turkey and surrounded by data that included harsh economic times similar to the current environment. The tangibility of assets, R&D expenditure, and other variables representing previous literature, specifically growth and tangibility measures, were used. However, we did not find that these growth measures were highly correlated to financial leverage within renewable energy.

The SPX and ECO indices' financial leverage was tested against the R&D expenditure and the average market capitalization from 2005-2020. The regressions had 64 observations quarterly from 2005-2020 to determine if the growth measures or size played a role in ECO's capital structure. However, the ECO and SPX Index outputs had a very low correlation to the variables tested.

VI Renewable's Repricing of Risk

Governmental Risk Factors

Due to Covid-19, horizon risk within the renewable energy sector has increased, but now there are new risks that will affect renewable energy companies and their operations. In the last few years, federal governments have been prone to levy more costs through tariffs. Tariffs will affect the cost of raw materials within the renewable energy sector and their production price. Moreover, Ecuador is the leading producer of the wood needed in turbines for wind power, but Covid-19 production has stalled, causing high demand and cost for the wind power supply chain (Barnett 2020). There is also a rising concern that production tax credit and the investment tax credit will step down in addition to supply chain cost. Currently, any projects constructed after 2019 will have no tax credit benefits for alternative energy production. Guidelines from the US Internal Revenue Service state that residential and commercial solar projects qualify for a 30% ITC through 2019 as long as it is completed by 2024. Beginning in 2020, "the ITC is set to decline to 26%, then to 22% in 2021" (Kang, 2020).

The delay for a tax credit on large-scale wind producers has stalled due to Covid-19 (Barnett 2020). The aid was a catalyst for development in this sector, but now the progress seems to be impeded by the pressures of SARS-COv2. If governmental help does not support renewable energy production, it could significantly affect this sector's growth. The intent of this incentive allowed for renewable energy companies to receive a small percentage of tax breaks for the production of cleaner sources of energy. These were vital drivers in large-scale alternative energy productions, but now these risks create more uncertainty within the sector. Much of power sector investment is based on incentives and regulations for producers. These incentives have been stalled during the global pandemic. Thus, halting the future investment activities of 2021 and thereafter. Although resiliency has been a strong suit of renewables compared to other subsectors in the last year, the next few years have high uncertainty that can partially be credited to stalled incentives on future projects and infrastructure.

Expectations of Uncertainty

Much of the investment activity has been slow for renewable energy due to the lockdowns; this is partly from restrictions but has also affected the supply of goods, machinery, and equipment (IEA, 2020). According to the International Energy Agency, energy producers have pressure to reduce emissions in recent years, but from 2019 – 2020 energy investment dropped by nearly 20%. Despite the drop-in investment activity for the fifth year in a row, power production exceeded the oil and gas supply.

Although the IEA expects renewable energy to drop 10% for the year, it has been more dependable in current market conditions than other energy sectors such as fossil fuels. This resilience can be credited to long-term contracts that stabilized revenues for the period. The duration of this downtrend across the energy sector and renewables is mainly dependent on the return of consumer spending and supply chain normalcy. Hence, the energy sector has high uncertainty leading to 2021. This unprecedented level of low investment activity saw similar drops in the global financial crisis of

2008. However, this crisis is dependent on the recovering global economy and dependent on the effectiveness and speed of a vaccine.

VII Concluding Comments

There is little doubt that an eventual shift towards cleaner energy sources is on the horizon. If not, there could be plenty of repercussions to the long-term effects of climate change on our environment. Along with the environmental risks, there are financial risks associated as well. In examining some of the new risks associated with renewable energy, the focal point in this study was to determine financial leverage's contribution to clean energy's overall risk. In this process, several variables were tested to find the determinants of leverage within the industry, using benchmarking of indexes representing the market and renewable energy. The SPX Index and ECO Index were used for these findings. The findings for the determinants of DCL within ECO were inconclusive because of the high deviation between quarters for leverage. Despite the result, there were some key findings in our study of leverage in this sector. Specifically, the low unlevered beta indicated that ECO has a high amount of debt in their capital structure. This debt appetite could be detrimental in times of high systematic risk.

In pursuit of examining the risk associated with leverage within the sector, the beta was calculated for three individual securities against the SPX Index. These figures gave a snapshot of the volatility between 2007-2009 and 2018-2020, two periods of financial instability, to gain what should be the riskiest time for the market holistically. The securities maintained a beta around 1.0 or typically higher during these six observations. This increased volatility varied for each company, depending on the period. Also, the beta was calculated for ECO to assess the clean energy performance in the market.

Many clean energy contributors were resilient to the pandemic's effect, but the added debt still displays high uncertainty about how future earnings will be used. Using the beta value for ECO, the unlevered beta was calculated (0.02718901). This unlevered beta measure vastly contrasted the market beta for the ECO Index (1.70803735). By stripping away the debt aspect and separating the risk due solely to company assets, the unlevered beta provided some feedback on ECO and its capital structure. In particular, the volatility is more accurately displayed once the debt was removed. The contrast can be misunderstood because the effects of debt can cause significant differences in this volatility measure. As Sadorsky (2010, p.47) argues, high oil prices can lead to more interest in clean energy investment. However, the pandemic questions this relationship. It was shown that during this unprecedented time, oil prices remained very low because of low demand. Yet, renewable energy over this same period rebounded after the initial shock, similar to the behavior of tech and market indices.

Renewable energy investment has increased in the last few years. However, according to IEA (2021), the small-cap size renewable energy securities with a high tolerance for risk leading into the pandemic could see their downfall. This may depend on a number of factors, most notably the vaccine's rollout and effectiveness. Moreover, one of the leading market drivers for wind, solar, and hydropower is tax breaks, and they will decline going forward. These tax breaks, depending on the sector, would give tax breaks to expand activities or tax breaks based on the wattage of power produced. Many of these incentives are getting incrementally downsized for projects following 2020. If the risk and associated risk of leverage can be nullified to safer levels and clean energy proves to be a profitable form of substitute, it would make for a more appealing energy source to investors. Although stifled by restrictions and less consumer spending, this transition could return to normal levels following the vaccine.

Leverage can be used as a shield to disguise the risk associated with clean energy investment. When used appropriately, it can significantly increase returns helping all stakeholders including competitors. However, when leverage is abused, it can result in a significant loss. The empirical evidence suggests that renewable energy has had high uncertainty heading into 2021. That is based on the historical appetite for risk, horizon risk associated with Covid-19, beta value relative to the SPX Index, and reduction in government incentives that help drive clean energy production. Yet, there is little reason to believe renewable energy will become less attractive to investors over time because of environmental concerns and improved efficiency in cost per wattage of production. This will help make clean energy become a more cost-effective form of energy than substitutes. Clean energy can be an attractive long-term investment if some risk is diversified away. Moreover, based on this research, there are high amounts of debt in the capital structure of clean energy, but time will tell how much risk is associated with financial leverage regarding this debt. However, it is only a matter of time before the drastic change in clean energy production is at the forefront of major societal issues.

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