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Renewable energy stocks and risk

(Systematic risk factors in the renewable energy sector)

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Abstract

The renewable energy sector is an industry that expects tremendously growth in years to come. This opens interesting investment opportunities for investors and poses challenges for government and legislators as to how to best support the change to a low-carbon emission energy mix. In this study, we have explored the risk and returns characteristics for stocks, focusing on macroeconomic systematic risk. The stock returns from renewable energy sector was regressed on the macroeconomic variables: S&P500, VIX, nominal interest rates, real interest rates, inflation, industry growth, oil price returns, the term structure and credit spreads. Our findings show that returns in renewable energy stocks are affected by the S&P, the nominal interest rates and the oil price returns. The risk premiums varied greatly within our sample, which made us come to the conclusion that the companies in renewable energy sector are far from a homogenous group of companies. This challenges the choice of strategy potential investors should employ in their portfolio optimization.

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1. Introduction

In this master thesis, the risk and return characteristics of renewable energy stocks will be explored. In particular, we will study how stocks in renewable energy sector are sensitive for macroeconomic systematic risk factors in addition to the market beta, and how investors can profit on an industry that is expected to grow in years to come.

The renewable energy sector has experienced tremendous growth in recent years, and is expected to grow even further in years to come. The new annual report from the international energy agency[1] shows that the energy system is undergoing a reorientation towards a more eco-friendly energy mix. The sector that has experienced the biggest growth is solar photovoltaics and wind power, with China and the OECD countries in the lead. Renewables now accounts for 22.3% (2014) of the world's total electricity production, making it the second largest electricity source, globally. EIA[2] estimates that the world total energy consumption will increase by 48% between 2012-2040 and that the fastest growing subsector in the power industry will be renewable energy. The drivers for this growth is primarily the increasing demand for primary energy in the future. Growth in energy demand and economic growth goes hand in hand and is linked to prosperity and reduction of poverty around the globe. There has been a greater focus in recent years from governments and legislators around the world in reducing carbon dioxide emissions accelerate the shift to clean renewable energy. At the climate conference in Paris (COP21), December 2015, 195 countries for the first time ever adopted a universally binding global climate deal, where the main goal is to keep global warming under 2 degrees[3]. All over the globe, climate laws are being passed, and according to the global climate legislation study(Nachmany, Fankhauser et al. 2014), the amount of

[1] International energy agency newsroom – news November
[2] U.S energy information agency
[3] EU commission climate action

climate laws has doubled every 5th year since the Kyoto protocol was signed in 2005. Climate laws are being passed in Africa, the Americas, Asia and Europe, all over the globe. The clean power plan(CPP) was announced on August 3, 2015 by President Obama and US environmental protection agency. It represent a historic and important step to reach climate goals. From 2015 level, the CPP is expected to increase electricity generation from renewables with 99% in 2030 and by 152% in 2040[4]. According to NBIM,[5] it is not until after the early 2000 renewable energy sector has grown considerably. The adaptation of the Kyoto protocol in 2005 trigged a growth in renewable energy investments around the world. The sector also seemed to recover already in 2009 and continued to do so, after the financial crisis hit the markets.

Concerns about the climate has motivated governments and legislators to increase the share of energy from renewable sources. There is a need for big investments in renewable energy to keep global warming below 2 degrees. Government budgets are not sufficient to close the climate investment gap.

A growth sector, like renewable energy, holds great potentials for investments. The challenge is that the performance of the stocks in the renewable energy sector has varied greatly. Some of the stocks has performed very well beating the market on both returns and risk. Unfortunately, that does not hold true for the majority of the stocks in the sector, and the risk in renewable energy stocks has been rather high for many companies. Losses and bad investments reduces potential future investors' willingness to invest more money in a sector that relies on private initiative to reach the international climate goals set. At the same time, the expected growth in the industry represent potential profitable investment opportunities. If renewable energy is going to be able to draw funds from private investors, more information about the risk and return features in renewable energy stocks could benefit investors make better decisions regarding investments.

[4] U.S energy information administration Annual energy outlook 2016 – with projections to 2040
[5] Norges bank investment management

In this master thesis, the risk and return characteristics of renewable energy stocks will be explored. In particular, we will answer the question: “how stocks in renewable energy sector are sensitive for macroeconomic systematic risk factors in addition to the market beta?”

This paper has the following organization: In this chapter, introduction of the renewable energy sector with description of current trends and expectations to future development is presented. In chapter two, the relevant literature on the field with a focus on how the various factors are theorized to affect the stock returns in renewable energy are gathered. The third chapter holds the data for this study, where data for both the dependent and independent variables are described and preliminary analyzed. The fourth chapter is about methodology used in this study and the risk model tested is described. In Chapter five, the results are discussed and presented and in chapter six, the conclusion from this paper is drawn.

2. Literature review

The capital asset pricing model was developed in a series of articles by William Sharpe (Sharpe 1964), John Lintner(Lintner 1965)and Jan Mossin(Mossin 1966) . Harry Markowitz(Markowitz 1952) laid down the foundation for modern portfolio theory in 1952 and the Capital asset pricing model (CAPM) builds upon notions in Markowitz work regarding investors having a preference for mean-variance-efficient portfolios.

Lintner (Lintner 1965)and Sharpe(Sharpe 1964) argued that because investors can diversify their risk by holding several assets, the only risk that matter is an assets contribution to an investors portfolios total risk, represented by an assets beta. It is common to view Beta as a measure of systematic risk, as it is a measure of how much a security varies with systematic forces, represented by the market. The CAPM gives an intuitive understanding about how investors value a risky cash flow, but many studies have shown that the CAPM does not hold in reality, especially for individual securities. John Lintner (Lintner 1965) showed by studying NYSE stocks between 1954-1963 that the security market line (SML) in the CAPM is too flat and that high β firms, on average had delivered a lower return than predicted by their β, while the opposite was true for the low β companies. Fama and MacBeth (Fama and MacBeth 1973) found that portfolio returns has a linear relationship to beta, and nonsystematic risk did not explain average excess returns.

The Arbitrage Pricing model Theory (APT) was developed primarily by Ross (Ross 1976). Both the CAPM and the APT links expected returns to risks. The mechanisms that provides this effect is different in the two theories. In the CAPM prices returns to equilibrium when many investors makes small changes in their portfolios, if a price equilibrium is violated. In the CAPM, all investors are mean-variance optimizers and prices are set when investors tilt their portfolios towards underpriced securities and away from overpriced ones. In the APT model, the investor wants to take as large as possible positions if arbitrage opportunities exists, and will increase the position until the arbitrage opportunity is exploited, and equilibrium prices are restored. In the multifactor APT theory, extra-market risks, in addition to the market beta exist. This extra market risk will determine risk premiums, just like the market beta. Ross argued that if no arbitrage opportunities exist, the expected returns of any security should be related to the factor loadings for these extra-market risks, in a linear way. In the APT, expected returns are related to several macroeconomic factors, and the factor loadings of each factor determines the degree the securities return is sensitive to that factor. Because the macroeconomic factors are systematic factors, they can be used to hedge risk for that factor and the security market line [6](SML) becomes multifactor. (Bodie, Kane and Marcus, 2014)

Chen, Roll and Ross (1986) was one of the first studies of the undefined factors in the arbitrage asset-pricing model developed by Ross (1976). In their article, they explained equity returns as a function of macroeconomic state variables.

[6] The security market line shows how an assets expected return is a function of its market beta

In their model, the stock market is endogenous, relative to other markets and they studied how the state variables: industrial production as a proxy for economic growth, expected inflation, unexpected inflation, risk premium, the term structure, the market indices, consumption and oil price affected stock returns. They found a positive risk premium for industry production and the risk premium in the market. The term structure and the expected and unexpected inflation had a negative risk premium. Their findings supported the APT theory about a multifactor SML.

Several other studies have explored the effect of the state variables on stock returns, after the Chen Roll and Ross study. Like Chen, Roll and Ross (1986) did, some have focused on the effect of many state variables on stock returns simultaneously. While others have focused on the effect of only one or a few of these variables on stock returns. Fama (Fama 1990) found evidence that stock returns could be explained by expectation of forecast to real activity in the USA. Yin-Wong, Cheunga and Ngb(Yin-Wong Cheunga and Ngb 1998) found International evidence on the stock market and the state variables. Chen (Chen 2009) found that macroeconomic variables can serve as leading and predicting indicators of stock market recessions for the S&P500. Their study showed that inflation and term structure are the best indicators of a bear market. As it seems from the studies above, macroeconomic factors affect stock returns. In the next section, I will have a look at how the literature explains the effect of these macroeconomic variables on stock returns.

The risk factors for returns in stocks can be divided into systematic and unsystematic risk factors. Where the systematic risk factors are risk factors that are included in the system and will be the same for all securities in the investment universe. Typical systematic risk factors are macroeconomic variables, like the market itself, interest rates, economic growth, inflation etc. It is common to view the systematic risk factors as undiversifiable; as they are risk factors included in the system and the same for all assets and asset classes and therefore cannot be reduced by holding more assets. The other type of risks that influence a stocks return is the unsystematic component, which is firm specific. Stock returns are both affected by systematic risk factors, like the ones mentioned above, and unsystematic firm specific risk factors like size and B/E(Fama and French 1996). Because of the limitations and the topic in this master thesis, only literature for systematic risk factors are included in this chapter.

As a proxy for the market, we have chosen The Standard and poor's 500. The S&P 500 is a market index for stocks, based on the 500 largest companies listed on NYSE or NASDAQ. The S&P500 is of many considered a good proxy for the stock market in general and is considered a trend indicator of the U.S economy. The S&P is a good proxy for systematic risk factors as it shows how all the other stocks in the market are affected by the systematic risk factors. The S&P is an equity only index, and does not include bonds or options.

Hypothesis 1: there will be a positive risk premium for the market beta.

It is common to view stock prices as discounted future cash flows that are earned by the owner of the stock $P_o = \Sigma_t \text{E}(cf_t)/(1 + k_t)^t$. Where P_o is the stock price, cf is the expected cash flow, and k_t is the alternative capital cost (Gjerde and Saettem 1999). Any influence from systematic risk factors on any part of this equation, will therefore affect returns and risk in renewable energy sector stocks.

Industrial growth

When the economy is growing, income and cash flows are expected to increase, and stock prices go up. Some studies confirm this, but the evidence from the literature goes both ways. Like Chen, Roll and Ross, Fama (Fama 1981) found evidence that real stock returns are positively related to measures of real activity. On the contrary, Ritter (Ritter 2005) found that over the 1900–2002 period, there was a negative correlation between real stock returns and economic growth for the 16 countries he studied. He also found that technological changes did not provide firms with increased profits, unless the firm had monopoly. Madsen et al(Madsen, Dzhumashev et al. 2013) studied the relationship between economic growth and stock returns for 20 OECD countries for a century. Except from the period 1930-1950, there is an absence of a positive relationship between stock returns and economic growth. They find that economic growth is determined entirely by technological progress, whereas stock returns are determined by the risk free interest rate and the cost of bearing equity risk. Chun, Kim and al (Chun, Kim et al. 2016), found that nominal productivity growth and stock returns were correlated positively in firm-level data, but negative in data for other firms growth rates, indicating a negative spillover effect between other firms technological advances and negative stock price returns for firms in the same industry. (Megna and Klock 1993) also found evidence consistent with a negative spillover effect. When firms experienced technological breakthrough, there was a negative spillover effect on the competitors share prices in the semiconductor sector. This might reflects Schumpeterian creative destruction. While a few technological firms become the winners in technology driven growth, many other firms becomes technological losers with declining profitability. Economic growth is measured in output growth; it is measured in increased value of what is produced in an economy. The value of a firm is measured in discounted future *net* cash flows. If the economy is growing due to technological advances, it might lead to reduced profits and net cash flows when the value of the old technology is impaired.

Hypothesis 2: Economic growth can have both a positive or negative risk premium on stock returns. If the economic growth is mainly driven by technological revolutions, it will have a negative risk premium while.

Oil price returns.

When the activity in the economy is growing, the demand for energy is also growing, and the main source for energy production has been since the mid 1950's, and still is oil. Many studies have documented the correlation between growth in economic activity and oil prices (Hamilton 1983, Mork 1989). When economic activity increases, demand for oil will increase, and if there is not an equally increase in supply, oil prices will rise. LeBlanc (LeBlanc, 2004) confirms this belief with his study where he studied the connection between oil price rises and inflation. In his study he found a positive effect between oil price changes and inflation for Japan, France, Germany, the United and United Kingdom.(Cologni and Manera 2008) also confirms that oil price shocks are translated into inflation for all G-7 countries except Great Britain and Japan. Some studies seems to indicate that the link between inflation and oil prices are weaker now than in earlier years and Herrera (Herrera, 2009) found that the influence of oil price shocks on inflation is smaller in the period that ranges from 1985-2006 than 1959-1979. However weaker, the link between oil prices and inflation seems to persist. All though smaller in recent years, this study also find the correlation between inflation and oil prices to be quite high (0,6855) in the period 2007-2016. If increasing oil prices are tied to economic growth and economic growth is related to increasing inflation, how does changes in oil prices translate into stock returns?

(Huang, Masulis et al. 1996) found that oil prices do lead some stock returns for oil related companies, but they found little effect from oil prices on broad-based indices like the s&P500. Tjaaland, Westgaard, Osmundsen and Frydenberg 2016 also found evidence that oil price fluctuations are positively and statistically significant related to oil and gas company stock return, across countries. Jones and Kaul, on the other hand, found evidence for an oil price effect on general stock returns. (Jones and Kaul 1996).

(Park and Ratti 2008) found a significant effect from oil price shocks on real stock returns found that oil price shocks have a significant effect on real stock returns in the U.S and for 13 European countries. The stocks in the oil exporting country, Norway, shows a significant positive response to oil price shocks.

Sadorsky (2012) found that systematic risk for companies in renewable energy sector was reduced by increased sales growth and increased by increasing oil price returns. Firms in renewable energy sector, operates within the same sector as energy companies and that might explain why their systematic risk are so affected by oil price returns. Oil companies and renewable energy companies both produce energy, and constitutes alternative competing ways to produce energy. When oil prices are high, alternative ways to produce energy should become more competitive, allowing for a bigger market share for alternative energy. When oil prices are high, oil projects will have a higher net present value, making them more attractive for potential energy investors as compared to other energy projects, ceteris paribus. Chen and Chen(Chen and Chen 2007) found that real oil price returns affect real exchange rates for a panel of G7 countries from 1972 – 2005. Exchange rates affects the cash flows of firms in different ways depending on how their income/cost structure are related to and affected by exchange rates.

Hypothesis 3: There can be both a positive or negative risk premium for oil price returns depending on how exchange rates and oil prices affect different countries, industries and companies cash flows.

The nominal and the real rate of interest.

Several studies document a link between inflation and stock returns that is negative, see Geske and Roll (1983), Fama and Schwert (1977). When inflation rises, one way the central banks can fight it, is with their monetary policy. When the FED reduces the amount of money in the economy it will cause the new equilibrium for the nominal interest rates to rise. Increasing nominal rates are bad for the stock market for at least three reasons. First, it cools down the activity in the economy reducing consumption, investments and reduce company cash flows. Secondly it increase the cost of capital in company cash flows evaluations (Bernanke and Frank 2007). Thirdly, it increases the financial cost of loans.

The negative relation between stock return and nominal interest rates is documented in many studies. Jareño, Ferrer et al (Jareño, Ferrer et al. 2016) showed in their quantile regression approach how American companies sensitivity for interest rates changes vary across industries and time periods. They also found that the sectors most sensitive to nominal interest rate changes were the information technology, health care, materials, industrials and telecommunications services. The less affected, by real interest rate changes were energy, finance, consumer discretionary and consumer staples. (Bjørnland and Leitemo 2009) also found a strong negative interaction between the S&P500 and the interest rate setting, where much of the effect was found to happen contemporaneously. (Huang, Mollick et al. 2016) has studied the link between U.S stock returns in response to monetary policy during the period 2003-2015. They split the period into two sub periods, to compare effects from changes in the real rate on stock returns in two different periods. In the latter period, the real rate of interest has been negative, while it was positive in the first period. Their general finding was that stock prices was negatively correlated with the real rate of return in both periods, but more so in the recent periods when real interest rates had been negative. They also found that real rate of interest react negatively to increases in the oil price. (Cologni and Manera 2008) found that inflation is translated into the economy as an increase of the interest rates. The relationship between stock returns and oil prices was slightly positive. This is consistent with (Mollick and Assefa 2013) who argue that rising oil prices represent better outlooks for the world economy. Sadorsky (Sadorsky 1999) finds that interest rate shocks has a large and statistically significant negative impact on stock returns. Interest rate shocks also have a negative effect on industrial production, but the initial response is positive. The industrial production turns down after about 4 months. Oil price shocks has an initially negative impact on stock returns. It does so through increased costs, for companies. Oil price shock also has an initially positive impact on interest rates. Positive industrial production shocks had little impact on real stock returns.

Interestingly Hamilton(Hamilton 1983) 1983 found that 90 percent of the recessions in U.S economy was preceded by a spike up in oil prices. If oil prices causes' inflation and the central banks increase their nominal interest rates to fight inflation to the level, where the economy is starting to cool down too much, the central banks might also indirectly send the economy into recession with their monetary policy. Because investors are concerned with real rates of returns, there should be expected higher nominal interest rates when inflation is higher. The higher nominal rate maintain the expected real return from an investment. The interest rate, interesting for savings, is the real rate of interest. The real interest rate is the rate the real purchasing power increases over time. Low real interest rates, discourages people from saving and instead spending their money right away. Rational decision makers will maximize their wealth in the long run. The FED decrease or increase the supply of money in the market through open-market operations where the FED either buys or sells government bonds(Bernanke and Frank 2007) thereby increasing or decreasing the money supply, affecting the nominal interest levels directly and indirectly the real rate of interests in the economy. The FED cannot control the real rate of interest, directly, but through the equation:$r_n = r_r + i$. A lower real rate of interest encourages to higher spending, while a higher real rate of interest, encourages to more savings.

Short interest rates are mainly set by monetary policy and business cycles. The long-term interest rates are more indicative of future expectations of the economy.

Hypothesis 4 There will be a negative risk premium on renewable energy stock returns for inflation.

Hypothesis 5: There will be a negative risk premium on renewable energy stock returns for changes in the nominal rate of interests.

Hypothesis 6: There will be a negative risk premium on renewable energy stock returns for changes in real rate of interests.

Term structure

The term structure shows the interest rates in the markets at different maturities. Recent empirical work indicates that the change in the term structure has predictive power of directions of future changes in spot rates. (Fernandez-Perez, Fernández-Rodríguez et al. 2014) Estrella also confirms that changes in the slope of the term structure, predict the correct direction of future changes in spot rates. (Estrella 1991) (Estrella and Hardouvelis 1991) finds that a positive slope in the term structure is associated by increase in real economic activity, and that the slope of the yield curve can predict cumulative changes in real output for up to 4 years into the future. (Fama and Bliss 1987) finds that long-term maturity forward rates also have predictive power 2 to 4 years ahead. Fama and French (1986) show that excess returns on US stocks and bonds are positively related to the slope of the term structure of US treasury securities. They find the slope being high when business conditions are poor and low when business conditions are blooming. Gjerde and Sættem (1999) on the other hand, found an immediate negative relationship between real short-term rate and axis returns in the Norwegian market, while Chen, Roll and Ross (1986) found a negative relationship between the term structure of interest (the difference between long and short rates) and equity returns in the US market.

Fama and French (1989) found a connection between the default spread and business condition. They found the default spread to be high when business conditions are poor and low when business conditions are good. For the term spread they found that it is low near business-cycles peaks and high near bottoms. The slope for the term spread is positive, which indicate it carries a positive risk premium. (Estrella and Trubin 2006) has shown that the yield slope has a good record in forecasting recessions in real-time and has marginal predictive power for US recessions (Rudebusch and Williams 2012)

Hypothesis 7: There will be a positive risk premium for companies in renewable energy sector for changes in the slope of the term structure, as it signals improved economic conditions.

Credits spreads

Credit spreads changes systematically with changes in the economy. Credit spreads widen in a declining economy and narrow during economic expansion. The economic rationale is that in a declining economy, revenues and cash flows declines, making it harder for companies to service their contractual debt obligations. The widening occurs when investors are selling off corporate bonds and invest the proceeds in treasury securities. The widening occurs due to the opposite forces. When there is expansion in the economy, the revenue and cash flows from the corporates increase, and there will be an increased probability that the firms will be able to meet their debt obligations. This in turn will increase demand for corporate bond, and decrease the demand for treasury securities, widening the gap. (Fabozzi 2007)

Hypothesis 8: There will be a negative risk premium for the credit spread, as it signals diminishing cash flows and worsened business conditions.

The SPX VIX

The CBOE Volatility Index is a key measure of market expectations of the volatility on the S&P 500 the nearest 30 days. The VIX is an index of the implied volatility of the 30-day options on the S&P 500. The implied volatility is the stock volatility, when put into the Black Scholes and Merton option pricing formula, that will yield the observed prices of puts and calls in the market thus can be thought of as a measure of how much investor and market sentiment expects the S&P to move within the next 30 days. According to the CAL7, investors will require higher returns, if volatility is expected to rise. If there is only expected higher risk but not a proportional amount of higher returns, stock prices will drop as investors flee the market to securities that are less risky. The sharp rate shows the steepness of the Capital allocation line(CAL). The CAL shows the relationship between risk and returns for all the investments opportunities available to investors from the risk free interest rate to the more riskier securities in the investment universe. The CAL shows the excess return per risk units, and a steeper Sharpe ratio is generally preferred over a less steep sharpe ratio. (This can be shown as a maximizing problem for the sharp rate with 2 assets of different risk levels.)When investors are tilting their portfolios towards a bigger share of securities with a lower risk profile, it will cause a selloff in riskier assets that will cause prices of those assets to drop. According to this, when expected volatility rise and all the other factors are held constant, investors will increase their share of more secure assets in their portfolios which will make the share of riskier assets to drop and this selloff will cause prices in riskier assets to fall. Ghulam Sarwars (Sarwar 2012)study of how changes in the VIX affects the S&P 500 also supports that claim and he finds an asymmetrical relation between stock returns and changes in VIX, suggesting that VIX is more of a fear measure and less a measure of investors positive sentiment. The relationship between changes in the VIX and changes in the S&P was found to be negative in his study. Whaley(2009) argues that because the main purpose of options is for hedgers to secure against potential market drops in the stock market, the VIX can also be thought of as an indicator of the price for portfolio insurance. (Haug, Frydenberg et al. 2010) argues that implied volatility also will reflect the supply and demand of options, and not only the expectations the market has to the implied volatility the next 30 days. According to both Whaley and Haug et al, high levels of VIX can be seen as a measure of both the expected volatility on the S&P500 the next 30 days, and the supply or demand dynamics of options

[7] Capital allocation line

on the S&P500. Therefore, when the VIX is rising, it implies not only that the expected volatility to the S&P500 goes up, but also that the demand for options is rising.

Fleming et al find a negative contemporaneous correlation between VXO changes and the S&P index returns. (Fleming, Ostdiek et al. 1995) Giot (Giot 2005) found that high levels of VIX often coincides with market bottoms, and seems to indicate oversold markets. He also found some evidence that very high levels of VIX is associated with oversold markets and found that for very high levels of VIX, returns are always positive, while for very low levels of VIX, the returns was always negative. This is consistent with how CAL explains how investors trade returns for risk. When investors' expectations to future returns rise it will cause investors to tilt their portfolios towards equities, bidding prices up. Like the example with increased volatility above, where the maximizing of the sharp rate when volatility was rising and all the other factors were held constant, increasing expected future returns will cause prices to rise as investors are tilting their portfolios towards equities again. The expectation for the VIX is therefor that it can carry both positive and negative risk premiums depending on the expectations to *both* risk and returns the next 30 days for securities.

Hypothesis 9: There will be a positive or negative risk premium for the VIX, depending on the expectations from the markets regarding risk and returns.

As the literature overview above shows, there has been many studies of the effect of macroeconomic, systematic variables on stock returns. Most of these studies is done on equity indices and a few on individual stocks. Companies in various industries are different and might react differently to the state variables. To the best of my knowledge, there has not been done any studies of how companies in renewable energy sector react to macroeconomic systematic risk factors. This study will therefor extend the existing literature by exploring how systematic risk factors affect and perhaps can reduce the systematic risk in renewable energy stocks.

In this master thesis, I will explore how some of the state variables as specified by Chen, Roll and Ross (1986) influence the risk in renewable energy sector.

3. Data

The stocks in renewable energy sector (dependent variable)

To explore how companies in renewable energy sector is exposed to systematic risk factors, stock data for renewable energy companies were gathered. The companies in this study are selected from The NASDAQ® Clean Edge® Green Energy Index or the MAC Global Solar Energy Stock Index. Both of these indexes are designed to track the performance of companies that are involved in the renewable energy sector as distributors, manufacturer's developers or installers of clean energy technologies. MAC Solar is a pure solar index The NASDAQ® Clean Edge® Green Energy Index (CELS) began on November 17, 2006. The Mac solar index is designed to track companies within different segments of the solar power industry. The index is comprised of stocks selected based upon the relative importance of the solar power within the company's business model. Only businesses that has at least one third of their revenue from solar related business are included in the index. Links to detailed description for being a member of either of these indices is in the appendices. As we were interested in exploring the risk factors for companies in different parts of the value chain in renewable energy sector and in different subsectors of the renewable energy sector, we include companies from both of these indices.

For this study, we investigated the risk and return characteristics of renewable energy stocks of 26 renewable energy firms divided into seven sub sectors. The choice of firms for the research was motivated by the interest in assessing the effects of various factors in different sectors and subsectors in renewable energy. We wanted to investigate both solar, wind, ethanol, hydrogen fuel, geothermal as well as renewable technology and management, to have a better overview of renewable energy sector. Initially we had chosen more than 26 companies but limitation in presented data for the 10 years' period that we were interested to investigate abbreviated our choice into the selected companies. Stock prices for the 26 companies were downloaded in daily sequences and were converted into weekly and monthly sequences. While we did not find any missing observation in our data, we did notice the effect of financial crisis in 2008 on stock prices.

Macro factors (independent variables)

The Chen, Roll and Ross (1986) study inspire five of our selected macro factors while four are chosen from other empirical findings. The term structure, industry factor, oil price returns, general market and credit spread are the same as the risk factors employed by Chen Roll and Ross (1986).

S&P returns

As a proxy for the market, we have chosen The Standard and poor's 500. The S&P500 is a stock market index based on the 500 largest companies listed on NYSE or NASDAQ. The S&P500 is considered of many a good proxy for the stock market in general and is considered a trend indicator of the U.S economy. The S&P is a good proxy for systematic risk factors as it shows how all the other stocks in the market are affected by the systematic risk factors. The S&P is an equity only index, and does not include bonds or options.

Returns S&P500 =$\ln(\frac{S\&P_t}{S\&P_{t-1}})$.

The CBOE Volatility Index

The CBOE Volatility Index is a measure of expectations from the market to the volatility on the S&P 500 the next 30 days. The VIX uses the implied volatilities of calls and puts on the S&P500. The implied volatility is the volatility, when put into the Black Sholes Merton option pricing formula, will yield the observed prices of puts and calls in the market. The CBOE Volatility index - VIX returns are calculated as $\ln(\frac{VIX_t}{VIX_{t-1}})$

Inflation

Inflation is measured through changes in the consumer price index measured by the U.S. Department of Labor, Bureau of Labor Statistics[8].

Real rate of interest and the nominal rate

In this study, the nominal risk free rate is the 3-month-tbill. The 3-month Treasury bill is chosen over the 1-month Treasury bill because the 1-month Treasury bill has been negative in parts of our sample period and a negative T-bill would make it impossible to calculate returns as $\ln(\frac{r_{n,t}}{r_{n,t-1}})$. The real rates of return can be calculated with fisher's equation in two ways:

$$rr = \frac{r_n + i}{1+i} \qquad (1)$$

$$r_n = r_r + i. \qquad (2)$$

Where the real rate is: r_r and r_n is the nominal rate and *i* is the inflation. In this paper, the real rates are calculated with fisher's approximation rule (2), as it yields results that are more accurate for periods with low inflation. The average monthly inflation in our 10-year period has been 0.13%, which can be considered as low. The real rate of return is calculated by subtracting the inflation from the nominal interest rates. The calculation of the returns on the real rate of returns is done by absolute returns, as it has been negative in our sample period. $R_t = \frac{r_{r,t} - r_{r,t-1}}{r_{r,t-1}}$ where R is the returns on the interest rate.

[8] http://www.seattle.gov/financedepartment/cpi/historical.htm

Term structure

The term structure is the difference between the 10-year treasury bonds minus the 1-month treasury bills $_{t-1}$. $10TB - 1MTB_{t-1}$. Where 10TB is the 10-year government Treasury bond and 1MTS is the 1-month Treasury bill.

Industry

The industry factor is the returns on the Federal Reserve's monthly index of industrial production and the related capacity indexes and capacity utilization rates – G17. 9. The returns $= \ln(\frac{\text{industri prod}_t}{\text{rindustry prod}_{t-1}})$. The industry factor is measured in real terms, se footnote for details.

Oil price returns

The oil price returns are the monthly spot prices on Cushing, OK WTI spot price FOB[10]. $\ln(\frac{P_t}{P_{t-1}})$

[10] http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm

Figure 1 Macroeconomic variables 2007-2016

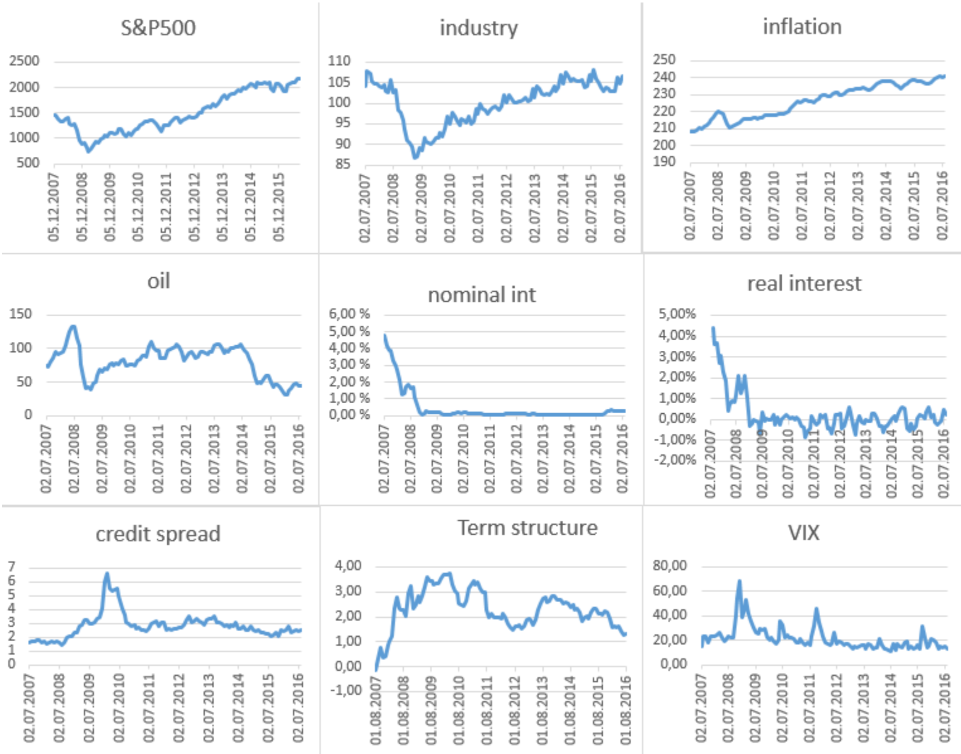


Figure 1 shows the development of all the nine risk factors in the sample period. In light of what was found in the literature section, it is interesting to see, how especially the industry and inflation follows the same track as the S&P500, while the nominal interest rates has been close to zero in the period these 3 indicators has been rising. The real interest rates has hovered around zero from 2009 -2016, and been negative in some of the sample period. Both oil prices, credit spreads and the VIX spiked at the time the financial crisis took its toll on the markets, while the term structure was on the rise before, during and after the financial crisis of 2007/2008.

Table 1 Descriptive statistics for all state variables 2007-2016

	S&P	INDUSTRY R	OILr	NOMINAL INTEREST	REAL INTEREST	Term structure	VIX	INFLATION	CREDIT SPREAD
Mean	0,36 %	-0,01 %	-0,45 %	-2,44 %	-148,58 %	1,89 %	-0,60 %	0,14 %	0,37 %
Standard Error	0,53 %	0,15 %	0,95 %	4,65 %	126,23 %	1,81 %	2,25 %	0,04 %	0,88 %
Median	1,65 %	-0,17 %	1,00 %	0,00 %	-35,88 %	0,00 %	-3,04 %	0,16 %	0,80 %
Standard Deviation	5,54 %	1,59 %	9,90 %	48,33 %	1311,82 %	18,76 %	23,42 %	0,42 %	9,10 %
Kurtosis	2,05	0,27	1,56	3,93	96,64	9,10	1,82	5,11	2,62
Skewness	-0,85	0,21	-0,84	0,29	-9,55	1,21	0,75	-1,27	0,57
Minimum	-18,36 %	-5,06 %	-33,20 %	-184,58 %	-13294,08 %	-79,11 %	-55,86 %	-1,93 %	-20,31 %
Maximum	14,61 %	3,44 %	21,39 %	179,18 %	1662,36 %	85,18 %	91,63 %	1,00 %	39,72 %
Count	108	108	108	108	108	108	108	108	108

As the table 1 shows, there have been extreme values for the interest rates in the sample period. The interest rates has been abnormally low, and percentage change show up as dramatic even interest rates has been changing by small amounts in values. For instance, the real rate of interest was 0, 005558% in October 2010 and increased to 0, 09794% in November the same year. A very small change in the value of the interest rates, yet still it calculates as a change of 1662, 36%!

Table 2 Risk factor correlation 2007-2016

	S&P	*INDUSTRY R*	*OILr*	*NOM INTER*	*INFLATION*	*REAL INTER*	*C.SPREAD*	*TERM STR*	*VIX*
S&P	1,0000								
INDUSTRY R	0,0676	1,0000							
OILr	0,3412	0,0750	1,0000						
NOMINAL INTEREST	0,3761	0,1381	0,0356	1,0000					
INFLATION	0,3650	0,1972	0,6855	0,2088	1,0000				
REAL INTEREST	-0,0813	-0,1516	-0,0162	0,0076	0,0181	1,0000			
CREDIT SPREAD	-0,1160	0,0023	-0,0027	-0,0648	-0,0519	-0,0106	1,0000		
Term structure	0,0360	-0,0243	0,1607	-0,0657	0,1031	0,0103	-0,0125	1,0000	
VIX	-0,7496	0,0866	-0,2439	-0,4085	-0,2468	0,0814	0,1109	-0,0195	1,0000

There is a negative correlation between the industry, the real rate of interest and the term structure.

The industry is negatively correlated with the real rate of interest and the term structure. When the real rate of interest goes up, savings goes up. When savings goes up, investments tend to go down. If in a closed economy with no export or import, total production must equal total expenditure: Y = C + I + G + S and total savings is equal to S = Y – C – G – I . Where Y is the total production, C is the total consumption, G is government spending, I equals the total investments[11] and S equals the savings. (Bernanke and Frank 2007)When the interest rate goes up, the discounting factor in net present value calculations goes up, and fewer investments projects becomes profitable. In this way, the real rates of interest will have a negative influence on the industry growth. If the markets view the term structure of interests as a predictor of future interest rate levels, a widening of the maturity spread, should have the same effect as an increase in the real rates of interest. There is a positive correlation between the industry, oil returns, the nominal interest rates, inflation, credit spread and the VIX. Several studies has linked the growth in economy to an increased demand for oil. The correlation between oil and inflation is quite high (0, 6855). The literature supports the idea that a growing industry increases the demand for oil. Because the oil prices are so highly correlated with inflation and the FED uses nominal interest rates to fight inflation, the positive relationship between economic growth and nominal interest rates becomes more plausible.

The oil price is negatively correlated with the real interest rates, credit spreads and VIX. The negative correlation with the real interest rates is consistent with the positive correlation between industry and real rate of interest rates mentioned above. The negative correlation to credit spreads might happen

[11] Investments in this equation only includes investments into real capital done in an economyl like factories investments in new infrastructure for industry and machines goes down, and does not include investment in financial assets like stocks. (Bernanke and Frank, 2007)

when oil prices increases, inflation increases, making nominal interest rates go up, increasing the cost of interest paid on loans, increasing the default rates on loans.

A higher inflation reduces the real interest rates, which will make it more likely that the central banks will reduce the money supply, to restore equilibrium of nominal interest rates at a higher level and indirectly increase the real rate of interest. The industry is positively correlated with all the other variables except for the real rate of return and the term structure. When the real rate of interest goes up, savings goes up, making money more expensive for investments and consumption, and there will be expected an inverse relationship. Both oil and inflation is linked to economic growth, and a positive correlation should therefore be expected. The positive correlation with nominal interest rates, is more puzzling, but can possibly be explained through the dynamics between inflation and the nominal interest rates. The positive correlation between these two risk factors of 0.2088 supports that conclusion.

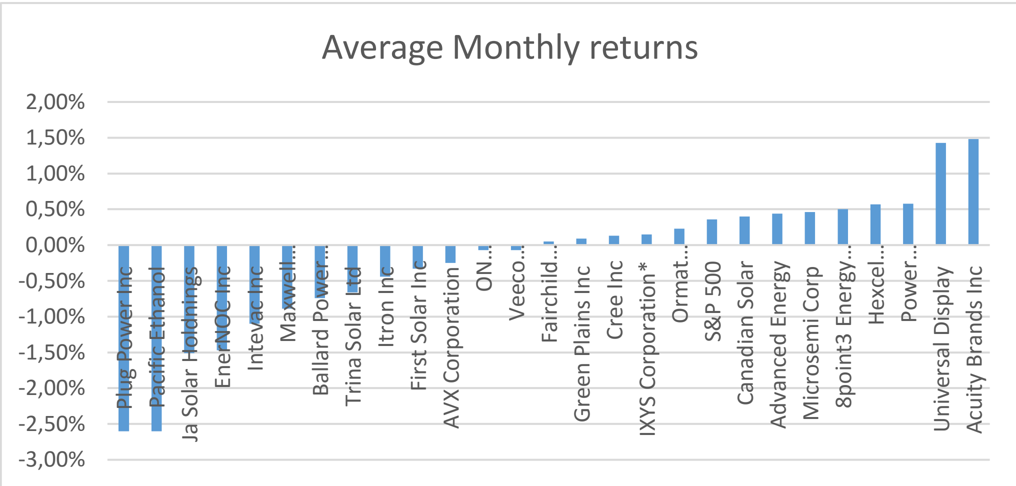
The S&P500 is positively correlated with the industry, the oil price returns, the nominal interest rates, inflation, ant the term structure of interest and negatively correlated with the real rate of interests, the credit spread and the VIX. To start with the negative correlations: when the real rate of interest rates increases, saving increases and the cost of capital increase. When savings increase, investments and consumption decrease, making the cash flows that are now, compounded by a higher cost of capital, smaller. The credit spread goes out in economic recessions, and the decreasing cash flows explains the negative correlation to stock returns. The positive correlation between inflation, industry, nominal interest rates and the term structure, is puzzling in light of the literature in the field. The nominal interest rates and the inflation has been very low in the sample period, and the real rate of interests has been negative.

Descriptive statistics for the renewable companies

The descriptive statistics for the sample is calculated from May 2007 – August 2016. Due to the limitation in this paper, we continued our research with monthly returns. Only descriptive statistics for monthly returns are included in this chapter, while the daily and weekly statistics can be found in our appendix.

Monthly returns: The average monthly company returns of the renewable energy stocks is very different within our sample.

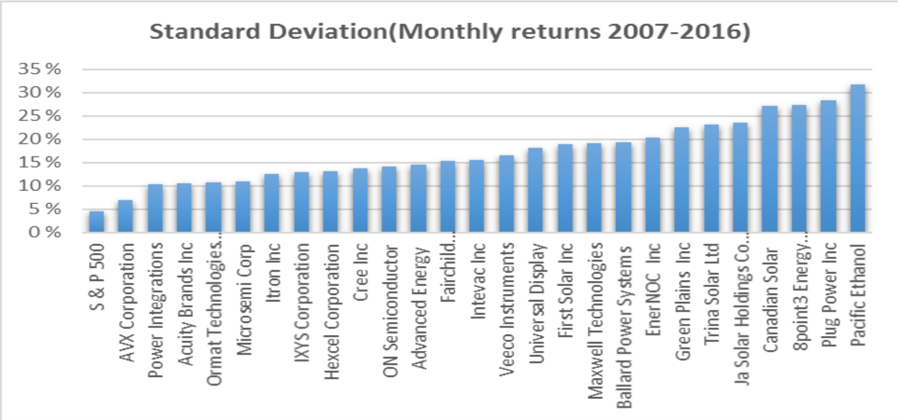
Figure 2 Average monthly returns for company stocks 2007-2016



The best performing one is Acuity brands INC with an average monthly return of 1.48%., well above the S&P, which has a monthly return of 0,36 %. The worst performing one is Plug Power Inc. with a negative monthly return of minus 2,6%. Plug Power is a producer of hydrogen fuel. The hydrogen fuel production is still in its infancy as there are still very few hydrogen vehicles on the roads, but leading car producers like Toyota, Hyundai Mercedes Benz and Chevrolet all have Hydrogen car models in their assembly lines by now. Acuity Brands, which is in the leading end of the scale and is an electronics company that creates innovative lighting solutions to save energy.

Monthly standard deviation: The monthly standard deviations of the renewable companies also varies a lot, and all the companies have higher risk than the S&P500.

Figure 3 standard deviation company stocks 2007-2016

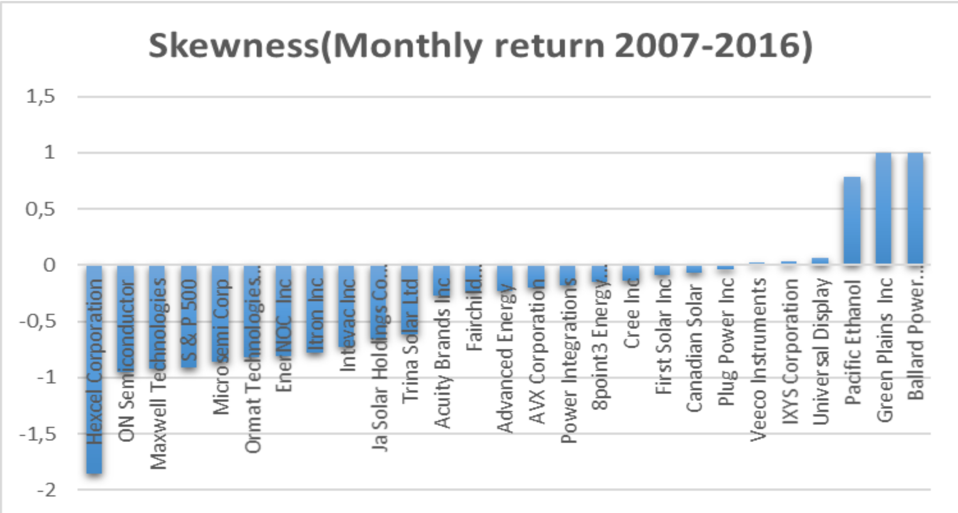


Many of these companies are technology companies, and it is not uncommon for technology companies to have high standard deviations. The standards deviation for the renewable energy stocks ranges from 7% to 32% in average on a monthly basis. The company with the highest monthly standard deviation is Pacific ethanol who is a company that is a marketer of low-carbon renewable fuels and leading producer in the United States. Pacific ethanol is a producer of renewable energy and is on the top of the value chain. The company with the lowest monthly risk is AVX Corporation. AVX is a passive, interconnect electronics company who delivers Passive, and interconnect solutions for renewable energy. AVX is a subcontractor in the renewable energy value chain.

Test of normality: To test whether the sample data has the skewness and kurtosis of a normal distribution, a Jarque Bera test was performed. JB=$\frac{T}{6}\left(s^2 + \frac{(K^2)}{4}\right) \sim x^2(2)$. The general finding is that the null hypothesis about a normally distributed distribution was not rejected for most of the companies. The null hypothesis was rejected for Green Plains Inc., Hexcel Corporation, Intevac Inc., IXYS Corporation, and Plug Power Inc.

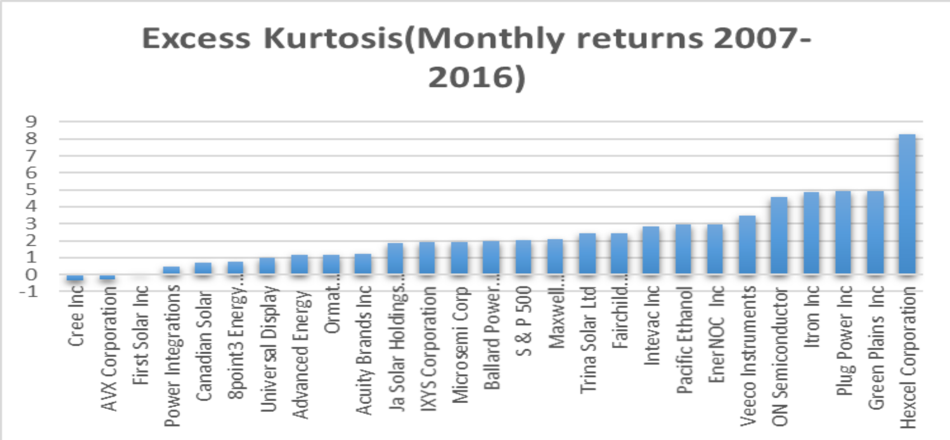
Distribution: The return distributions for the renewable energy companies, is in general skewed to the left for most companies (20 out of 26). A left skew means that there are more values to the left of the mean, than the mean central tendency measures imply. It also implies that the standard deviation underestimates risk. Hexcel is the company with the largest left skewness, while Ballard is the company with biggest right skew and will have smaller risk than estimated by its standard deviation.

Figure 4 Skewness monthly returns 2007-2016



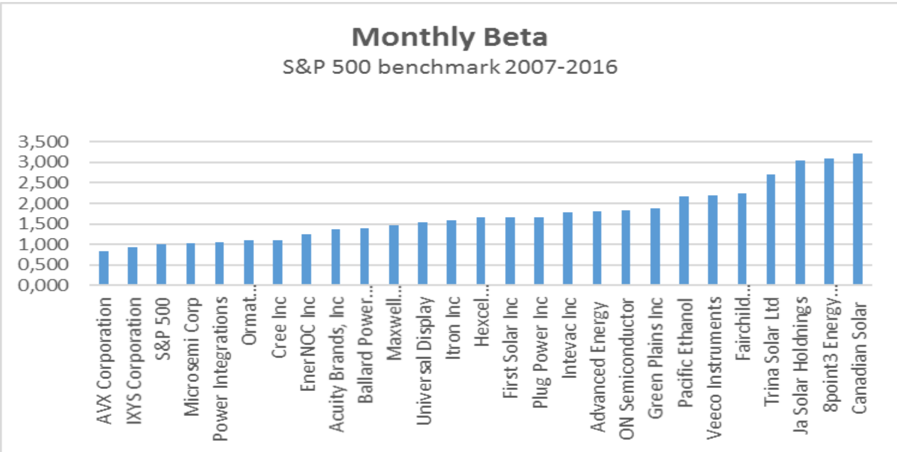
Excess Kurtosis: Is a measure of extreme values on either side of the mean. Kurtosis is a measure of the fatness of the tails. Generally speaking, when a distribution has fat tails, it has a bigger probability of extreme values, then predicted by the normal distribution. Most of our companies shows signs of fatter tails than the normal distribution and the return distribution will therefore have a larger share of extreme values than the normal probability distribution predicts.

Figure 5Excess Kurtosis monthly returns 2007-2016



Monthly Betas: The Company's returns were regressed on the S&P500, to learn more about the systematic market risks of these companies.

Figure 6 Monthly S&P500 beta for all companies 2007-2016



The comparative stocks return volatility and assessed systemic risk on monthly return were estimated based on movements of The Standard & Poor's 500. Most of the companies in our sample have a higher market beta than the S&P500. With a Beta of 3,21 Canadian Solar has the highest monthly beta and AVX incorporated has the lowest one. Canadian solar is a producer of solar energy, while AVX is a producer of electronics to the renewable energy sector, and a subcontractor. The betas estimated are average betas for the 10-year period. The true betas are time varying, and rolling betas from 24-month rolling window regressions are included in appendix D.

Descriptive analysis for subsectors: In the descriptive analysis of the companies in our sample, we found great variation as to both the returns, the standard deviations and the betas.

Table 3 Subsector statistics 2007-2016

Subsector	beta	returns	σ
Geothermal	1,10	0,23 %	11,00 %
Wind	1,19	0,36 %	10,33 %
Ethanol	1,14	0,30 %	10,67 %
Electronics	1,45	0,13 %	14,18 %
Energy Management	1,59	-0,44 %	12,00 %
Hydrogene Fuel	1,52	-0,16 %	13,09 %
Solar	2,28	-0,26 %	19,38 %

The subsector analysis shows that the risk is greatest in the solar industry where both the highest standard deviation and the highest monthly beta occur. As shown in table 3, the companies engaged in the solar sector, in average had a much higher beta than the other companies did with an average monthly beta of 2, 28%, or more than twice as much as the S&P500 did. Geothermal had the lowest monthly beta, and is about as risky as the market in general with a beta of 1,10. The average monthly returns have been -0,26% per month. The best performing subsector is the wind sector, with a beta of 1,19 and monthly returns of 0,36%. In general, our analyses shows that the subcontractor has a far better performance than the firms that are directly involved in the production of renewable energy. This makes sense as the firms that are subcontractors might have multiple sources for their income, while the income to the producers of renewable energy comes from fewer sources and might be more vulnerable to changes in market conditions. Another interesting finding is that the firms with the highest average monthly betas has a much bigger share of fixed, tangible assets than the low beta companies in this sample.[12] Fixed tangible assets typically consist of investments in machines and equipment and are intended to generate future income for the firm. Investments typically involve a bigger payout in the year of the investment, while the future income is expected to cover interests and profits. In industries that are very technology driven, changes happens fast, and the winners of today can soon be the losers of tomorrow, making the value of investments done under a different technological regime, crumble into shreds. The bigger share of fixed tangible assets in a technology company might contribute and enhance the risk of the firms, as technological breakthroughs both can apply losses to firms if their assets suddenly become inferior and enhance their income if their technology makes a boost. A more detailed overview of subsector statistics are found in the appendix.

As the descriptive statistics for these renewable energy companies show, the performance and the risk in the companies vary greatly. Another finding is that the risk in these companies are quite high both in measures of standard deviations and market betas. This finding aroused our curiosity as to why the risk and return vary so greatly within our sample. Because systematic risk is the only risk that matters from a portfolio perspective, we decided to focus our research on the effect of systematic risk factors on renewable stock returns. Our choice of systematic macroeconomic risk factors stems from earlier empirical works presented in the literature section and economic intuition. As there is no agreed upon common model for what macroeconomic risk factors to include, we will explore how stocks in renewable energy sector is sensitive to: S&P500, VIX, industrial growth, oil price returns, inflation, nominal interest rates, real rate of interests, term structure and credit spreads.

[12] See appendix E for details

4. Methodology

Risk model testing: The risk model is tested with time series regressions. We choose the time series regressions over a cross-sectional or a panel data approach because we were interested in exploring how the risk factors affect the stocks over time.

$$r_{it} = \alpha + \beta_1 X_{S\&Pt} + \beta_2 X_{Vixt} + \beta_3 X_{rnt} + \beta_4 X_{rrt}$$
$$+ \beta_5 X_{oilt} + \beta_6 X_{inflt} + \beta_7 X_{indt} + \beta_8 X_{termt} + \beta_9 X_{credt} + e_t$$

r_{it}= monthly stock return at time t, for company i.

α = the intercept, mispricing

$X_{S\&Pt}$ = monthly returns on S&P500 at time t

X_{Vixt}= monthly returns on The CBOE Volatility Index at time t

X_{rnt}= monthly returns on the nominal interest rate at time t

X_{rrt}= monthly returns on the real rate of interest at time t

X_{oilt} = monthly returns on oil prices at time t

X_{inflt}= monthly returns on inflation at time t

X_{indt}= monthly returns on the industry index, at time t

X_{termt}= monthly returns on the term structure, at time t

X_{credt}= monthly returns on the credit spread, at time t≠

e_t= The error term captures influence on stock returns from factors not included in this model, for instance unsystematic firm specific risk

The following hypotheses was developed for the risk model:

$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = 0$

$H_1: \beta_1 \neq 0 \text{ and or } \beta_2 \neq 0 \text{ and or } \beta_3 \neq 0 \ldots \neq 0$

We regressed all our companies on all of the systematic risk factors, to explore the stock returns sensitivity to our risk factors or factor loadings. We started by doing simple regressions in excel, but we found little evidence of the risk factors effects on our stocks returns, so we asked the question what if the risk factors has explanatory power of stock returns, but that the effect is lagged or leading? According to Carter(Carter 2007) certain variables in the economy can be thought of as leading, lagging or concurrent indicators of financials. Leading indicators provide signals about expected changes in the business cycles, and can provide an early warning system for identifying financials. With this notion as a hypothesis, we regressed our companies on the risk factors with lags to study the leading, lagged or concurrent effect of these risk factors. Our regressions was done by Ox metrics[13], which allows for sensitivity for the risk factors in several time lags, using up to 5 lags to find the model with the highest r^2 adjusted value. We first searched for the optimal lag model, and then ran a new regression with lags and risk factors fixed to the optimal model. We also ran regressions where the company stocks returns was regressed on the S&P 500 alone, to learn about the additional explanatory power of our macro economical risk factors. The S&P was regressed on the risk factors. The following specification test were performed on the residuals in Ox metrics: Normality test, Heteroscedasticity test, AR 1-2 test, ARCH test, Reset test. To deal with the heteroscedasticity, companies were regressed with robust standard errors. The OLS model rests upon certain assumptions for its parameters to be reliable, and the specification tests, tests to what degree these assumptions has been present in the regressions. The results from the specification tests are included in appendix F.

Chow test Due to the finance crisis effect on our data, chow test was performed to test for parameter stability in our test period or if there has been structural break in the data. To apply Chow test we divided our monthly return data into two sub-samples, 2007-2011 and 2012-2016. Chow test uses an F-test to determine whether a single regression is more efficient than two separate regressions of the two sub-periods. It is a test to see if two parameters in two linear regressions are equal.

[13]

To apply the Chow test, regression for the whole period and the two sub-periods were run while collecting the Restricted Sum of Squares (RSS) for the total period RSS_t and for the two sub-periods RSS_1 and RSS_2 were collected. These values were used to calculate the test statistic with the formula

$$F = \frac{RSS_t - (RSS_1 + RSS_2\ )/k}{(RSS_1 + RSS_2\ )/(n_1 + n_2 - 2k)} \sim F[k\{n_1 + n_2 - 2k\}]$$

Structural breaks in the parameters were found for Veeco instruments and Fairchild semiconductor. The other companies all showed parameter stability in the sample period. The results for the Chow test is included in Appendix E.

5. Results

OLS regression does not imply a causal relationship between the variables. "A statistical relationship, however strong and however suggestive, can never establish causal connection: our ideas of causation must come from outside statistics, ultimately from some theory or other" (Kendall and Stuart 1963)

Table 4 S&P beta

Standard and Poor's 500 Beta - in various time lags								
	β[0]	t-value	β[-1]	t-value	β[-3]	t-value	β[-4]	t-value
8point3 Energy Partners LP	3,093	8,150						
Acuity Brands Inc	1,416	11,400			0,293	1,570		
Advanced Energy	1,786	9,700						
AVX Corporation	0,851	9,340						
Ballard Power Systems	1,622	4,720						
Cree Inc	1,205	6,190						
EnerNOC Inc	1,182	3,480						
Fairchild Semiconductor	2,371	14,900						
Green Plains Inc	2,656	7,590					-1,241	-3,910
Hexcel Corporation	1,686	10,200	0,747	3,050				
Intevac Inc	2,410	7,330						
Itron Inc	1,470	6,290						
IXYS Corporation					-0,421	-2,050		
Ja Solar Holdings Co Ltd	3,075	11,000						
Maxwell Technologies	1,458	4,760						
Microsemi Corp	1,125	7,210						
Trina Solar Ltd	3,022	9,510						
Universal Display	1,535	5,420						
Veeco Instruments	2,802	9,820						
Canadian Solar	3,213	8,800						
First Solar Inc	1,696	5,920						
ON Semiconductor	1,524	8,130	0,326	2,030				
Ormat Technologies Inc	1,057	6,990						
Pacific Ethanol	1,745	3,050						
Plug Power Inc								
Power Integrations	1,142	8,570						

.

Hypothesis 1: there will be a positive risk premium for the market beta.

Twenty-five out of twenty-six companies has a significant beta towards the S&P500. When the market moves, the companies in renewable energy moves with it. As mentioned in the descriptive statistics the market betas of the renewable energy sector varies a lot and the lowest observed significant beta value is negative (-1,241) for Green plains incorporated. The negative beta value is observed in (t-4) and the same company has a positive beta value in time t of (2,656) so the negative beta value from S&P500 more than cancel it out. The average beta is 1,454 and the highest, for Canadian Solar is 3,21 which means that Canadian Solar moves more than 3 times as much as the market in general. Almost all the companies in renewable sector had a sensitivity to the S&P500.

Table 5 Industry beta

Industry production Beta - in different time lags				
	β[-2]	t-value	β[-4]	t-value
Acuity Brands Inc	-1,296	-2,890		
EnerNOC Inc			-2,504	-2,060
Fairchild Semiconductor	-1,850	-3,310		
Green Plains Inc			2,565	2,230

Hypothesis 2: Economic growth can have both a positive or negative risk premium on stock returns. If the economic growth is mainly driven by technological revolutions, it will have a negative risk premium while.

Four out of twenty-six companies has a significant beta for the industry production. Of these four companies, three of them has a negative industry beta. A negative beta is the opposite of the Chen, Roll and Ross findings and are opposite of how the S&P500 reacts to this risk factor. The companies with the negative industry betas are Acuity brands, EnerNoc and Fairchild semiconductor. All of these companies operate within the technology sector as subcontractors of the renewable energy producers. Their negative relation with industry growth can be explained by Schumpeterian creative destruction. If the economic growth is driven by technology, old technology might become less competitive to the new one, and that might incur losses to the firms holding the old technology. When assets becomes less worth accountants impair the value to their real value, and that will be reflected in the financial statements of the firm, as losses. The only company with a positive industry beta is Green Plains Inc., Green plains is a producer of ethanol fuels. When the activity in the economy is rising, demand for fuels is also increasing, making sales income for fuel producers to go up.

While only four of the companies had a significant industry beta, it is challenging to say that stocks in renewable energy sector as a group have a factor loading for industrial growth. The pattern from the few companies that had a significant beta seems to confirm our expectations about a negative risk premium for stocks if technological advances mainly drive the grown. All the companies with negative risk premiums are from the technology sector, while the one with the positive beta is a fuel producer.

Table 6 Oil return beta

	Oil returns Beta - in various time lags					
	β[0]	t-value	β[-2]	t-value	β [-3]	t-value
Green Plains Inc					0,510	2,890
Intevac Inc			0,358	3,140		
Microsemi Corp	0,297	2,680				
Ormat Technologies Inc	-0,259	-3,040				
Pacific Ethanol	1,048	2,960				
Plug Power Inc	1,043	2,910				
Power Integrations	-0,251	-3,310				

Hypothesis 3: There can be both a positive or negative risk premium for oil price returns depending on how exchange rates and oil prices affect different countries, industries and companies cash flows.

The beta for oil returns ranges from -0,259 to 1,048. A total of seven of the companies in renewable energy sector shows sensitivity for oil price returns. Five of the companies has positive betas, while two have negative beta. The

S&P500 has a positive oil beta, while the beta found in Chen, Roll and Ross was found not to be significant. Green plains, Intevac, Pacific ethanol and Plug Power are all producers of renewable energy. When prices for oil goes up, it signals either an increasing demand for oil or a tightening of the supply. Increasing oil prices are also correlated with economic growth. When the oil price goes up, the prices for fuels in general will go up, and increase cash flows to energy producers in general. Microsemi Corp has a positive oil beta. Microsemi is a manufacturer of semiconductors. Its business areas are solutions for defense & security, data center, aerospace communications, and industrial markets. The last company with a positive beta is Intevac Inc., which is a producer of thin films for the technology and vacuum coating industries, and advanced systems for the defense industry.

Both Microsemi and Intevac are producers of defense solutions. Their positive oil beta can be explained by the link between oil prices and economic growth. The two companies with a negative oil beta is Ormat and Power integrations. Ormat is a geothermal company that both designs, develops, builds, owns, manufactures and operates geothermal power plants worldwide. When oil prices are rising, more oil investment projects becomes profitable, and less capital might go into renewable energy projects like building new factories for renewable energy. Seven out of twenty-six of the companies show sensitivity for oil price returns.

Table 7 Inflation beta

Inflation Beta - in different time lags				
	β [0]	t-value	β [-1]	t-value
Itron Inc	7,037	2,800		
IXYS Corporation	6,978	2,420		
Microsemi Corp	-9,171	-3,470		
Plug Power Inc			-20,417	-2,430

Hypothesis 4 There will be a negative risk premium on renewable energy stock returns for inflation.

Four of the companies in our sample shows a large and significant beta to the inflation. Microsemi Corporation and Plug Power both have large negative betas to the inflation, which means that the effect of inflation is quite eminent for these two companies. The r^2 values for these companies are on average low, so the effect on returns are smaller than indicated by the parameter values. Plug Power is a producer of hydrogen fuel cell power. Microsemi is a manufacturer of semiconductors. Its business areas are solutions for defense & security, data center, aerospace communications, and industrial markets. The S&P500 has a negative beta for inflation where the link is the nominal interest rates, which tend to go up when inflation is rising. IXYX Inc. and Itron Inc. both show large and significant positive betas for inflation. The S&P500 has a negative inflation beta, and the same was found in Chen, Roll and Ross's study.

Table 8 Nominal interest rate beta

	Nominal interest Beta - in different time lags									
	β[0]	t-value	β[-1]	t-value	β[-2]	t-value	β[-3]	t-value	β[-4]	t-value
Cree Inc			0,083	3,710						
Green Plains Inc	-0,112	-2,930								
Hexcel Corporation					-0,040	-2,080				
Itron Inc										
Microsemi Corp			0,035	2,130	0,057	3,210				
Trina Solar Ltd	-0,093	-2,520								
Veeco Instruments					0,058	2,630				
ON Semiconductor	0,060	2,950								
Ormat Technologies Inc					-0,039	-2,290				
Power Integrations							-0,054	-3,220	0,051	3,360

Hypothesis 5: There will be a negative risk premium on renewable energy stock returns for changes in the nominal rate of interests.

As many as nine companies has significant betas to nominal interest rates. Cree, Microsemi, Veeco and On semiconductor all have positive beta while the rest has negative betas which is expected.   The companies with a positive beta are all in the electronics business. All the nominal interest rate betas are small in the sample period. It is worth noting, that the nominal interest rates has been abnormally low in the sample period. After dropping from about 5% in 2007, nominal interest rates has stayed around zero from 2009 until today. Stocks in renewable energy are sensitive for changes in nominal interest rates. It is a little puzzling that some of the firms showed an opposite reaction of what was previously anticipated.

Table 9 Real inteerst rate beta

Real rate of interest beta - in different time lags								
	β[0]	t-value	β[-1]	t-value	β[-2]	t-value	β[-5]	t-value
Acuity Brands Inc					-0,001	-2,250		
Cree Inc			0,002	2,460	-0,002	-2,720		
Trina Solar Ltd					-0,004	-2,800		
Plug Power Inc							-0,007	-3,790
Power Integrations	-0,002	-3,280						

Hypothesis 6: There will be a negative risk premium on renewable energy stock returns for changes in real rate of interests.

Five renewable energy companies has significant betas for the real rate of interest. All the betas are very small in this period, and the real rate of interest has been very low in 2009-2016, which might explain the very low betas. Four out of the five companies has a negative beta, which should be expected as saving increases when the real rates of interest goes up in the economy. When savings increase, investment and consumption tends to go down, reducing companies’ cash flows, and increasing the cost of capital.

Table 10 Term structure beta

Term structure Beta - in different time lags						
	β[1]	t-value	β[-1]	t-value	β[-4]	t-value
Cree Inc	0,198	2,770				
Microsemi Corp			0,153	3,410		
Power Integrations					0,134	3,260

Hypothesis 7: There will be a positive risk premium for companies in renewable energy sector for changes in the slope of the term structure, as it signals improved economic conditions.

Three companies has a positive beta for the term structure. When the term structure goes out, it might signal expected improved conditions of the economy. The positive term structure beta for Cree, Microsemi and power integrations should therefore be expected. In the Chen, Roll and Ross study, the term structure was found to have a negative risk premium. The empirical findings in this study therefore does not support those findings. Only three of the companies were found to have significant betas for the credit spreads.

Table 11 Credit spread beta

	Credit spread Beta - in different time lags							
	β[0]	t-value	β[-1]	t-value	β[-2]	t-value	β[-3]	t-value
Cree Inc	0,352	2,960	0,294	2,460				
Green Plains Inc					0,394	2,030		
Itron Inc							0,319	3,570

Hypothesis 8: There will be a negative risk premium for the credit spread, as it signals diminishing cash flows and worsened business conditions.

Three of the companies has a positive beta for the credit spread. This is opposite of how the S&P500 reacts to the credit spread and opposite of the Chen, Roll and Ross(1986) findings, and opposite of what should be expected, unless these are firms that tend to have improved performance when the economy is declining. Itron has a negative industry beta, positive inflation beta and a positive credit spread. Itron produces technology solutions related to smart gas, water and grid solutions that analyze consumption. Its products consists of measurement devises and control technology for resource management and efficiency.

Companies that are selling equipment to save resources or to repair broken ones are companies that might thrive during economic recessions when consumers become more aware of saving resources and repair broken equipment instead of buying new ones.

Table 12 VIX beta

	CBOE Volatility index Beta - in different time lags							
	β[t]	t-value	β[-1]	t-value	β[-3]	t-value	β[-4]	t-value
Acuity Brands Inc					0,109	2,540		
IXYS Corporation	-0,170	-3,290						
Microsemi Corp			0,088	2,330				
Veeco Instruments	0,179	2,610						
Pacific Ethanol							0,485	2,670
Power Integrations					-0,116	-3,310		

Hypothesis 9: There will be a positive or negative risk premium for the VIX, depending on the expectations from the markets regarding risk and returns.

Six companies has a significant beta for the VIX. Four of the companies has a positive VIX beta and two has a negative VIX beta. The S&P500 has a negative risk premium for VIX. The firms with a positive VIX beta are Acuity, Microsemi, Veeco and Pacific ethanol. A positive VIX beta means that the stocks returns has a positive risk premium for increasing volatility in the market. Five out of six of the companies are subcontractors to the renewable energy sector while only one producer of renewable energy has a significant beta towards the VIX. The subcontractors in renewable energy sector was found, in average to have lower risk than the producers both measured by their beta and their standard deviations. According to the CAL, when risk is increasing, investors require a higher return, and if there is not expected an additional amount of higher return when volatility is rising, it will cause a selloff of the more riskier assets, and an increased demand of securities with a lower risk profile. Because the subcontractors, on average, have a lower standard deviation and beta than the producers, they might have a positive risk premium because they are considered safer investments, when volatility is rising. This is consistent with previous findings.

Table 13 summary table - company sensitivity for all risk factors

Summary table - company sensitivities for all risk factors					
	Low	Median	Average	High	Number of sensitive companies
Standard and poors 500	-1,241	1,578	1,736	3,213	25
Industry production	-2,504	-1,573	-0,771	2,565	4
Oil returns	-0,259	0,358	0,392	1,048	7
Inflation	-20,417	-1,096	-3,893	7,037	4
Real interest	-0,007	-0,002	-0,002	0,046	6
Credit spread	0,294	0,335	0,340	0,394	3
Term structure	0,134	0,153	0,162	0,198	3
VIX	-0,170	0,088	0,070	0,485	6
Nominal interest rates	-0,112	0,035	0,000	0,083	9

Even though many of the companies did not show any direct sensitivity to the individually macroeconomic risk factors, they do probably react to the macroeconomic variables through their market beta. When the monthly return for the S&P500 is regressed on the macroeconomic variables, it shows an adjusted r^2value of 0,73, which is quite high. The extra sensitivities eighteen of these companies shows to the macroeconomic factors, demonstrates how the factors affect different companies in different ways. Many of the companies in renewable energy sector also has negative betas for some of the macroeconomic risk factors, implying that their exposure to systematic risk is really smaller then expressed though their market beta. As the total systematic risk of a security will be determined by their total exposure for all systematic risk factors. Hedging opportunities might exist with other firms that behaves in opposite ways to these risk factors.

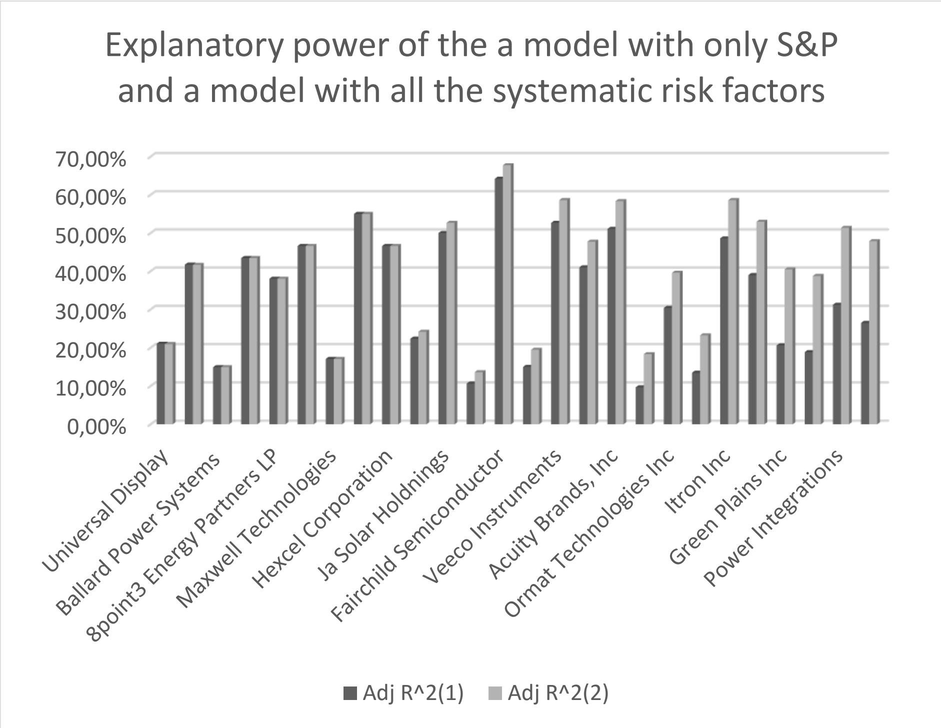
Table 14 Macroeconomic influence on S&P500

S&P500 sensitivity for risk factors		
	Coefficients	t-HACSE
Constant	0,0113	4,2854
INDUSTRY R_2	1,0281	4,2719
INDUSTRY R_3	0,8507	3,3243
OILr_2	0,1352	4,5265
VIX	-0,1574	-8,6312
INFLATION_2	-4,2786	-3,4120
INFLATION_3	2,8568	1,9924
INFLATION_5	-4,0026	-4,3445
CREDIT SPREAD_2	-0,0832	-3,1031
R^2	0,7565	
Adj,R^2	0,7358	

As the table shows, the returns on the S&P500 is in a large extent determined by the macroeconomic risk factors employed in this study. The r^2 adjusted value is 0,7358.

Does the state variables increase the predictability for stock returns?

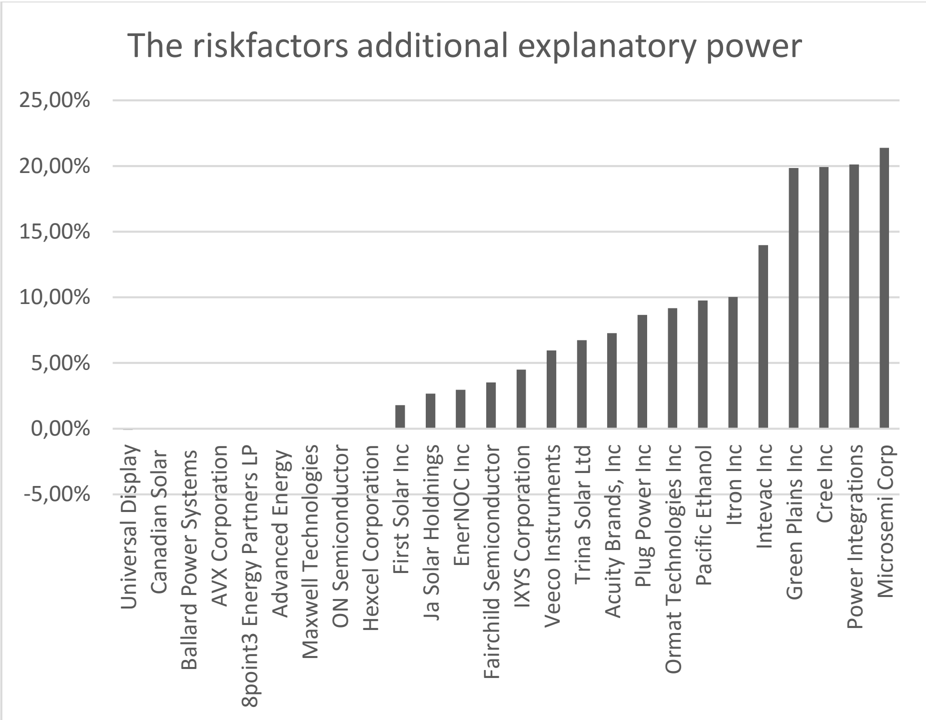
Figure 7 the risk models explanatory power of stock returns compared to only S&P500's explanatory power of stock returns



When the firms in renewable energy sector are regressed on all the risk factors, and not only the S&P500, they achieve a higher r^2 value as shown in the figure. When the stocks in this sample are regressed on the macroeconomic risk factors, they achieve an adjusted r^2 value that ranges from 20,96%-67,72%. The returns for many of these stocks are largely determined by systematic factors in the risk model. The values has a big spread and for the firms with the lowest adj r^2 values, the opposite will be true and the returns will largely be determined outside the risk model.

To compare the explanatory power the risk factors add in addition to the explanatory power of the S&P500, for stock returns in renewable energy, the companies were regressed with only the S&P500 as independent variable. The results are shown in the figure below.

Figure 8 the risk models additional explanatory power for stock returns



The additional explanatory power of the risk factors when regressed together with S&P is estimated by subtracting the r^2 value from a regression with all risk factors from a regression with only the S&P500 as explanatory variable. As the figure shows, the risk factors add explanatory power to 18 out of 26 companies. For Microsemi, it adds as much as 20% explanatory power compared to when the company was regressed on the S&P alone. In the other end of the scale is universal display where the risk factors have a zero contribution to explanatory power for the stock return.

6. Conclusion

The renewable energy sector has grown considerably during the last years and is expected to continue to grow even further in years to come. Growth is facilitated by legislations to reach climate goals that are passed all over the globe. The expected growth might represent investment opportunities for both private and institutional investors. This study explores the risk and returns for renewable energy stocks and has especially been elaborating on how systematic risk factors affects stocks in renewable energy. In particular, we have tested how risk factors like the one in Chen Roll and Ross study from (1986) has affected stock returns for renewable energy stocks.

As we have showed in this study, our descriptive analysis showed that the risk and returns varied greatly within our company sample. The companies directly involved in renewable energy production has a less favorable risk and return characteristics than the subcontractors that supply the sector. When the companies in the sample was regressed on the macroeconomic variables the risk factors added explanatory power for almost all of the firms in our sample, as compared to when the companies was only regressed on the S&P500. The negative betas that was found for some of the risk factors implies systematic risk is smaller than expressed through the market beta of these securities.

The analysis of systematic risk factors showed that these companies varies a lot in their sensitivities to the risk factors and there could only be detected a sensitivity for the S&P500, the oil price returns and the interest rates for the companies as a group. Small spread in the betas are found only for credit spreads, term structure, the real and the nominal interest rates. Which makes predictions more stable. Breaking down systematic risk tells us more about how and why the stocks in renewable energy sector behave as they do - and the story they tell is that the stocks in renewable energy are not a homogenous group but consist of companies that differ significantly on how they react to changing market conditions.

Because renewable energy stocks are not a homogenous group, legislators need to take that into account when programs to stimulate development in renewable energy are considered. Government should target their incentives to the parts of the renewable energy sector, that are struggling with profitability and returns, while the parts that are already profitable need no extra stimulations. The technological risk is high for investors in some of the sectors of renewable energy. Legislators need to take into account that renewable energy is an industry that is still in the mold, where the answers to what technology will prevail, is still unanswered.

As for the management in renewable energy companies, the negative betas can reduce the cost of capital for firms, as it reduces systematic risk and total systematic risk. The cost of capital becomes more accurate with a multifactor beta value, and it should increase the net present value of cash flows, if a lower beta value is utilized in the cost of capital.

The risk in renewable energy has been high for many companies, and investors need to be cautious when choosing investments to optimize their investment portfolios. The inclusion of other extra market risk factors ads to the explanatory power of the risk factor model, and investors should exploit this in their portfolio optimizing. A more detailed knowledge about how systematic risk factors affect the stocks in renewable energy makes possible for a better hedge of systematic risk. It is also worth noting that some of the sensitivities are found in lagged returns for the stocks, meaning that the changes in the state variables has served as predictors for stock returns in our sample period.

To reveal the full investment potential stocks in a growing industry like renewable energy sector will represent in the years to come, a better understanding of the unsystematic risk factors are crucial. A suggested follow up study to this paper will be to do a panel data study of how risks are not only driven by macroeconomic factors, like the ones we have studied in this thesis, but also risks like the Fama French factors.
Another follow up study could be to explore what part of the renewable energy chain the government should target?

Finally yet importantly, a follow up study should focus on how renewable energy could change the equation for Oil price, inflation and economic growth – renewable energy as a game changer?

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9. List of abbreviations

CAPM = Capital asset pricing model

VIX= CBOE Volatility index

S&P= Standard and poor's 500

CAL=Capital allocation line

CPP=Clean power plan

10. Appendices

Appendix A Information about the data

The CBO volatility index VIX http://www.cboe.com/micro/vix/vixintro.aspx

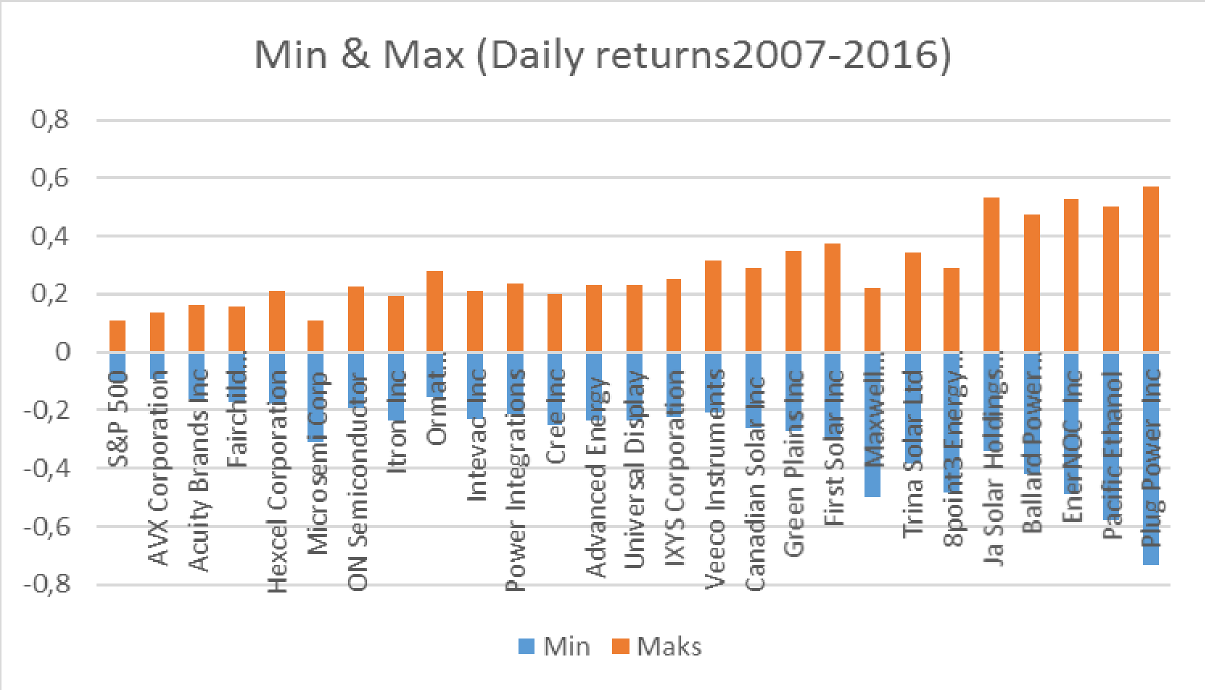
CELS http://cleanedge.com/indexes/stock-index/cels

MAC http://www.macsolarindex.com/stocks-in-the-index/

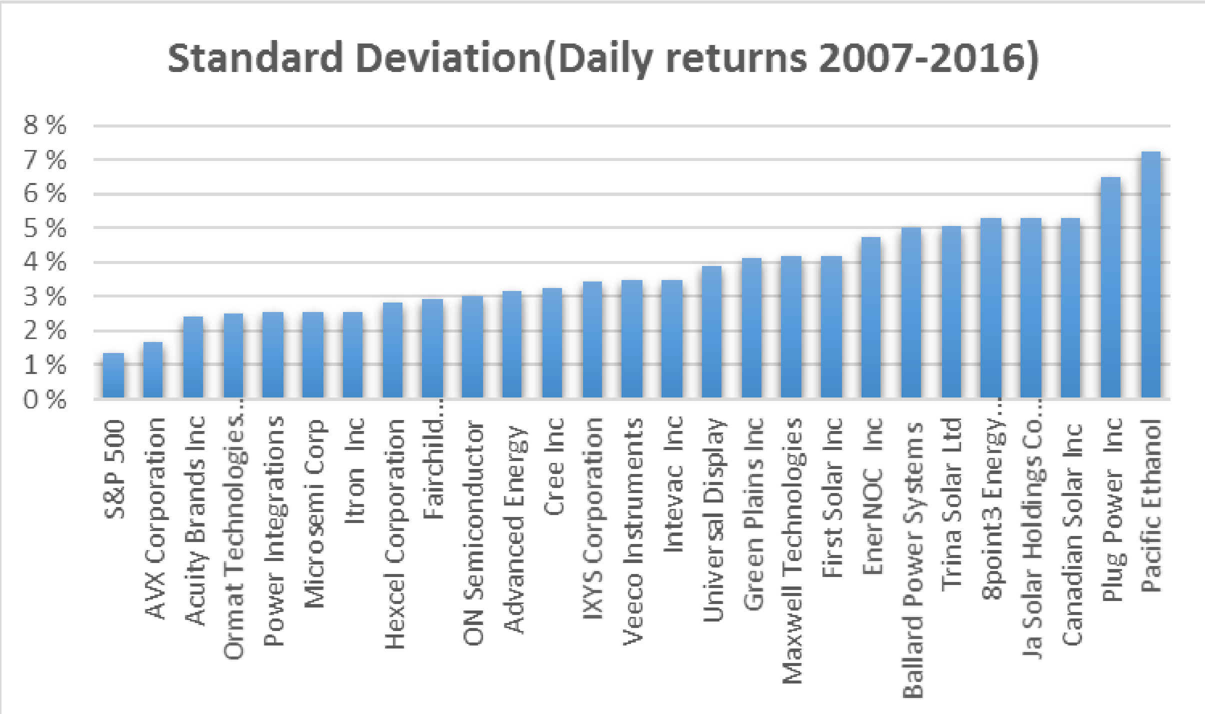
Industry production https://www.federalreserve.gov/releases/g17/download.htm

Appendix B: Descriptive statistics

Daily data



Min & Max (Daily returns2007-2016)
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
S&P 500
AVX Corporation
Acuity Brands Inc
Fairchild...
Hexcel Corporation
Microsemi Corp
ON Semiconductor
Itron Inc
Ormat...
Intevac Inc
Power Integrations
Cree Inc
Advanced Energy
Universal Display
IXYS Corporation
Veeco Instruments
Canadian Solar Inc
Green Plains Inc
First Solar Inc
Maxwell...
Trina Solar Ltd
8point3 Energy...
Ja Solar Holdings...
Ballard Power...
EnerNOC Inc
Pacific Ethanol
Plug Power Inc
Min
Maks



Standard Deviation(Daily returns 2007-2016)
8 %
7 %
6 %
5 %
4 %
3 %
2 %
1 %
0 %
S&P 500
AVX Corporation
Acuity Brands Inc
Ormat Technologies...
Power Integrations
Microsemi Corp
Itron Inc
Hexcel Corporation
Fairchild...
ON Semiconductor
Advanced Energy
Cree Inc
IXYS Corporation
Veeco Instruments
Intevac Inc
Universal Display
Green Plains Inc
Maxwell Technologies
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EnerNOC Inc
Ballard Power Systems
Trina Solar Ltd
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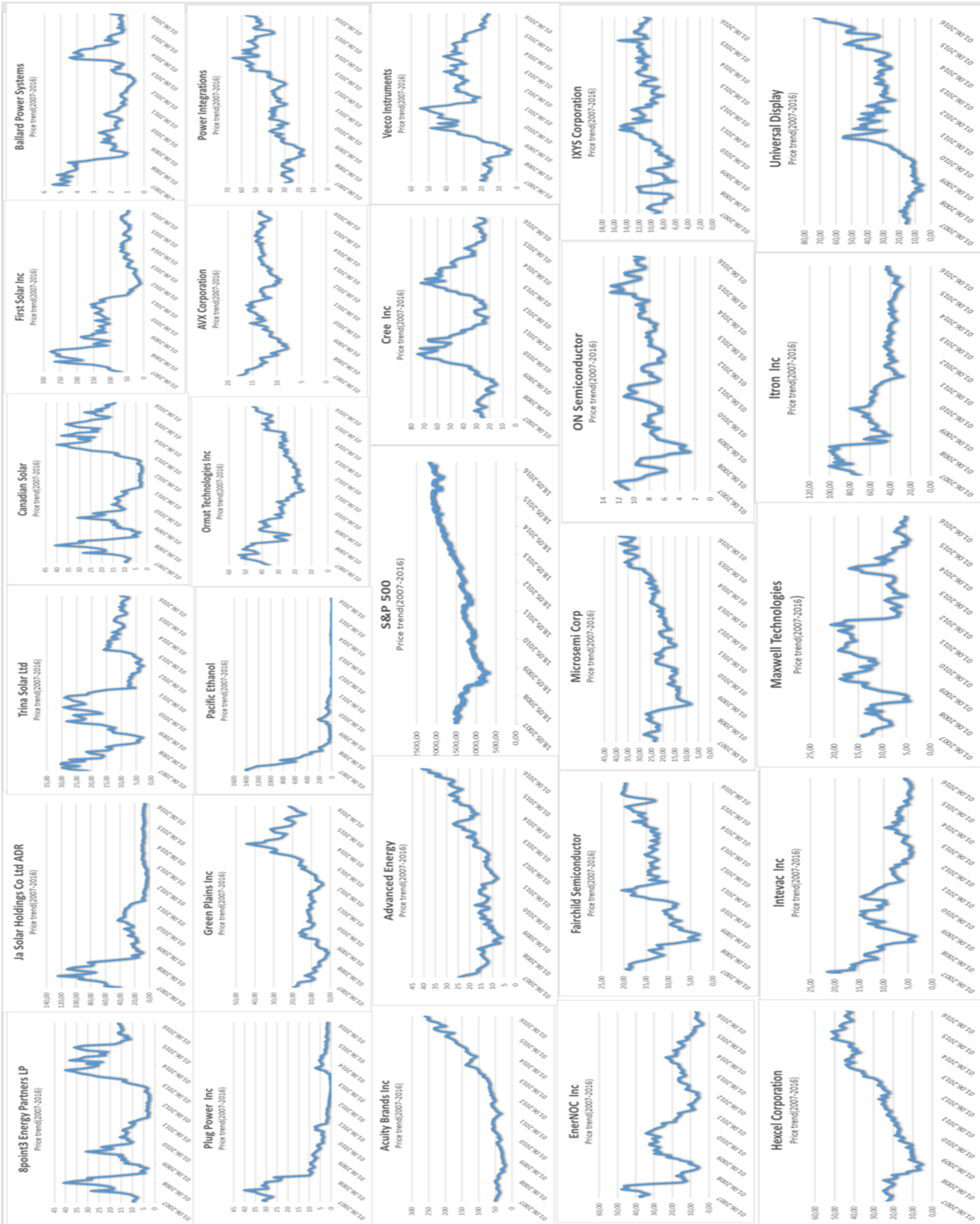
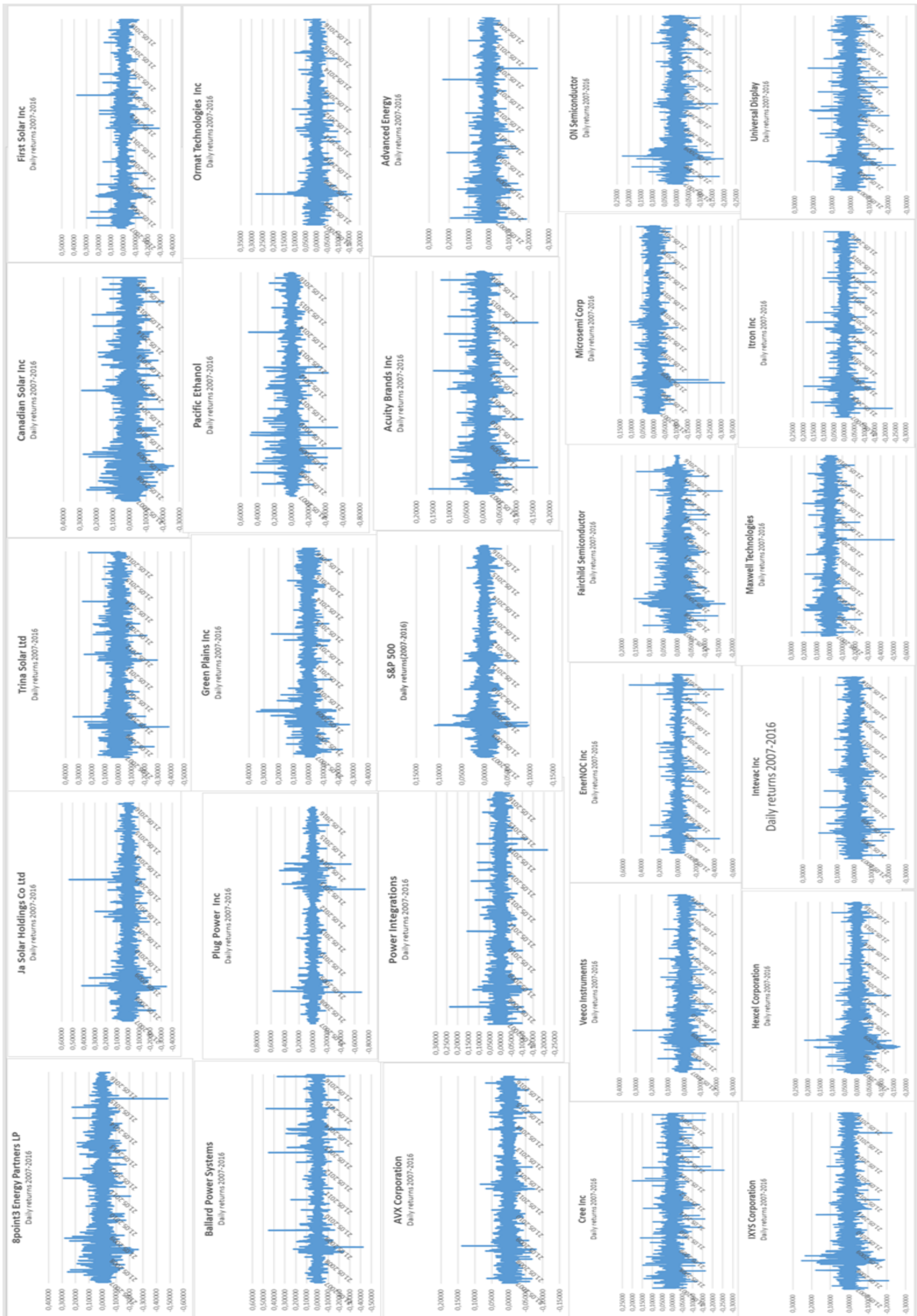
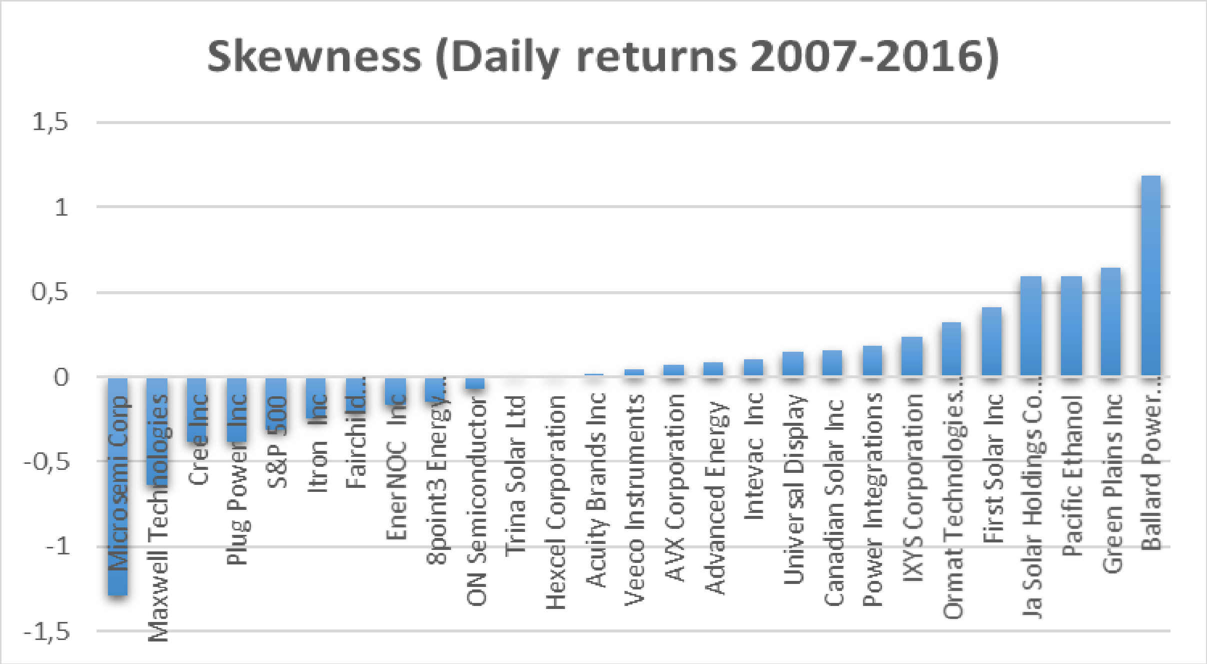
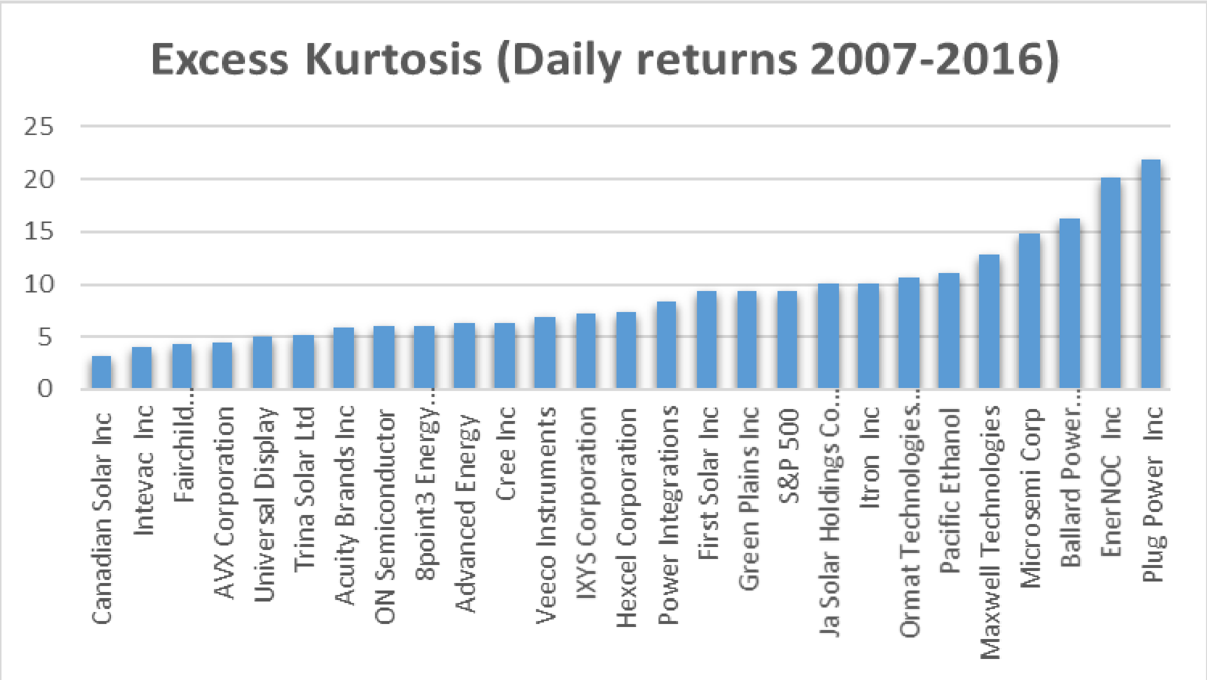
Ja Solar Holdings Co...
Canadian Solar Inc
Plug Power Inc
Pacific Ethanol


8point3 Energy Partners LP
Price trend(2007-2016)
Ja Solar Holdings Co Ltd ADR
Price trend(2007-2016)
Trina Solar Ltd
Price trend(2007-2016)
Canadian Solar
Price trend(2007-2016)
First Solar Inc
Price trend(2007-2016)
Ballard Power Systems
Price trend(2007-2016)
Plug Power Inc
Price trend(2007-2016)
Green Plains Inc
Price trend(2007-2016)
Pacific Ethanol
Price trend(2007-2016)
Ormat Technologies Inc
Price trend(2007-2016)
AVX Corporation
Price trend(2007-2016)
Power Integrations
Price trend(2007-2016)
Acuity Brands Inc
Price trend(2007-2016)
Advanced Energy
Price trend(2007-2016)
S&P 500
Price trend(2007-2016)
Cree Inc
Price trend(2007-2016)
Veeco Instruments
Price trend(2007-2016)
EnerNOC Inc
Price trend(2007-2016)
Fairchild Semiconductor
Price trend(2007-2016)
Microsemi Corp
Price trend(2007-2016)
ON Semiconductor
Price trend(2007-2016)
IXYS Corporation
Price trend(2007-2016)
Hexcel Corporation
Price trend(2007-2016)
Intevac Inc
Price trend(2007-2016)
Maxwell Technologies
Price trend(2007-2016)
Itron Inc
Price trend(2007-2016)
Universal Display
Price trend(2007-2016)


First Solar Inc
Daily returns 2007-2016
Canadian Solar Inc
Daily returns 2007-2016
Trina Solar Ltd
Daily returns 2007-2016
Ja Solar Holdings Co Ltd
Daily returns 2007-2016
8point3 Energy Partners LP
Daily returns 2007-2016
Ormat Technologies Inc
Daily returns 2007-2016
Pacific Ethanol
Daily returns 2007-2016
Green Plains Inc
Daily returns 2007-2016
Plug Power Inc
Daily returns 2007-2016
Ballard Power Systems
Daily returns 2007-2016
Advanced Energy
Daily returns 2007-2016
Acuity Brands Inc
Daily returns 2007-2016
S&P 500
Daily returns(2007-2016)
Power Integrations
Daily returns 2007-2016
AVX Corporation
Daily returns 2007-2016
ON Semiconductor
Daily returns 2007-2016
Microsemi Corp
Daily returns 2007-2016
Fairchild Semiconductor
Daily returns 2007-2016
EnerNOC Inc
Daily returns 2007-2016
Veeco Instruments
Daily returns 2007-2016
Cree Inc
Daily returns 2007-2016
Universal Display
Daily returns 2007-2016
Itron Inc
Daily returns 2007-2016
Maxwell Technologies
Daily returns 2007-2016
Intevac Inc
Daily returns 2007-2016
Hexcel Corporation
Daily returns 2007-2016
IXYS Corporation
Daily returns 2007-2016


Skewness (Daily returns 2007-2016)
1,5
1
0,5
0
-0,5
-1
-1,5
Microsemi Corp
Maxwell Technologies
Cree Inc
Plug Power Inc
S&P 500
Itron Inc
Fairchild...
EnerNOC Inc
8point3 Energy...
ON Semiconductor
Trina Solar Ltd
Hexcel Corporation
Acuity Brands Inc
Veeco Instruments
AVX Corporation
Advanced Energy
Intevac Inc
Universal Display
Canadian Solar Inc
Power Integrations
IXYS Corporation
Ormat Technologies...
First Solar Inc
Ja Solar Holdings Co...
Pacific Ethanol
Green Plains Inc
Ballard Power...


Excess Kurtosis (Daily returns 2007-2016)
25
20
15
10
5
0
Canadian Solar Inc
Intevac Inc
Fairchild...
AVX Corporation
Universal Display
Trina Solar Ltd
Acuity Brands Inc
ON Semiconductor
8point3 Energy...
Advanced Energy
Cree Inc
Veeco Instruments
IXYS Corporation
Hexcel Corporation
Power Integrations
First Solar Inc
Green Plains Inc
S&P 500
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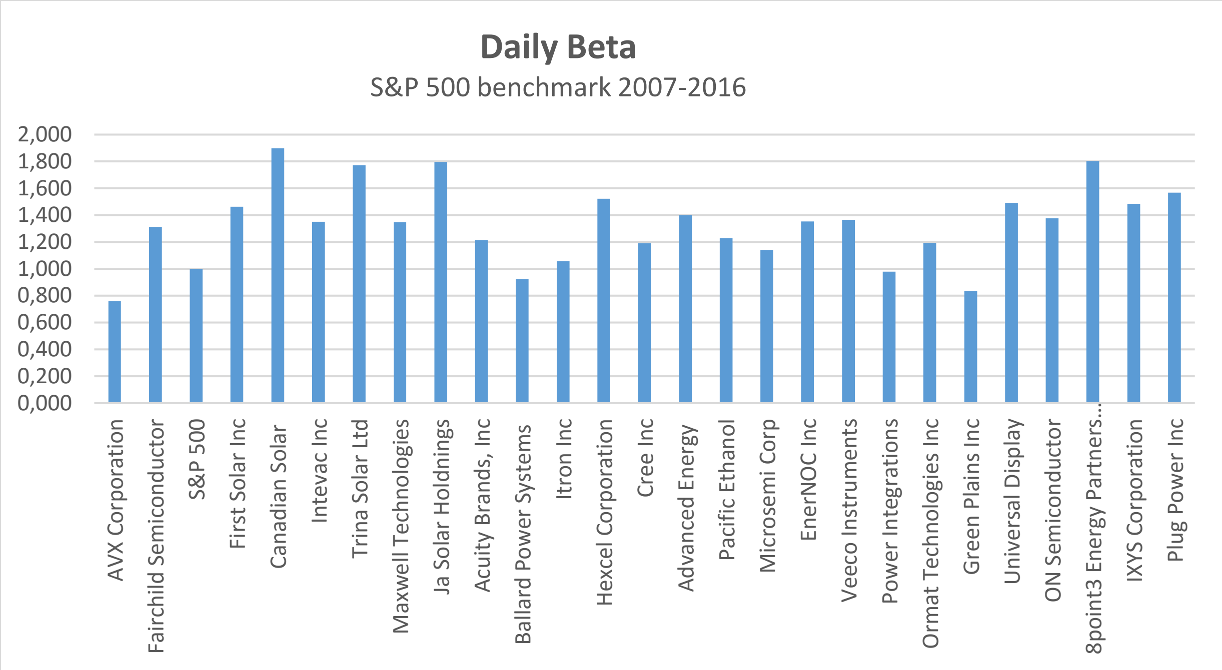
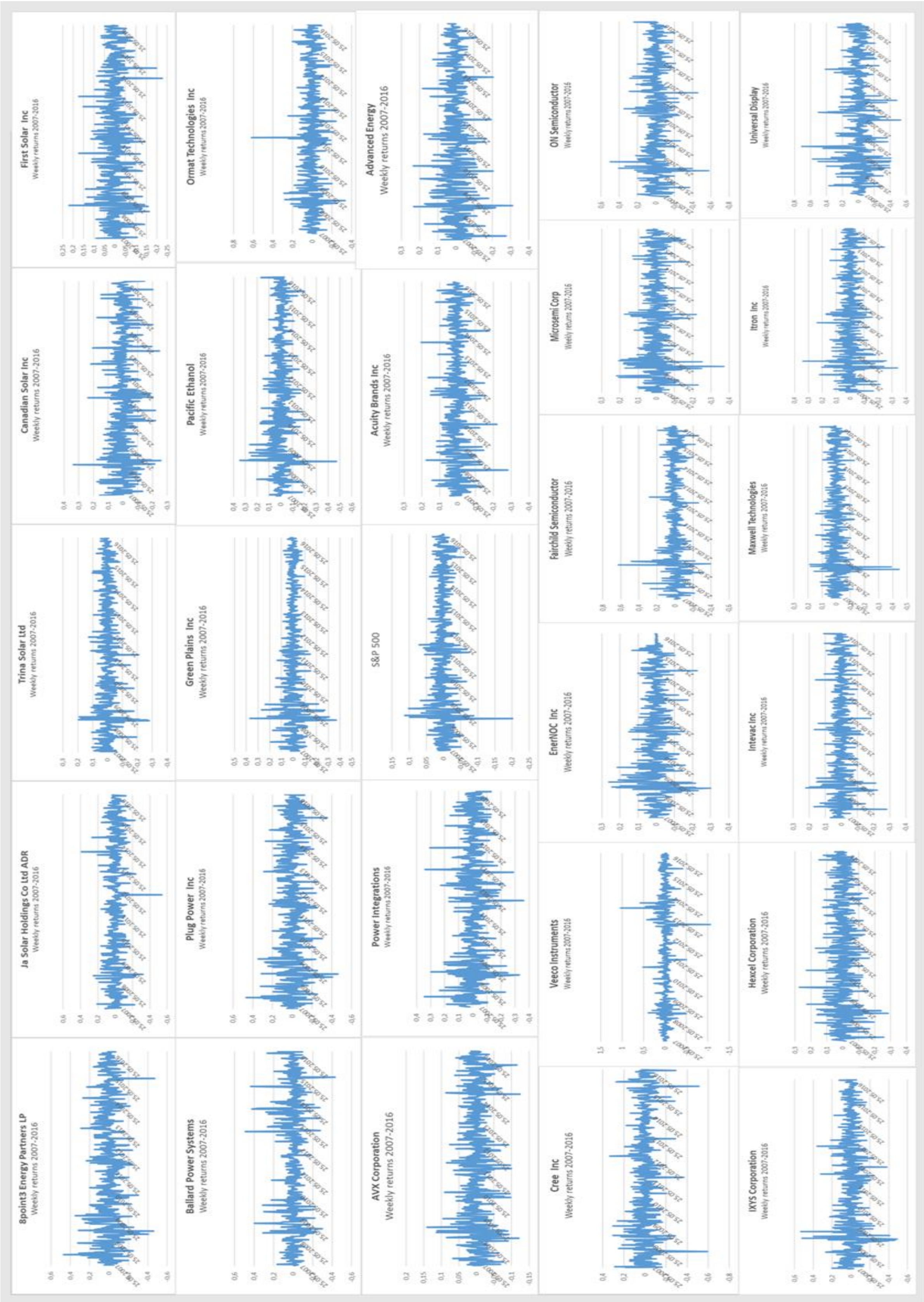
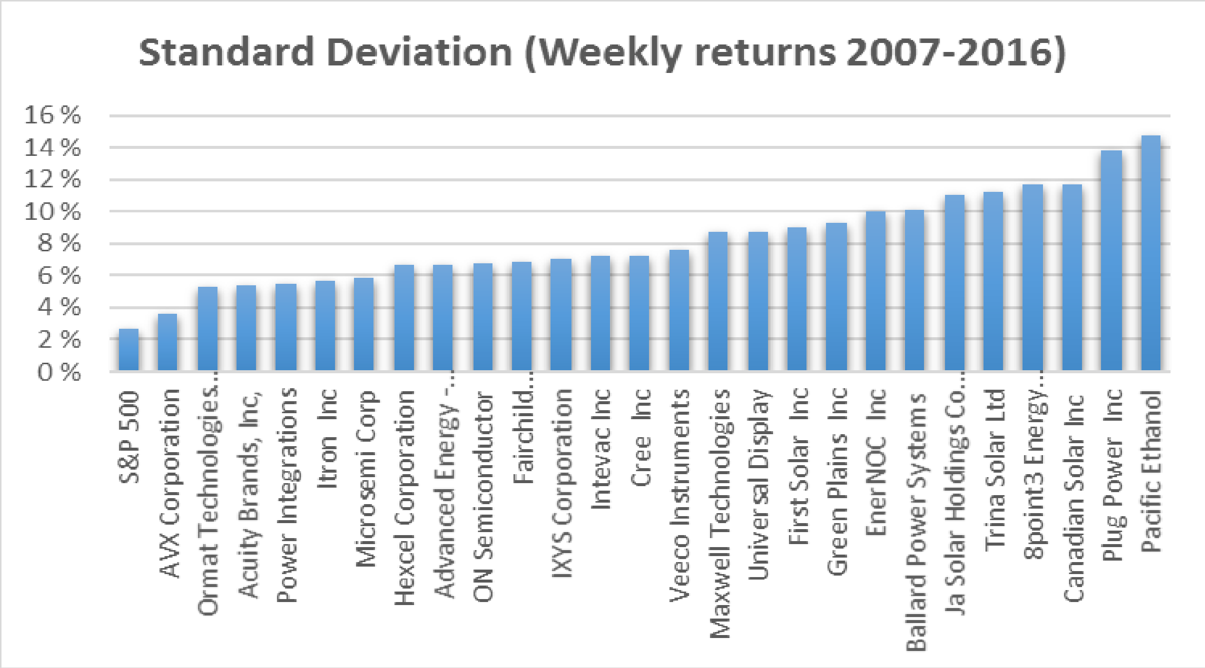
Itron Inc
Ormat Technologies...
Pacific Ethanol
Maxwell Technologies
Microsemi Corp
Ballard Power...
EnerNOC Inc
Plug Power Inc

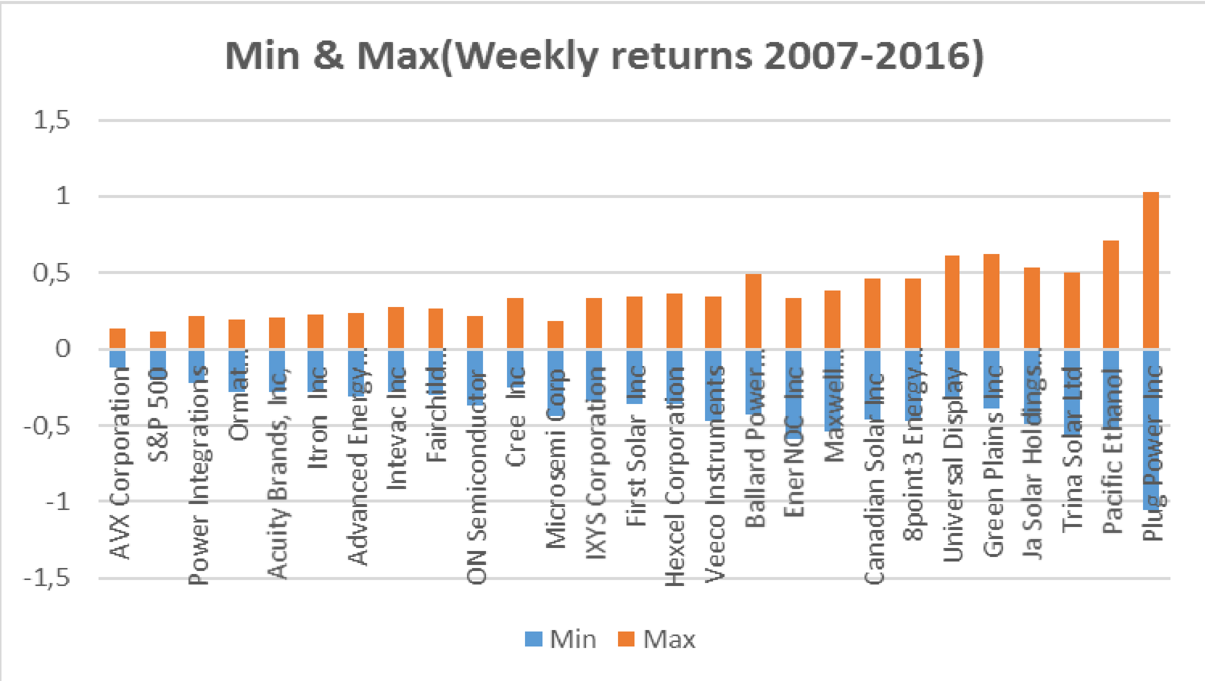


Daily Beta
S&P 500 benchmark 2007-2016
2,000
1,800
1,600
1,400
1,200
1,000
0,800
0,600
0,400
0,200
0,000
AVX Corporation
Fairchild Semiconductor
S&P 500
First Solar Inc
Canadian Solar
Intevac Inc
Trina Solar Ltd
Maxwell Technologies
Ja Solar Holdnings
Acuity Brands, Inc
Ballard Power Systems
Itron Inc
Hexcel Corporation
Cree Inc
Advanced Energy
Pacific Ethanol
Microsemi Corp
EnerNOC Inc
Veeco Instruments
Power Integrations
Ormat Technologies Inc
Green Plains Inc
Universal Display
ON Semiconductor
8point3 Energy Partners…
IXYS Corporation
Plug Power Inc

Weekly data


First Solar Inc
Weekly returns 2007-2016
Canadian Solar Inc
Weekly returns 2007-2016
Trina Solar Ltd
Weekly returns 2007-2016
Ja Solar Holdings Co Ltd ADR
Weekly returns 2007-2016
8point3 Energy Partners LP
Weekly returns 2007-2016
Ormat Technologies Inc
Weekly returns 2007-2016
Pacific Ethanol
Weekly returns 2007-2016
Green Plains Inc
Weekly returns 2007-2016
Plug Power Inc
Weekly returns 2007-2016
Ballard Power Systems
Weekly returns 2007-2016
Advanced Energy
Weekly returns 2007-2016
Acuity Brands Inc
Weekly returns 2007-2016
S&P 500
Power Integrations
Weekly returns 2007-2016
AVX Corporation
Weekly returns 2007-2016
ON Semiconductor
Weekly returns 2007-2016
Microsemi Corp
Weekly returns 2007-2016
Fairchild Semiconductor
Weekly returns 2007-2016
EnerNOC Inc
Weekly returns 2007-2016
Veeco Instruments
Weekly returns 2007-2016
Cree Inc
Weekly returns 2007-2016
Universal Display
Weekly returns 2007-2016
Itron Inc
Weekly returns 2007-2016
Maxwell Technologies
Weekly returns 2007-2016
Intevac Inc
Weekly returns 2007-2016
Hexcel Corporation
Weekly returns 2007-2016
IXYS Corporation
Weekly returns 2007-2016


Standard Deviation (Weekly returns 2007-2016)
16 %
14 %
12 %
10 %
8 %
6 %
4 %
2 %
0 %
S&P 500
AVX Corporation
Ormat Technologies...
Acuity Brands, Inc,
Power Integrations
Itron Inc
Microsemi Corp
Hexcel Corporation
Advanced Energy -...
ON Semiconductor
Fairchild...
IXYS Corporation
Intevac Inc
Cree Inc
Veeco Instruments
Maxwell Technologies
Universal Display
First Solar Inc
Green Plains Inc
EnerNOC Inc
Ballard Power Systems
Ja Solar Holdings Co...
Trina Solar Ltd
8point3 Energy...
Canadian Solar Inc
Plug Power Inc
Pacific Ethanol


Min & Max(Weekly returns 2007-2016)
1,5
1
0,5
0
-0,5
-1
-1,5
AVX Corporation
S&P 500
Power Integrations
Ormat...
Acuity Brands, Inc,
Itron Inc
Advanced Energy...
Intevac Inc
Fairchild...
ON Semiconductor
Cree Inc
Microsemi Corp
IXYS Corporation
First Solar Inc
Hexcel Corporation
Veeco Instruments
Ballard Power...
EnerNOC Inc
Maxwell...
Canadian Solar Inc
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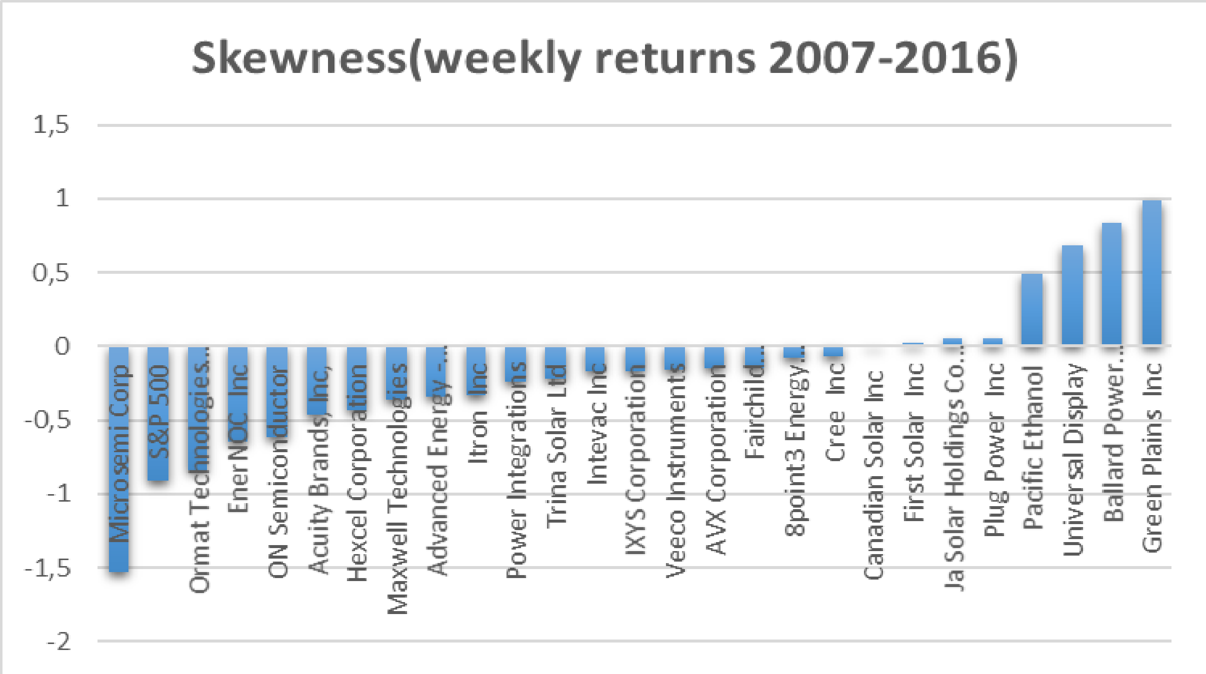
Universal Display
Green Plains Inc
Ja Solar Holdings...
Trina Solar Ltd
Pacific Ethanol
Plug Power Inc
Min
Max


Skewness(weekly returns 2007-2016)
1,5
1
0,5
0
-0,5
-1
-1,5
-2
Microsemi Corp
S&P 500
Ormat Technologies...
EnerNOC Inc
ON Semiconductor
Acuity Brands, Inc,
Hexcel Corporation
Maxwell Technologies
Advanced Energy -...
Itron Inc
Power Integrations
Trina Solar Ltd
Intevac Inc
IXYS Corporation
Veeco Instruments
AVX Corporation
Fairchild...
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Cree Inc
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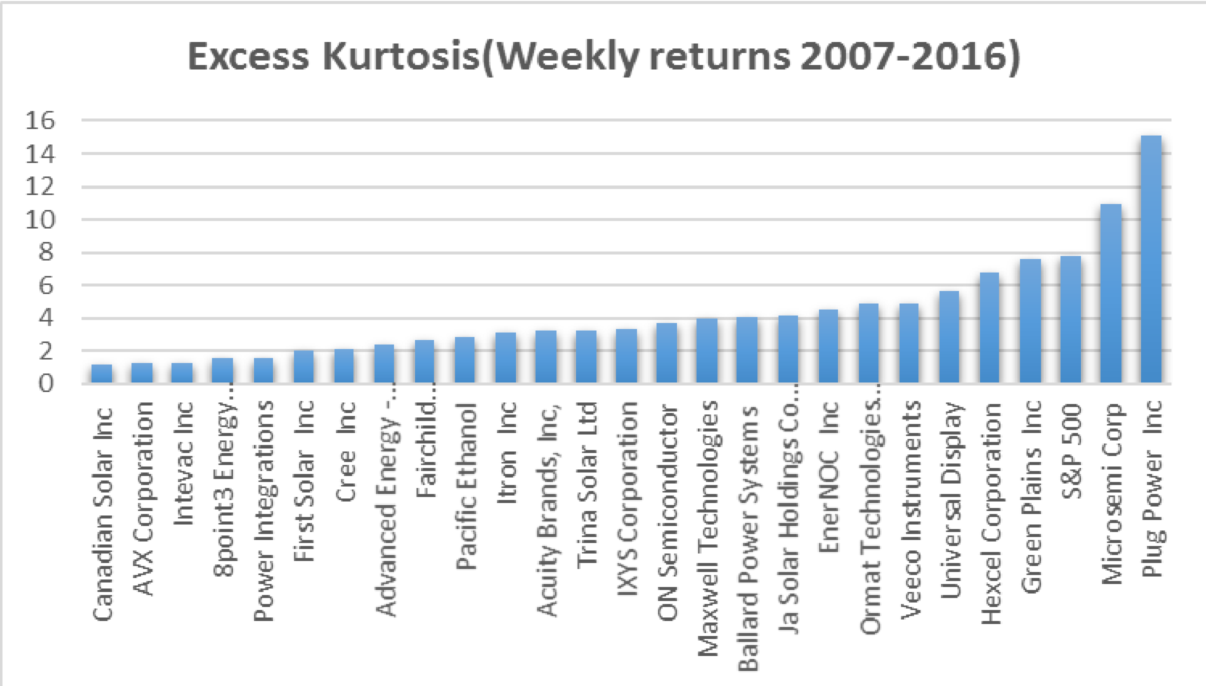
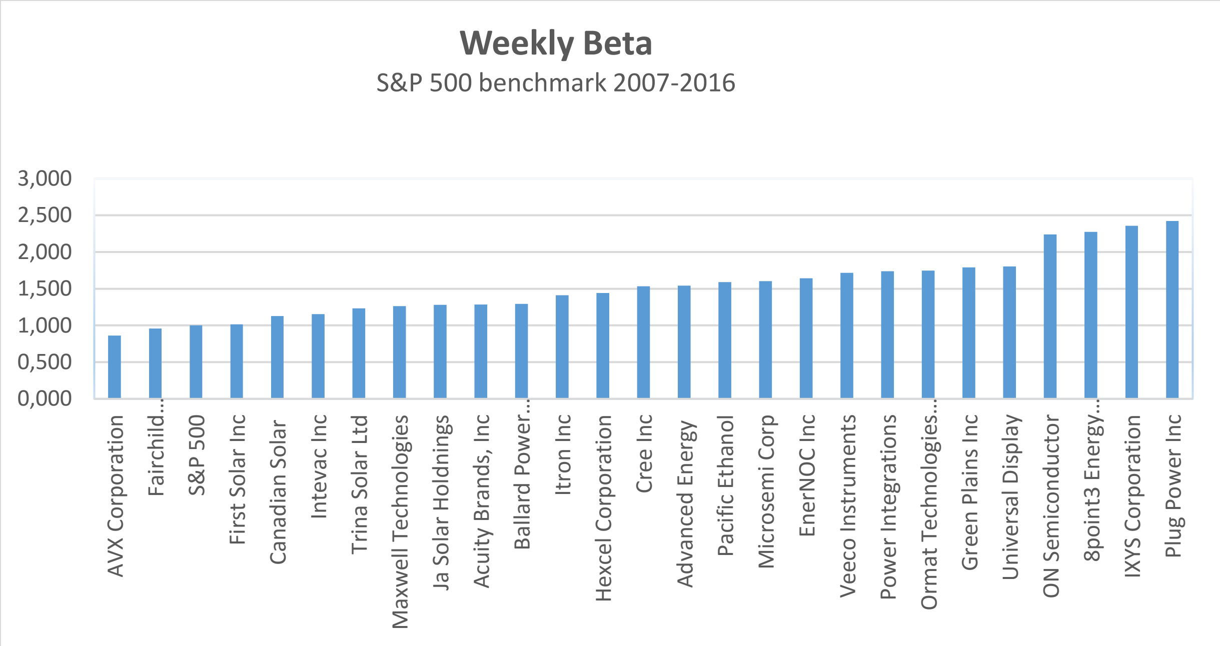
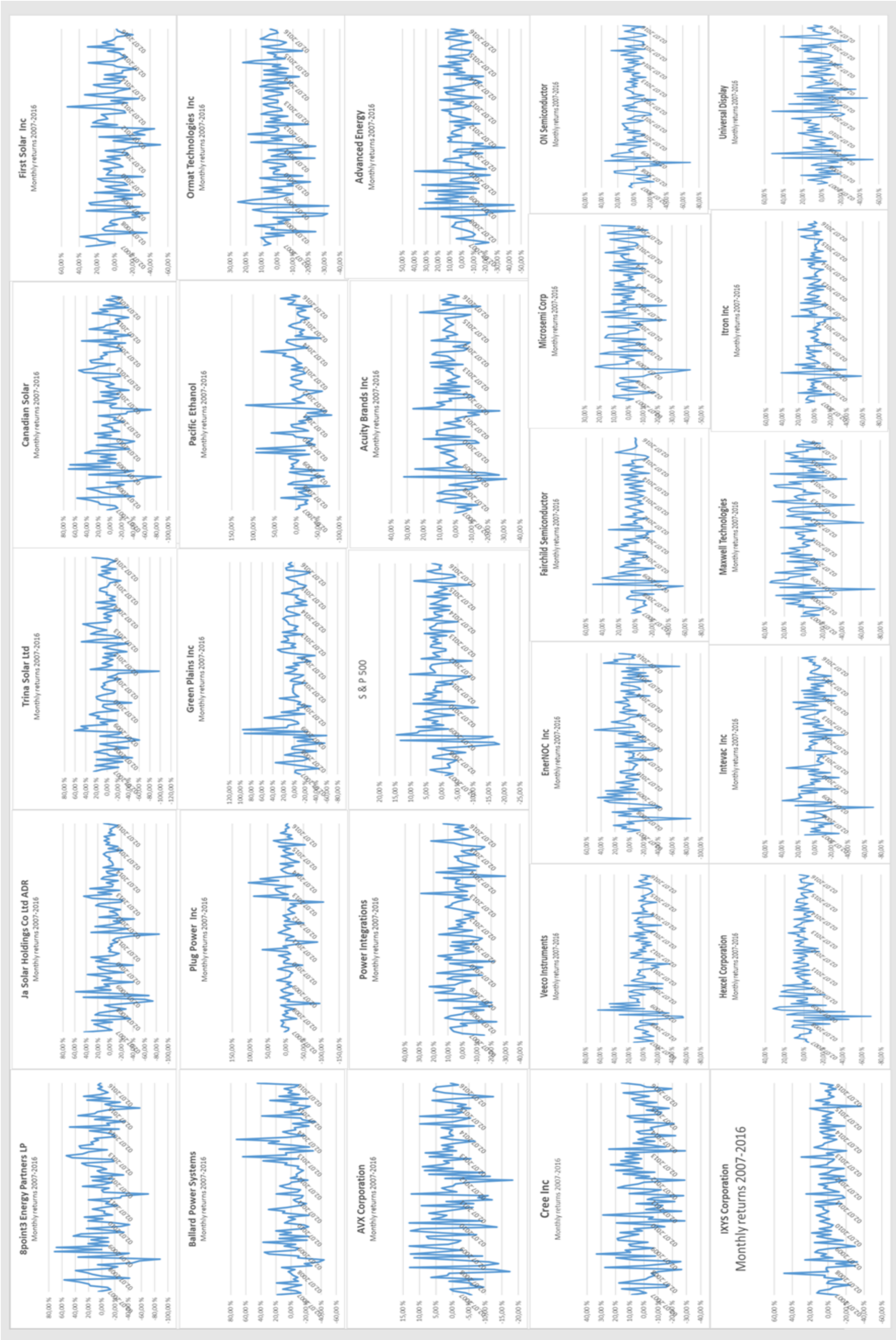
First Solar Inc
Ja Solar Holdings Co...
Plug Power Inc
Pacific Ethanol
Universal Display
Ballard Power...
Green Plains Inc

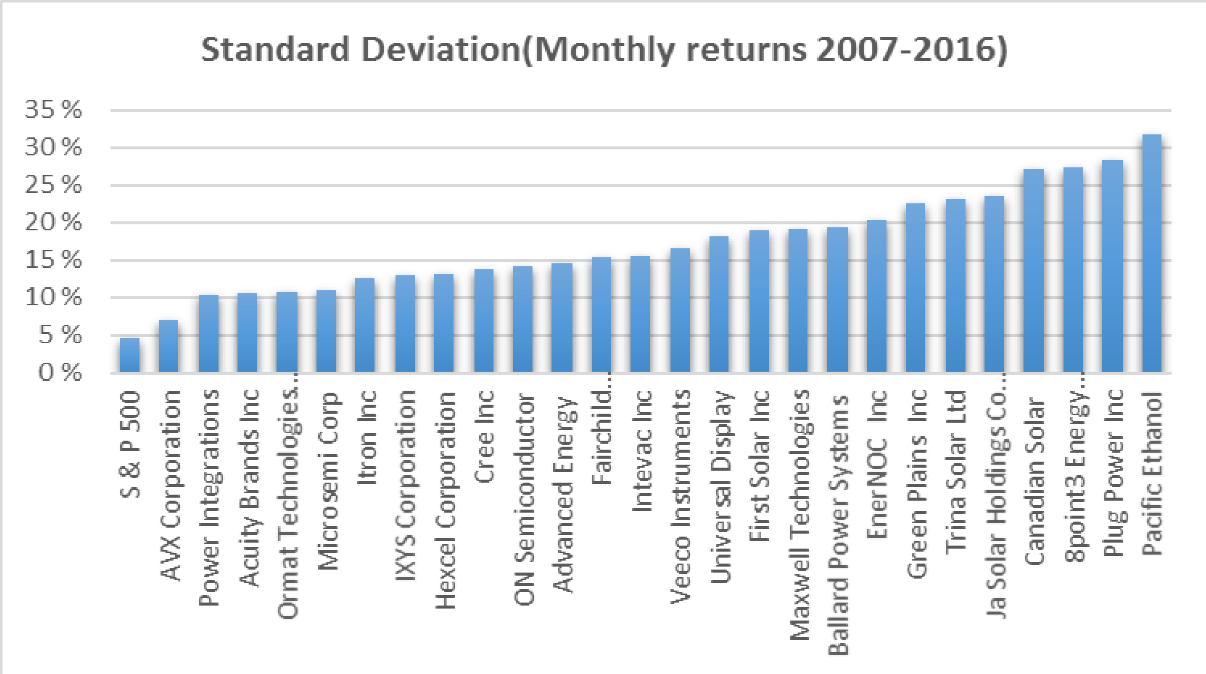

Excess Kurtosis(Weekly returns 2007-2016)
16
14
12
10
8
6
4
2
0
Canadian Solar Inc
AVX Corporation
Intevac Inc
8point3 Energy...
Power Integrations
First Solar Inc
Cree Inc
Advanced Energy -...
Fairchild...
Pacific Ethanol
Itron Inc
Acuity Brands, Inc,
Trina Solar Ltd
IXYS Corporation
ON Semiconductor
Maxwell Technologies
Ballard Power Systems
Ja Solar Holdings Co...
EnerNOC Inc
Ormat Technologies...
Veeco Instruments
Universal Display
Hexcel Corporation
Green Plains Inc
S&P 500
Microsemi Corp
Plug Power Inc

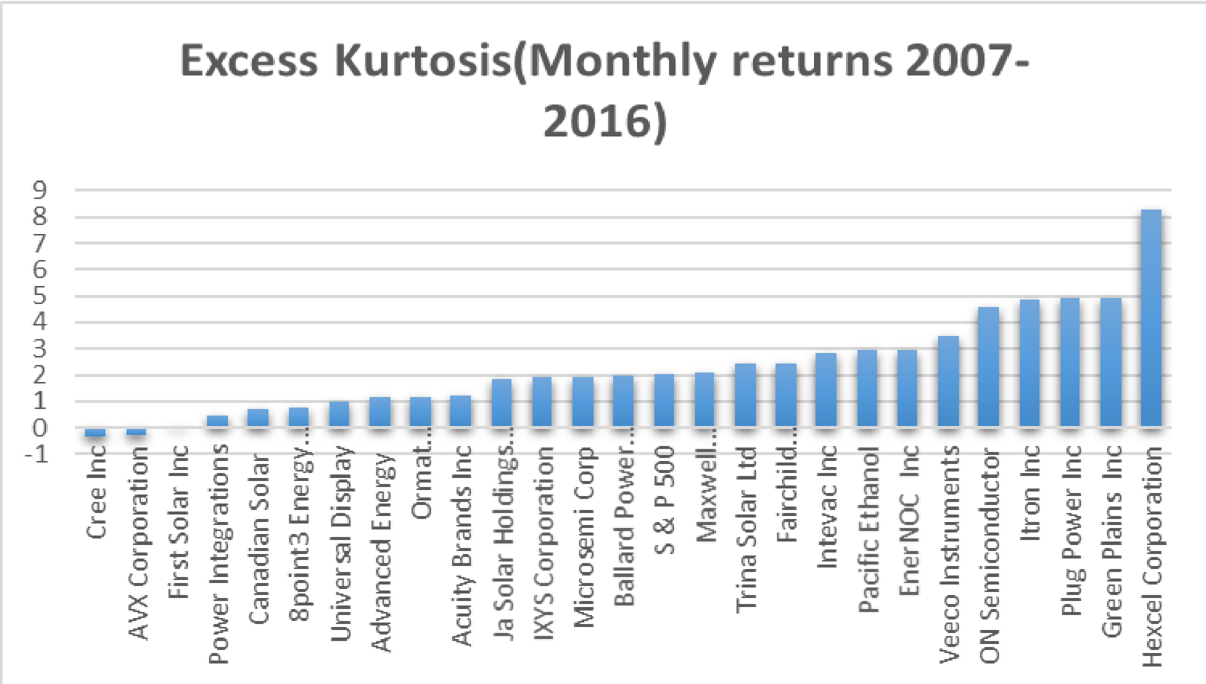


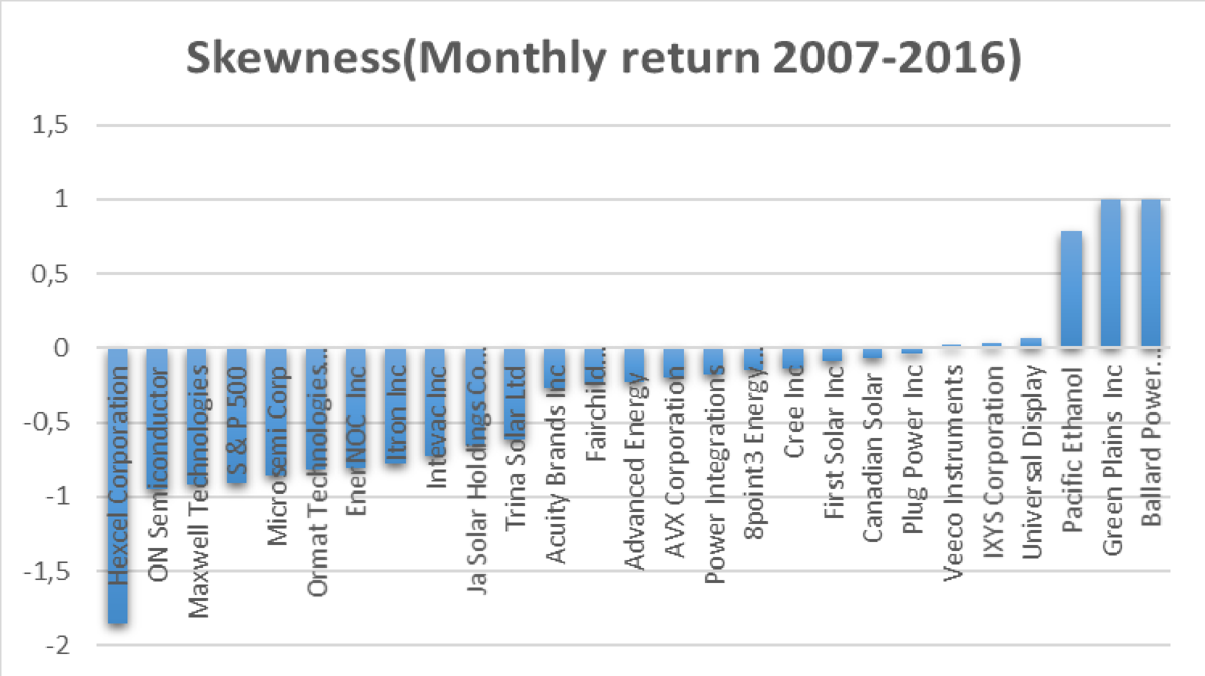
Weekly Beta
S&P 500 benchmark 2007-2016
3,000
2,500
2,000
1,500
1,000
0,500
0,000
AVX Corporation
Fairchild...
S&P 500
First Solar Inc
Canadian Solar
Intevac Inc
Trina Solar Ltd
Maxwell Technologies
Ja Solar Holdnings
Acuity Brands, Inc
Ballard Power...
Itron Inc
Hexcel Corporation
Cree Inc
Advanced Energy
Pacific Ethanol
Microsemi Corp
EnerNOC Inc
Veeco Instruments
Power Integrations
Ormat Technologies...
Green Plains Inc
Universal Display
ON Semiconductor
8point3 Energy...
IXYS Corporation
Plug Power Inc

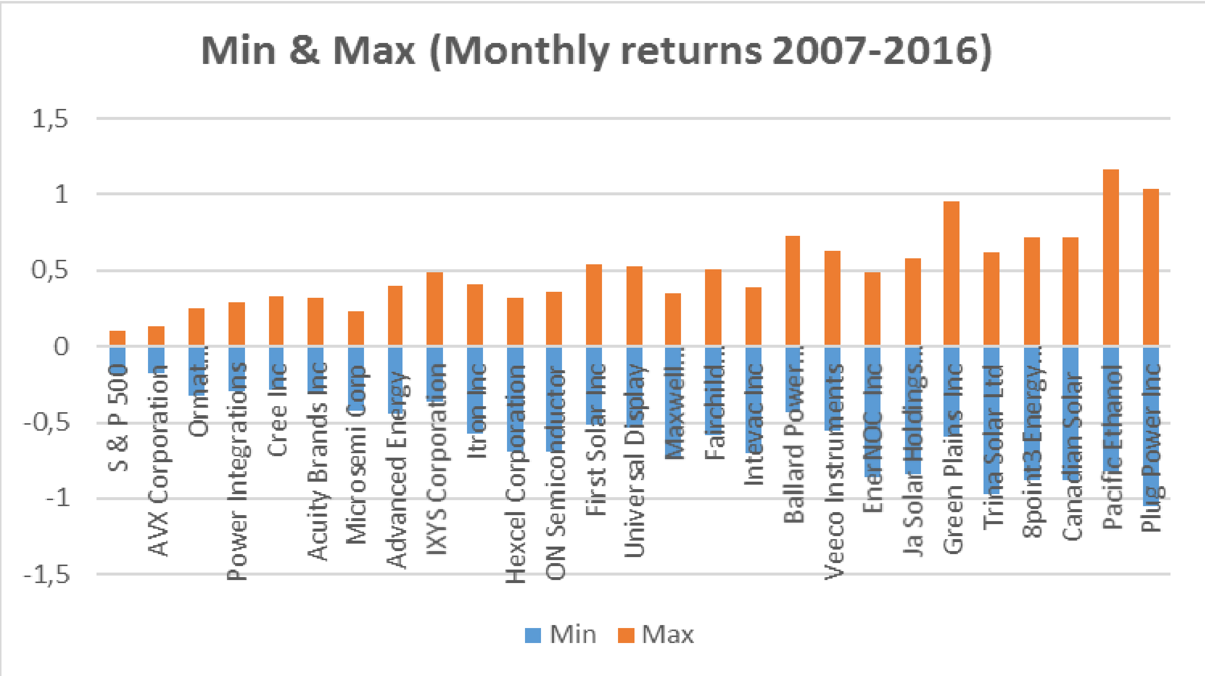
Monthly returns

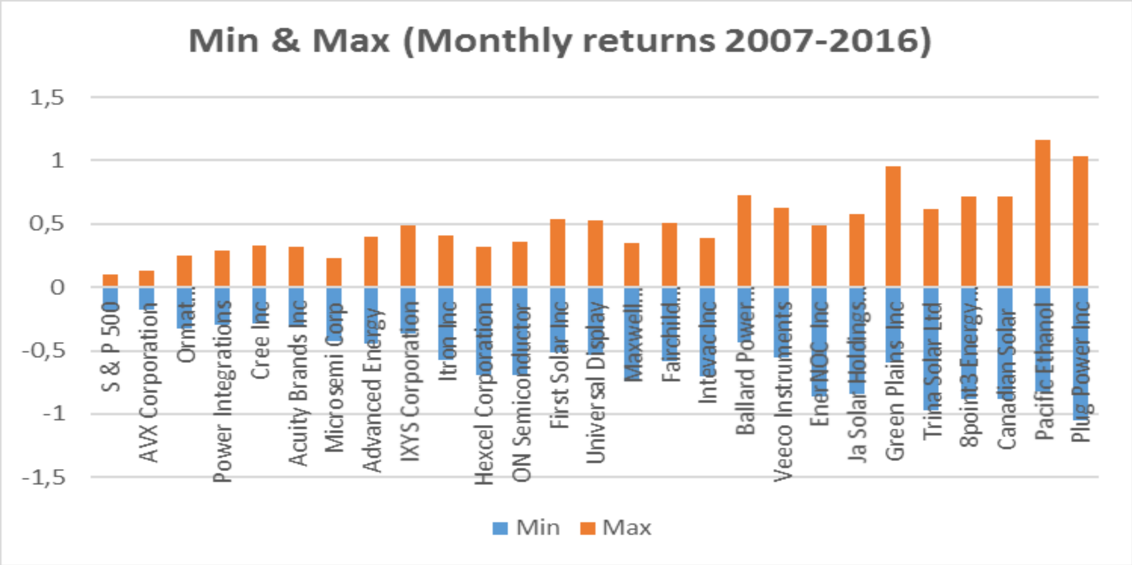



Standard Deviation(Monthly returns 2007-2016)
35 %
30 %
25 %
20 %
15 %
10 %
5 %
0 %
S & P 500
AVX Corporation
Power Integrations
Acuity Brands Inc
Ormat Technologies...
Microsemi Corp
Itron Inc
IXYS Corporation
Hexcel Corporation
Cree Inc
ON Semiconductor
Advanced Energy
Fairchild...
Intevac Inc
Veeco Instruments
Universal Display
First Solar Inc
Maxwell Technologies
Ballard Power Systems
EnerNOC Inc
Green Plains Inc
Trina Solar Ltd
Ja Solar Holdings Co...
Canadian Solar
8point3 Energy...
Plug Power Inc
Pacific Ethanol


Excess Kurtosis(Monthly returns 2007-2016)
9
8
7
6
5
4
3
2
1
0
-1
Cree Inc
AVX Corporation
First Solar Inc
Power Integrations
Canadian Solar
8point3 Energy...
Universal Display
Advanced Energy
Ormat...
Acuity Brands Inc
Ja Solar Holdings...
IXYS Corporation
Microsemi Corp
Ballard Power...
S & P 500
Maxwell...
Trina Solar Ltd
Fairchild...
Intevac Inc
Pacific Ethanol
EnerNOC Inc
Veeco Instruments
ON Semiconductor
Itron Inc
Plug Power Inc
Green Plains Inc
Hexcel Corporation


Skewness(Monthly return 2007-2016)
1,5
1
0,5
0
-0,5
-1
-1,5
-2
Hexcel Corporation
ON Semiconductor
Maxwell Technologies
S & P 500
Microsemi Corp
Ormat Technologies...
EnerNOC Inc
Itron Inc
Intevac Inc
Ja Solar Holdings Co...
Trina Solar Ltd
Acuity Brands Inc
Fairchild...
Advanced Energy
AVX Corporation
Power Integrations
8point3 Energy...
Cree Inc
First Solar Inc
Canadian Solar
Plug Power Inc
Veeco Instruments
IXYS Corporation
Universal Display
Pacific Ethanol
Green Plains Inc
Ballard Power...


Min & Max (Monthly returns 2007-2016)
1,5
1
0,5
0
-0,5
-1
-1,5
S & P 500
AVX Corporation
Ormat...
Power Integrations
Cree Inc
Acuity Brands Inc
Microsemi Corp
Advanced Energy
IXYS Corporation
Itron Inc
Hexcel Corporation
ON Semiconductor
First Solar Inc
Universal Display
Maxwell...
Fairchild...
Intevac Inc
Ballard Power...
Veeco Instruments
EnerNOC Inc
Ja Solar Holdings...
Green Plains Inc
Trina Solar Ltd
8point3 Energy...
Canadian Solar
Pacific Ethanol
Plug Power Inc
Min
Max



Renewable energy field	info	Companies	daily	weekly	monthly
Solar	Operating	8point3 Energy Partners LP	1,80	2,28	3,09
	Operating	Ja Solar Holdnings	1,80	1,28	3,04
	Operating	Trina Solar Ltd	1,77	1,23	2,71
	Operating	Canadian Solar	1,90	1,13	3,21
	Operating	First Solar Inc	1,46	1,02	1,66
	subcontractor	Advanced Energy	1,40	1,54	1,81
	subcontractor	IXYS Corporation*	1,48	2,36	0,93
	subcontractor	Intevac Inc	1,35	1,16	1,78
	Average Beta for the solar subsector		**1,62**	**1,50**	**2,28**
hydrogene fuel cell	producer	Ballard Power Systems	0,92	1,29	1,40
	producer	Plug Power Inc	1,57	2,42	1,66
	Average Beta for hydrogene fuel cellssubsector		**1,25**	**1,86**	**1,53**
Ethanol	producer	Green Plains Inc	0,83	1,79	1,89
	producer	Pacific Ethanol	1,23	1,59	2,18
	Average Beta for ethanol subsector		**1,03**	**1,69**	**2,03**
Geothermal		Ormat Technologies Inc	1,19	1,75	1,10
	Average Beta for geothermal subsector		**1,35**	**1,42**	**1,10**
electronics		AVX Corporation	0,76	0,86	0,85
		Power Integrations	0,98	1,74	1,06
		Acuity Brands Inc	1,22	1,29	1,37
		EnerNOC Inc	1,35	1,64	1,25
		Fairchild Semiconductor	1,31	0,96	2,25
	LED	Cree Inc	1,19	1,53	1,10
	LED	Veeco Instruments	1,36	1,72	2,20
	LED	Universal Display	1,49	1,80	1,53
	semiconductors	Microsemi Corp	1,14	1,60	1,04
	semiconductors	ON Semiconductor	1,38	2,24	1,84
	semiconductors	Maxwell Technologies	1,35	1,27	1,47
	Average Beta for electronics subsector		**1,23**	**1,51**	**1,45**
wind	subcontractor	IXYS Corporation*	1,48	2,36	0,93
	subcontractor	Hexcel Corporation	1,52	1,44	1,65
	Average Beta for	**wind subsector**	**1,50**	**1,90**	**1,29**
energy management		Itron Inc	1,06	1,41	1,59
	Average Beta for energy management subsector		**1,35**	**1,50**	**1,59**

Companies with the highest S&P500 betas - monthly values					
Renewable energy field	place in value chain	Companies	beta	returns	std
Ethanol	producer	Pacific Ethanol	2,18	-2,60 %	32 %
electronics	subcontractor LED	Veeco Instruments	2,20	-0,07 %	17 %
electronics	subcontractor	Fairchild Semiconductor	2,25	0,05 %	15 %
Solar	Producer	Trina Solar Ltd	2,71	-0,66 %	19 %
Solar	Producer	Ja Solar Holdnings	3,04	-1,51 %	19 %
Solar	Producer	8point3 Energy Partners LP	3,09	0,50 %	27 %
Solar	Producer	Canadian Solar	3,21	0,40 %	27 %

Companies with the lowest S&P500 betas - monthly values					
Renewable energy field	place in value chain	Companies	beta	returns	std
electronics	subcontractor	AVX Corporation	0,85	-0,25 %	7 %
wind	subcontractor	IXYS Corporation*	0,93	0,15 %	13 %
Solar	subcontractor	IXYS Corporation*	0,93	0,15 %	13 %
S&P 500	S&P 500	S&P 500	1,00	0,36 %	5 %
electronics	subcontractor	Microsemi Corp	1,04	0,46 %	11 %
electronics	subcontractor	Power Integrations	1,06	0,58 %	10 %
Geothermal	producer	Ormat Technologies Inc	1,10	0,23 %	11 %
electronics	subcontractor/LED	Cree Inc	1,10	0,13 %	14 %

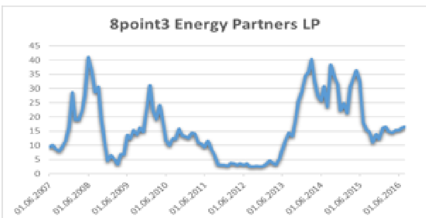
An Overview of S&P500 BETA

Company	Daily Beta	Weekly Beta	Monthly Beta
S&P 500	1,00	1,00	1,00
8point3 Energy Partners LP	1,802	2,277	3,092
Acuity Brands, Inc	1,215	1,287	1,375
Advanced Energy	1,400	1,541	1,809
AVX Corporation	0,761	0,863	0,846
Ballard Power Systems	0,923	1,294	1,395
Cree Inc	1,190	1,535	1,104
EnerNOC Inc	1,353	1,643	1,251
Fairchild Semiconductor	1,312	0,958	2,248
Green Plains Inc	0,835	1,790	1,887
Hexcel Corporation	1,522	1,441	1,648
Intevac Inc	1,351	1,157	1,780
Itron Inc	1,058	1,410	1,589
IXYS Corporation	1,484	2,359	0,929
Ja Solar Holdnings	1,797	1,282	3,042
Maxwell Technologies	1,349	1,266	1,468
Microsemi Corp	1,142	1,603	1,037
ON Semiconductor	1,376	2,241	1,840
Ormat Technologies Inc	1,193	1,749	1,095
Pacific Ethanol	1,229	1,589	2,175
Plug Power Inc	1,568	2,422	1,664
Power Integrations	0,979	1,738	1,058
Trina Solar Ltd	1,771	1,232	2,708
Universal Display	1,491	1,803	1,535
Veeco Instruments	1,365	1,719	2,198
Canadian Solar	1,899	1,130	3,210
First Solar Inc	1,463	1,016	1,656

Appendix C: Company info

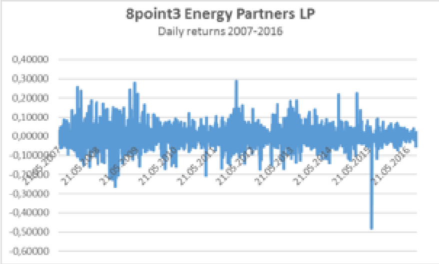
8point3 Energy Partners LP

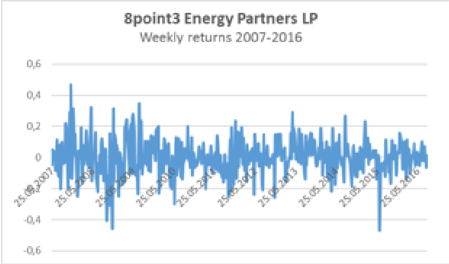
- **Subsector: Operating solar**
- "The company is a growth-oriented limited partnership formed by First Solar and SunPower to own, operate and acquire solar energy"
- www.**8point3energypartners**.com
- Price trend 2007-2016:

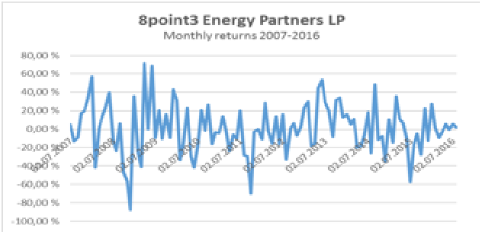


	8point3 Energy Partners LP		
	Daily	Weekly	Monthly
Mean	0,02 %	0,11 %	0,50 %
Standard Error	0,11 %	0,54 %	2,61 %
Median	0,00 %	-0,07 %	-1,15 %
Standard Deviation	5,27 %	11,69 %	27,40 %
Sample Variance	0,28 %	1,37 %	7,51 %
Kurtosis	6,04	1,54	0,77
Skewness	-0,14	-0,08	-0,14
Range	77,14 %	93,79 %	159,18 %
Minimum	-48,26 %	-46,97 %	-87,80 %
Maximum	28,88 %	46,82 %	71,38 %
Count	2331	465	110
Beta S&P 500	1,802	2,277	3,092

8point3 Energy Partners LP

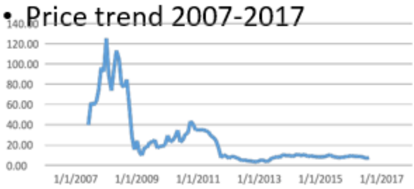






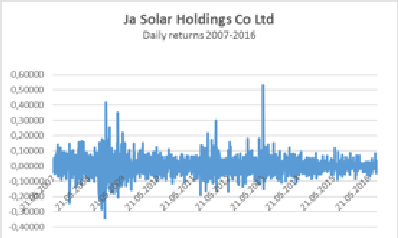
Ja Solar Holdings

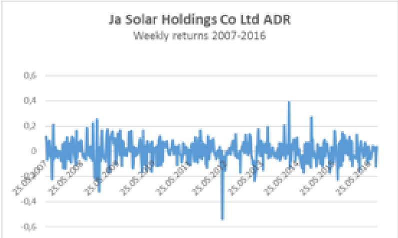
- **Subsector: operating solar.**
- "A world leading manufacturer of high-performance solar power products that convert sunlight into electricity, for residential, commercial and utility-scale power generation. Capitalizing on its strength in solar cell technology, it is committed to provide modules with unparalleled conversion efficiency, yield efficiency, and reliability to enable customers to maximize the returns of their PV projects. JA Solar adopts a selective vertical integration model, covering silicon wafer, cell and module production, as well as photovoltaic power plant investment, development, construction, operation and maintenance." http://www.jasolar.com/
- Price trend 2007-2017

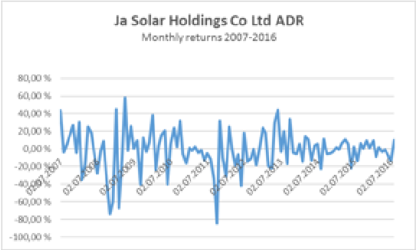


	Ja Solar Holdings Co Ltd ADR		
	Daily	Weekly	Monthly
Mean	-0,07 %	-0,34 %	-1,51 %
Standard Error	0,11 %	0,51 %	2,25 %
Median	-0,13 %	-0,53 %	-0,42 %
Standard Deviation	5,27 %	11,02 %	23,57 %
Sample Variance	0,28 %	1,22 %	5,56 %
Kurtosis	10,00	4,15	1,85
Skewness	0,59	0,05	-0,66
Range	87,16 %	102,13 %	142,51 %
Minimum	-33,89 %	-48,99 %	-84,35 %
Maximum	53,28 %	53,14 %	58,16 %
Count	2331	465	110
Beta S&P 500	1,797	1,282	3,042

Ja Solar Holdnings

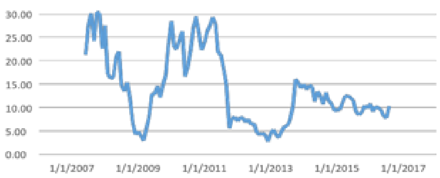






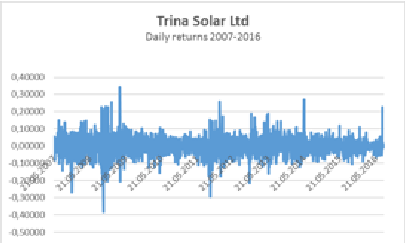
Trina Solar Ltd

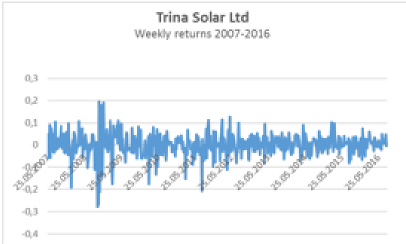
- **Subsector: operating solar.**
- **"**is a Chinese company develops and produces ingots, wafers, solar cells and solar modules. Providing sustainable energy solutions to cut your electricity bill and protect your business from rising energy expenses, and generate revenue from renewable energy subsidies, as well as increase your property value, and reduce your carbon footprint. "
- http://www.trinasolar.com/
- Price trend 2007-2016



	Trina Solar Ltd		
	Daily	Weekly	Monthly
Mean	-0,04 %	-0,19 %	-0,66 %
Standard Error	0,11 %	0,52 %	2,21 %
Median	0,08 %	0,18 %	-0,22 %
Standard Deviation	5,08 %	11,20 %	23,18 %
Sample Variance	0,26 %	1,26 %	5,37 %
Kurtosis	5,17	3,22	2,44
Skewness	0,00	-0,22	-0,61
Range	72,53 %	107,31 %	158,83 %
Minimum	-38,34 %	-57,46 %	-97,27 %
Maximum	34,19 %	49,85 %	61,55 %
Count	2331	465	110
Beta S&P 500	1,771	1,232	2,708

Trina Solar Ltd



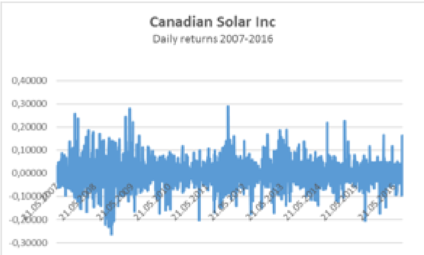


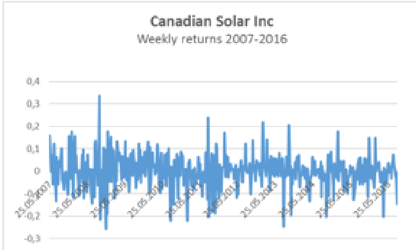
Canadian Solar

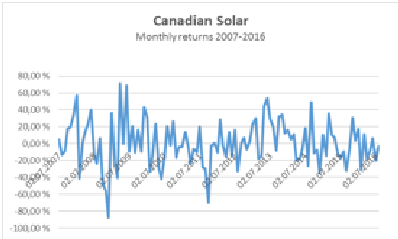
- **Subsector: operating solar.**"Operates as a global energy provider with business subsidiaries in 20 countries on 6 continents. Besides serving as a manufacturer of solar PV modules and provider of solar energy solutions, Canadian Solar has a geographically diversified pipeline of utility-scale power projects. With the company's recent acquisition of Recurrent Energy, Canadian Solar's total project pipeline is now 9 GW, including an increase in the late-stage project pipeline to 2.4 GW. Including two state-of-the-art manufacturing facilities in Ontario, Canadian Solar employs over 7,500 workers worldwide. This translates into more than 12 GW of panel shipments, or 30 million PV modules, in the past 14 years"
- http://www.canadiansolar.com/
- Price trend 2007-2016

	Canadian Solar Inc		
	Daily	Weekly	Monthly
Mean	0,02 %	0,08 %	0,40 %
Standard Error	0,11 %	0,54 %	2,59 %
Median	0,00 %	0,14 %	-2,07 %
Standard Deviation	5,29 %	11,73 %	27,19 %
Sample Variance	0,28 %	1,38 %	7,39 %
Kurtosis	3,18	1,15	0,73
Skewness	0,15	-0,01	-0,07
Range	54,75 %	92,80 %	159,18 %
Minimum	-25,87 %	-45,98 %	-87,80 %
Maximum	28,88 %	46,82 %	71,38 %
Count	2331	465	110
Beta S&P 500	1,899	1,130	3,210

Canadian Solar

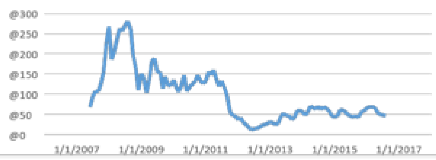






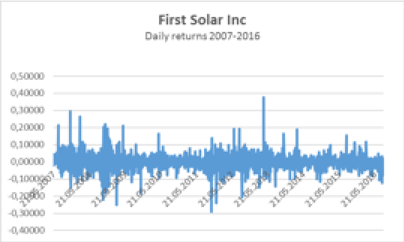
First Solar Inc

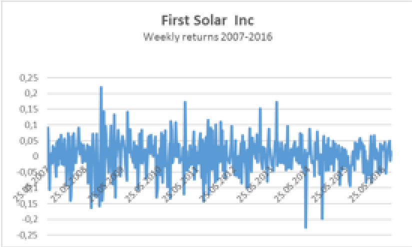
- **Subsector: Operating solar.** "designs and manufactures solar modules using a proprietary thin film semiconductor technology that is one of the lowest cost in the world. is an American photovoltaic (PV) manufacturer of rigid thin film modules, or solar panels, and a provider of utility-scale PV power plants and supporting services that include finance, construction, maintenance and end-of-lifepanel recycling. First Solar uses cadmium telluride (CdTe) as a semiconductor to produce CdTe-panels, that are competing successfully with conventional crystalline silicon technology.[2] In 2009, First Solar became the first solar panel manufacturing company to lower its manufacturing cost to $1 per watt[3] and produced CdTe-panels with an efficiency of about 14 percent at a reported cost of 59 cents per watt in 2013."
- http://www.firstsolar.com/

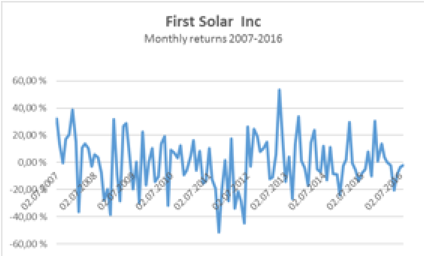


	First Solar Inc		
	Daily	Weekly	Monthly
Mean	-0,02 %	-0,11 %	-0,33 %
Standard Error	0,09 %	0,42 %	1,81 %
Median	0,04 %	-0,14 %	0,01 %
Standard Deviation	4,18 %	8,97 %	18,98 %
Sample Variance	0,17 %	0,80 %	3,60 %
Kurtosis	9,38	2,04	0,08
Skewness	0,41	0,02	-0,08
Range	66,73 %	70,31 %	105,01 %
Minimum	-29,21 %	-35,85 %	-51,54 %
Maximum	37,52 %	34,46 %	53,47 %
Count	2331	465	110
Beta S&P 500	1,463	1,016	1,656

First Solar Inc

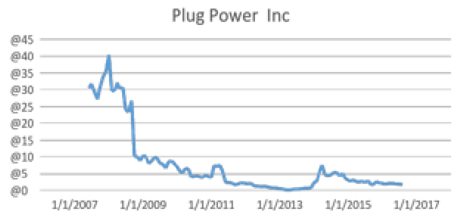






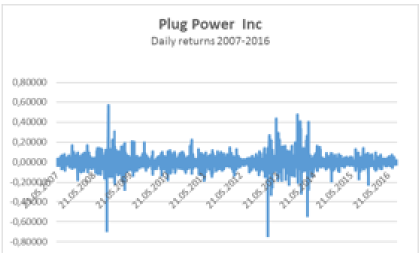
Plug Power Inc

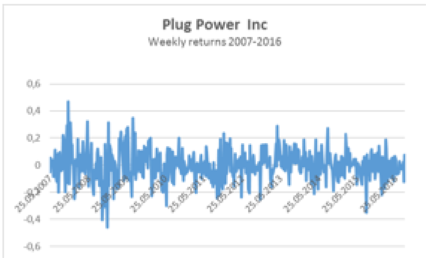
- **Subsector: Hydrogene fuell cell power.** "produces cost-effective hydrogen and fuel cell power solutions that increase productivity, lower operating costs and reduce carbon footprints. Is squarely focused on customer productivity – and providing the power to move businesses into the future with cost-effective hydrogen and fuel cell power solutions that increase productivity, lower operating costs and reduce carbon footprints."
- http://www.plugpower.com/

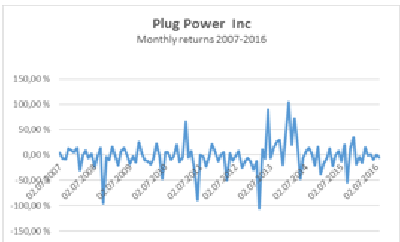


	Plug Power Inc		
	Daily	Weekly	Monthly
Mean	-0,12 %	-0,62 %	-2,60 %
Standard Error	0,13 %	0,64 %	2,70 %
Median	-0,31 %	-0,64 %	-3,01 %
Standard Deviation	6,50 %	13,85 %	28,29 %
Sample Variance	0,42 %	1,92 %	8,00 %
Kurtosis	21,86	1514,63 %	489,74 %
Skewness	-0,38	5,41 %	-4,10 %
Range	130,43 %	208,93 %	209,40 %
Minimum	-73,44 %	-105,92 %	-105,57 %
Maximum	56,99 %	103,01 %	103,84 %
Count	2331	465	110
Beta S&P 500	1,568	2,422	1,664

Plug Power Inc





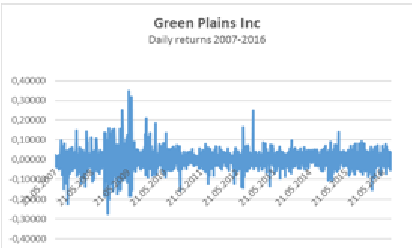


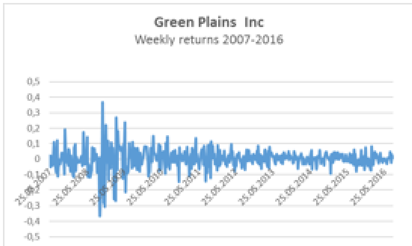
Green Plains Inc

- **Subsector: Ethanol**
- "is an American company claiming to be the fourth largest ethanol fuel producer in North America"
- http://www.gpreinc.com
- Price trend 2007-2016

	Green Plains Inc		
	Daily	Weekly	Monthly
Mean	0,01 %	0,03 %	0,09 %
Standard Error	0,09 %	0,43 %	2,14 %
Median	0,00 %	0,09 %	0,75 %
Standard Deviation	4,15 %	9,32 %	22,48 %
Sample Variance	0,17 %	0,87 %	5,05 %
Kurtosis	9,40	7,63	4,92
Skewness	0,64	0,98	0,99
Range	62,00 %	101,54 %	155,09 %
Minimum	-27,22 %	-39,06 %	-59,70 %
Maximum	34,78 %	62,49 %	95,39 %
Count	2331	465	110
Beta S&P 500	0,835	1,790	1,887

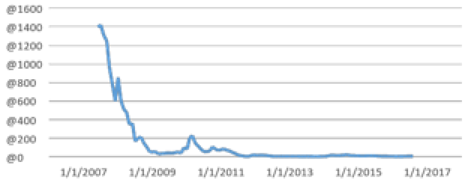
Green Plains Inc





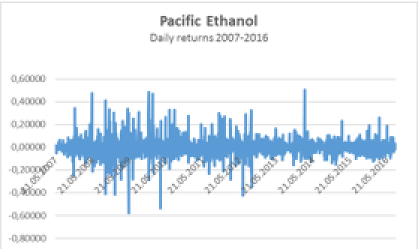
Pacific Ethanol

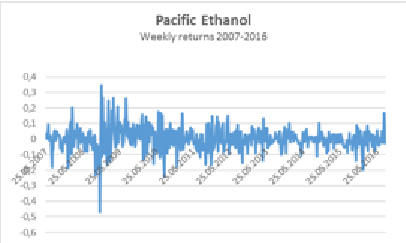
- **Subsector: Ethanol**
- **Pacific Ethanol** "is the leading producer and marketer of low-carbon renewable fuels in the Western United States"
- http://www.pacificethanol.net/
- Price trend 2007-2016

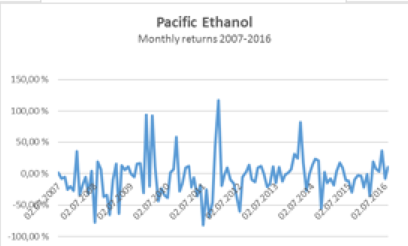


	Plug Power Inc		
	Daily	Weekly	Monthly
Mean	-0,12 %	-0,62 %	-2,60 %
Standard Error	0,13 %	0,64 %	2,70 %
Median	-0,31 %	-0,64 %	-3,01 %
Standard Deviation	6,50 %	13,85 %	28,29 %
Sample Variance	0,42 %	1,92 %	8,00 %
Kurtosis	21,86	15,15	4,90
Skewness	-0,38	0,05	-0,04
Range	130,43 %	208,93 %	209,40 %
Minimum	-73,44 %	-105,92 %	-105,57 %
Maximum	56,99 %	103,01 %	103,84 %
Count	2331	465	110
Beta S&P 500	1,568	2,422	1,664

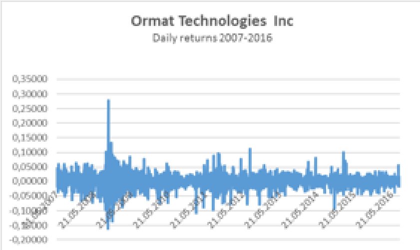
Pacific Ethanol

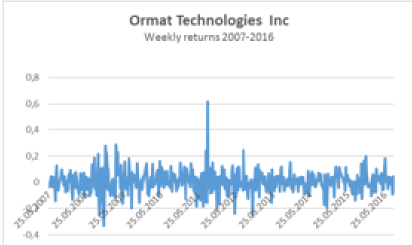


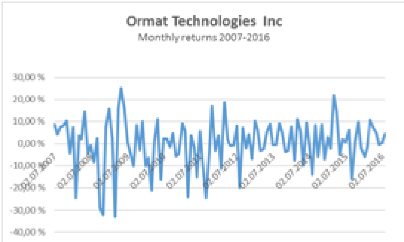




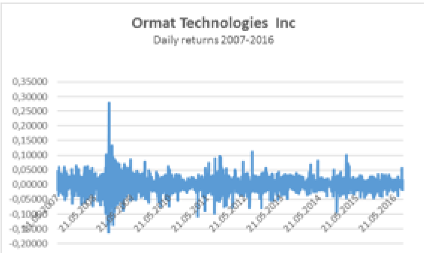
Ormat Technologies Inc

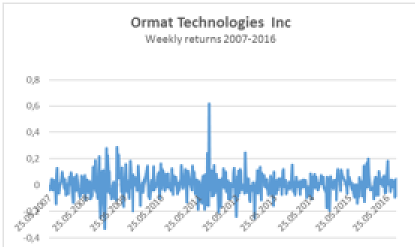


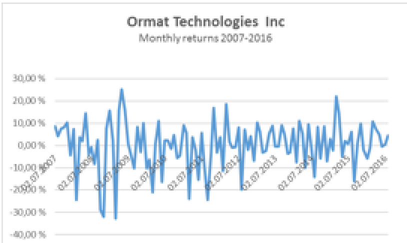




Ormat Technologies Inc





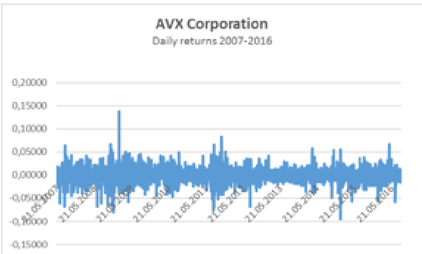


AVX Corporation

- **Subsector: electronics. "**AVX Corporation-- is a leading worldwide manufacturer and supplier of a broad line of passive electronic components and Interconnects solutions with multiple manufacturing and warehouse facilities located around the world. AVX offers a broad range of devices including capacitors, resistors, filters, couplers, timing and circuit protection devices and connectors."
- http://www.avx.com
- Price trend 2007-2016

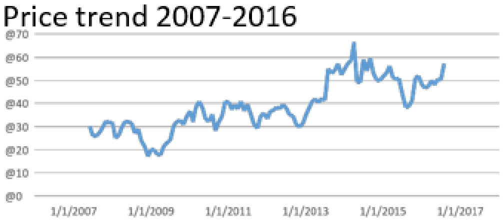
	AVX Corporation		
	Daily	Weekly	Monthly
Mean	-0,01 %	-0,06 %	-0,25 %
Standard Error	0,03 %	0,17 %	0,67 %
Median	0,00 %	0,00 %	0,04 %
Standard Deviation	1,66 %	3,60 %	7,03 %
Sample Variance	0,03 %	0,13 %	0,49 %
Kurtosis	4,46	1,25	-0,28
Skewness	0,07	-0,15	-0,19
Range	23,28 %	26,39 %	31,31 %
Minimum	-9,44 %	-12,34 %	-18,20 %
Maximum	13,84 %	14,05 %	13,10 %
Count	2331	465	110
Beta S&P 500	0,761	0,863	0,846

AVX Corporation



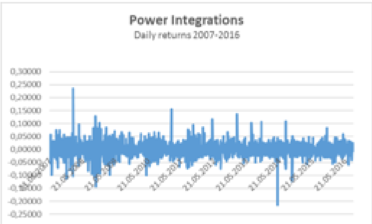
Power Integrations

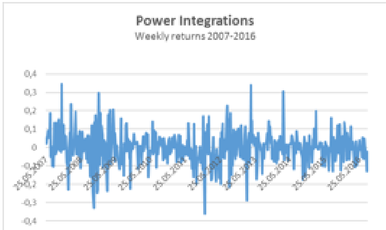
- **Subsector: electronics** "is a Silicon Valley-based supplier of high-performance electronic components used in high-voltage power-conversion systems"
- https://www.power.com/
- Price trend 2007-2016

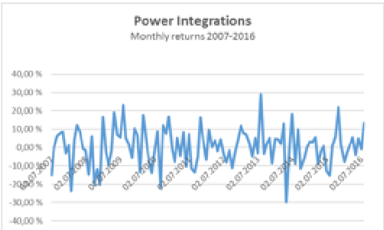


	Power Integrations		
	Daily	Weekly	Monthly
Mean	0,03 %	0,15 %	0,58 %
Standard Error	0,05 %	0,26 %	0,98 %
Median	0,03 %	0,25 %	1,26 %
Standard Deviation	2,54 %	5,52 %	10,32 %
Sample Variance	0,06 %	0,30 %	1,06 %
Kurtosis	8,41	1,61	0,45
Skewness	0,18	-0,24	-0,18
Range	44,81 %	44,47 %	58,81 %
Minimum	-21,26 %	-22,50 %	-29,94 %
Maximum	23,55 %	21,97 %	28,88 %
Count	2331	465	110
Beta S&P 500	0,979	1,738	1,058

Power Integrations





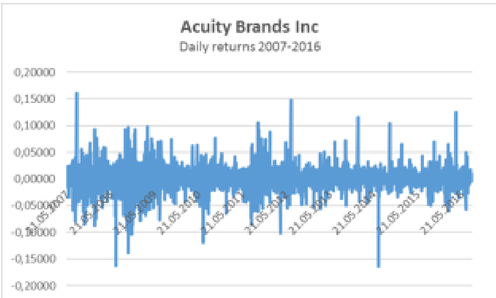


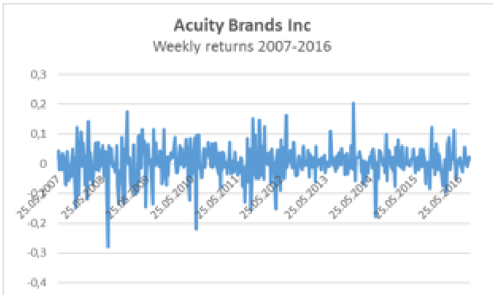
Acuity Brands Inc

- **Subsector: electronics (light)"** is a North American market leader and one of the world's leading providers of indoor and outdoor lighting and energy management solutions"
- http://www.acuitybrands.com
- Price trend 2007-2016

	Acuity Brands Inc		
	Daily	Weekly	Monthly
Mean	0,08 %	0,38 %	1,48 %
Standard Error	0,05 %	0,25 %	1,01 %
Median	0,08 %	0,43 %	2,49 %
Standard Deviation	2,42 %	5,36 %	10,54 %
Sample Variance	0,06 %	0,29 %	1,11 %
Kurtosis	5,86	3,20	1,22
Skewness	0,02	-0,47	-0,27
Range	32,29 %	48,44 %	63,54 %
Minimum	-16,16 %	-28,01 %	-31,41 %
Maximum	16,13 %	20,43 %	32,13 %
Count	2331	465	110
Beta S&P 500	1,215	1,287	1,375

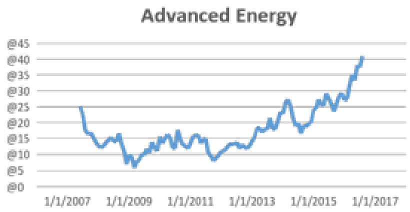
Acuity Brands Inc





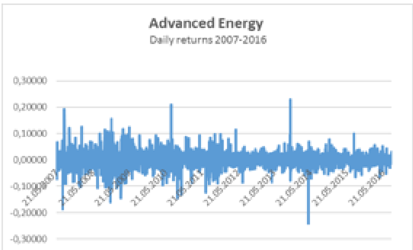
Advanced Energy

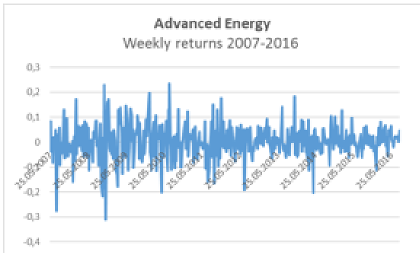
- **Subcontractor: solar".** has built a diversified and global business, delivering advanced power and control technologies to customers across a broad range of industries. **FORT COLLINS, Colo., June 29, 2015**—Advanced Energy Industries, Inc. (NASDAQ:AEIS), a leader in precision power conversion, today announced that it has made a strategic decision to focus solely on its Precision Power business and wind down its Solar Inverter business, which is operated under AE Solar Energy Inc., AEI Power GmbH and their subsidiaries. "Following on the heels of a strong 2014 and first quarter 2015 in Precision Power that reinforced the strength of our business model, and after an extensive strategic process over the last six months, we concluded that focusing solely on our Precision Power business, and exiting the Solar Inverter business aligns with our long-term goal of maximizing value for our shareholders," said Yuval Wasserman, President and CEO of Advanced Energy."
- http://www.advanced-energy.com

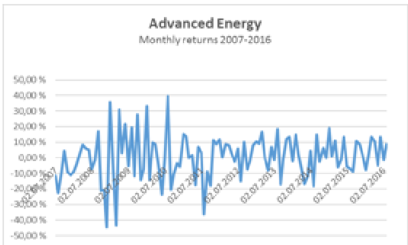


	Advanced Energy		
	Daily	Weekly	Monthly
Mean	0,03 %	0,13 %	0,44 %
Standard Error	0,07 %	0,31 %	1,38 %
Median	0,00 %	0,10 %	0,09 %
Standard Deviation	3,15 %	6,71 %	14,51 %
Sample Variance	0,10 %	0,45 %	2,11 %
Kurtosis	6,32	2,38	1,17
Skewness	0,09	-0,34	-0,23
Range	46,66 %	54,48 %	84,40 %
Minimum	-23,74 %	-30,98 %	-44,66 %
Maximum	22,92 %	23,50 %	39,74 %
Count	2331	465	110
Beta S&P 500	1,400	1,541	1,809

Advanced Energy





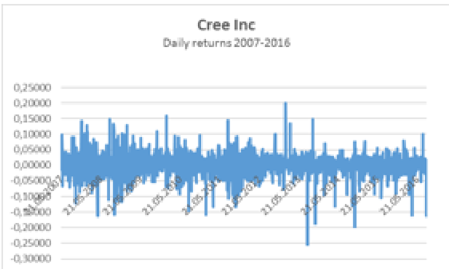


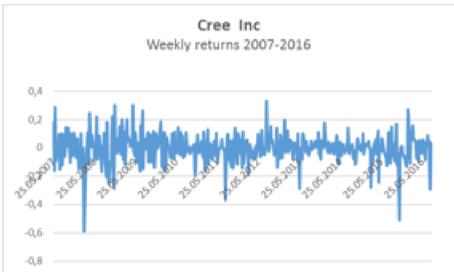
Cree Inc

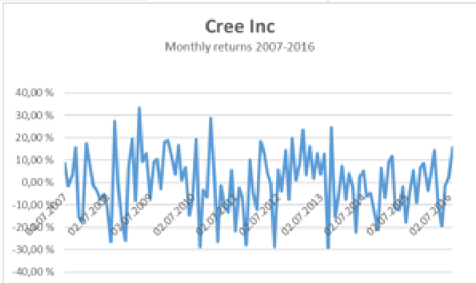
- **Subsector: electronics – led light.** **Cree** "is a market-leading innovator of lighting-class LEDs, LED lighting, and semiconductor solutions for wireless and power applications"
- http://www.cree.com
- Price trend 2007-2016

	Cree Inc		
	Daily	Weekly	Monthly
Mean	0,01 %	0,05 %	0,13 %
Standard Error	0,07 %	0,34 %	1,31 %
Median	0,09 %	0,04 %	0,48 %
Standard Deviation	3,25 %	7,25 %	13,73 %
Sample Variance	0,11 %	0,53 %	1,89 %
Kurtosis	6,33	2,11	-0,31
Skewness	-0,38	-0,07	-0,13
Range	45,22 %	59,12 %	62,37 %
Minimum	-25,29 %	-25,54 %	-29,04 %
Maximum	19,93 %	33,58 %	33,32 %
Count	2331	465	110
Beta S&P 500	1,190	1,535	1,104

Cree Inc





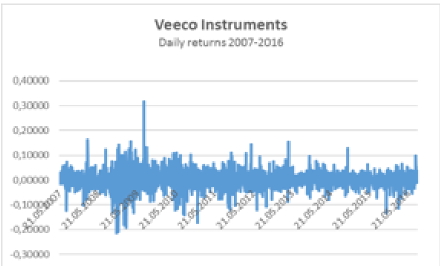


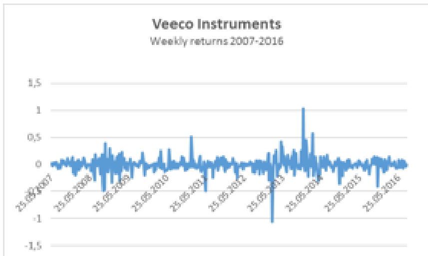
Veeco Instruments

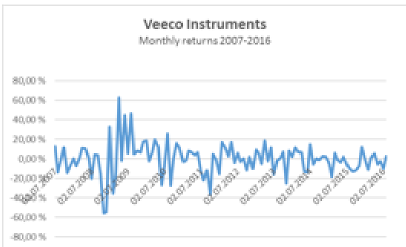
- **Subsector: Electronics – LED. Veeco** "is the market leader in MOCVD, MBE, Ion Beam and other advanced thin film process technologies"
- http://www.veeco.com/
- Price trend 2007-2016

	Veeco Instruments		
	Daily	Weekly	Monthly
Mean	0,01 %	0,03 %	-0,07 %
Standard Error	0,07 %	0,35 %	1,58 %
Median	0,00 %	0,17 %	0,61 %
Standard Deviation	3,47 %	7,57 %	16,61 %
Sample Variance	0,12 %	0,57 %	2,76 %
Kurtosis	6,83	4,87	3,48
Skewness	0,05	-0,16	0,02
Range	52,59 %	81,44 %	118,26 %
Minimum	-21,05 %	-46,95 %	-55,69 %
Maximum	31,54 %	34,49 %	62,58 %
Count	2331	465	110
Beta S&P 500	1,365	1,719	2,198

Veeco Instruments





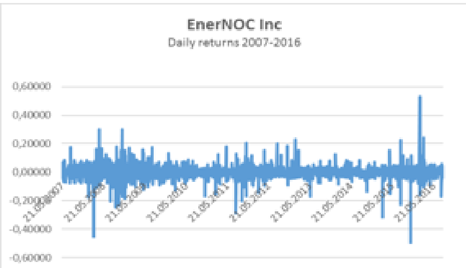


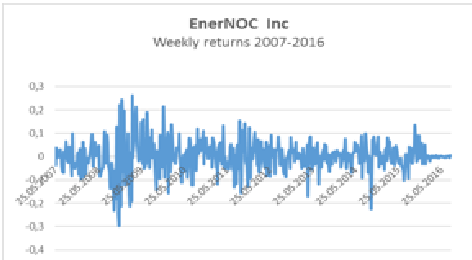
EnerNOC Inc

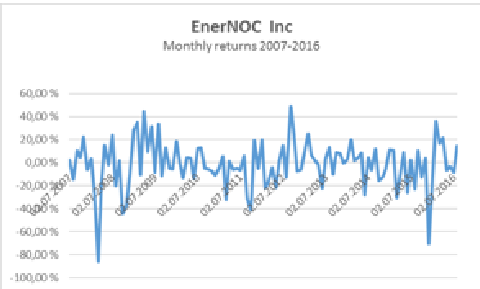
- **Subsector: electronics.** EnerNOC "provides energy intelligence software and services for commercial, institutional, and industrial customers, as well as electric power grid operators and utilities"
- https://www.enernoc.com
- Price trend 2007-2016

	EnerNOC Inc		
	Daily	Weekly	Monthly
Mean	-0,07 %	-0,37 %	-1,47 %
Standard Error	0,10 %	0,46 %	1,94 %
Median	-0,12 %	-0,42 %	-0,52 %
Standard Deviation	4,73 %	10,00 %	20,33 %
Sample Variance	0,22 %	1,00 %	4,14 %
Kurtosis	20,14	4,51	2,98
Skewness	-0,16	-0,64	-0,81
Range	101,56 %	92,12 %	135,02 %
Minimum	-48,81 %	-58,99 %	-85,92 %
Maximum	52,75 %	33,13 %	49,10 %
Count	2331	465	110
Beta S&P 500	1,353	1,643	1,251

EnerNOC Inc

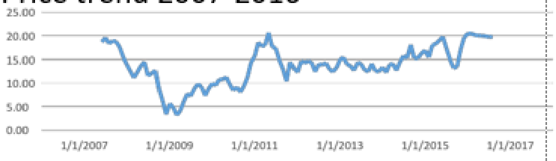






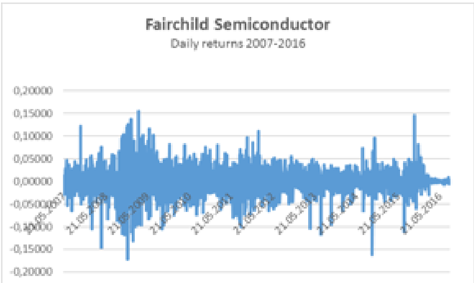
Fairchild Semiconductor

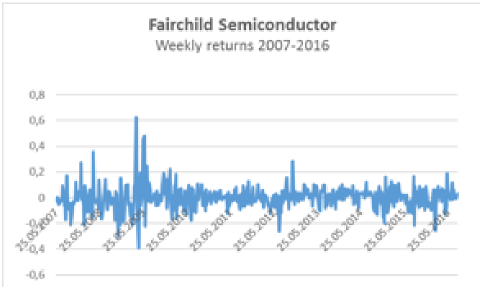
- **Subsector: electronics**
- **Fairchild** "delivers high performance semiconductor products to solve design challenges across a wide range of applications and industries"
- https://www.**fairchildsemi**.com
- Price trend 2007-2016

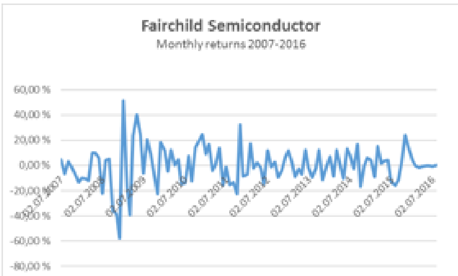


	Fairchild Semiconductor		
	Daily	Weekly	Monthly
Mean	0,00 %	0,01 %	0,05 %
Standard Error	0,06 %	0,32 %	1,47 %
Median	0,00 %	0,09 %	-0,24 %
Standard Deviation	2,94 %	6,87 %	15,40 %
Sample Variance	0,09 %	0,47 %	2,37 %
Kurtosis	4,29	2,64	2,45
Skewness	-0,21	-0,15	-0,24
Range	32,65 %	55,83 %	109,24 %
Minimum	-17,19 %	-29,78 %	-57,98 %
Maximum	15,46 %	26,05 %	51,26 %
Count	2331	465	110
Beta S&P 500	1,312	0,958	2,248

Fairchild Semiconductor





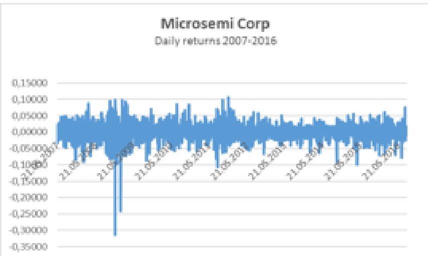


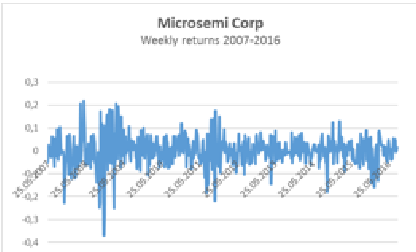
Microsemi Corp

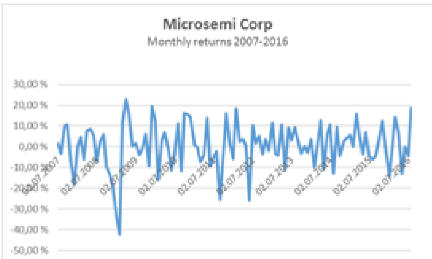
- **Subsector: semiconductors.** **Microsemi** "is a manufacturer of semiconductor and system solutions for communications, data center , defence & security, aerospace and industrial markets"
- http://www.microsemi.com/
- Price trend 2007-2016

	Microsemi Corp		
	Daily	Weekly	Monthly
Mean	0,02 %	0,11 %	0,46 %
Standard Error	0,05 %	0,27 %	1,04 %
Median	0,06 %	0,19 %	0,81 %
Standard Deviation	2,55 %	5,86 %	10,96 %
Sample Variance	0,06 %	0,34 %	1,20 %
Kurtosis	14,79	10,89	1,92
Skewness	-1,29	-1,53	-0,86
Range	41,83 %	63,37 %	65,31 %
Minimum	-31,14 %	-44,50 %	-42,39 %
Maximum	10,69 %	18,88 %	22,92 %
Count	2331	465	110
Beta S&P 500	1,142	1,603	1,037

Microsemi Corp

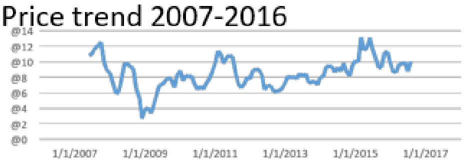






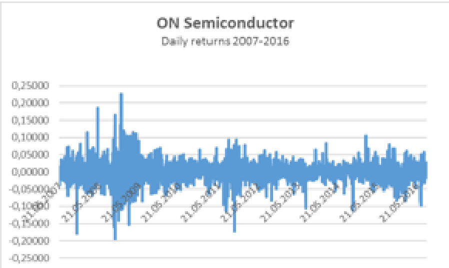
ON Semiconductor

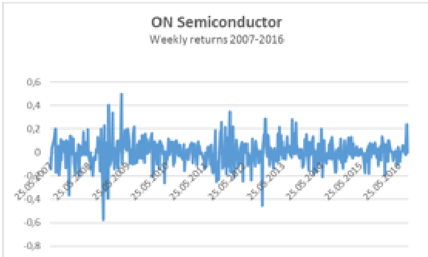
- **Subsector: semiconductors. ON semiconductor** "is a [Fortune 1000](#) is a semiconductor supplier company. Products include power and signal management, logic, discrete, and custom devices for automotive, communications, computing, consumer, industrial, LED lighting, medical, military/aerospace and power applications."
- http://www.onsemi.com/
- Price trend 2007-2016

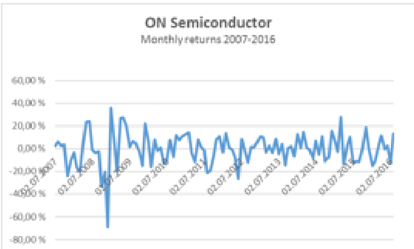


	ON Semiconductor		
	Daily	Weekly	Monthly
Mean	0,00 %	-0,02 %	-0,07 %
Standard Error	0,06 %	0,32 %	1,34 %
Median	0,10 %	0,15 %	0,85 %
Standard Deviation	3,00 %	6,80 %	14,07 %
Sample Variance	0,09 %	0,46 %	1,98 %
Kurtosis	6,00	3,72	4,55
Skewness	-0,07	-0,61	-0,95
Range	41,87 %	58,55 %	104,65 %
Minimum	-19,22 %	-36,86 %	-68,94 %
Maximum	22,65 %	21,69 %	35,70 %
Count	2331	465	110
Beta S&P 500	1,376	2,241	1,840

ON Semiconductor

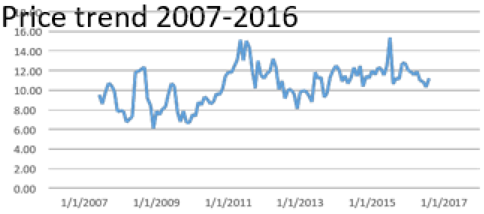






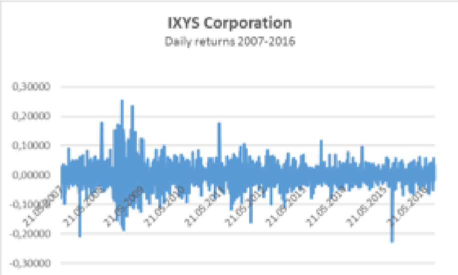
IXYS Corporation

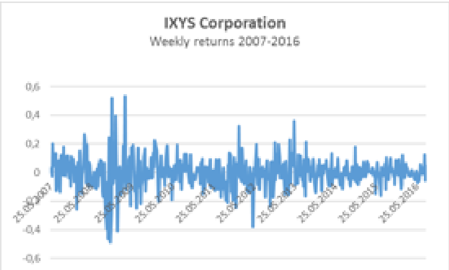
- **Subsector: subcontractor Solar and wind**
- **IXYS** "produces power semi- conductors, radi frequency(RF) powe semiconductors, and digital and analog integrated circuits (ICs)"
- http://www.ixys.com/
- Price trend 2007-2016

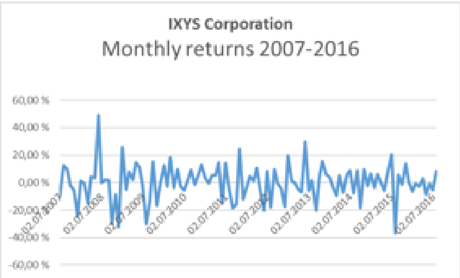


	IXYS Corporation		
	Daily	Weekly	Monthly
Mean	0,01 %	0,03 %	0,15 %
Standard Error	0,07 %	0,33 %	1,23 %
Median	0,00 %	0,12 %	-0,03 %
Standard Deviation	3,41 %	7,07 %	12,89 %
Sample Variance	0,12 %	0,50 %	1,66 %
Kurtosis	7,15	3,30	1,89
Skewness	0,23	-0,17	0,04
Range	47,72 %	67,64 %	85,79 %
Minimum	-22,52 %	-33,80 %	-36,87 %
Maximum	25,20 %	33,84 %	48,92 %
Count	2331	465	110
Beta S&P 500	1,484	2,359	0,929

IXYS Corporation







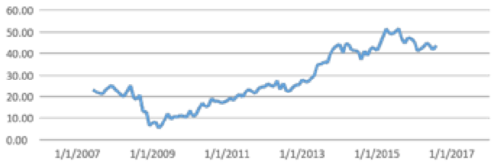
Hexcel Corporation

•**Subsector: subcontractor wind.**

Hexcel" is a global supplier of advanced materials - Carbon Fiber, Epoxy resins and adhesives, glass, aramid and carbon fabrics, aircraft flooring. is that manufactures composite materials and structural parts. And its first product was supplying honeycomb for the construction of military bombers. Hexcel claims to be the largest US producer of carbon fiber."

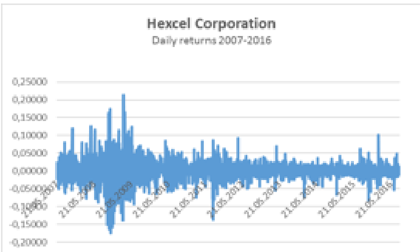
•"A world leader in prepregs and composites for wind turbine blades, Hexcel is also a specialist in fiber reinforcements, laminates, PU foam cores and gel coats for wind energy applications"

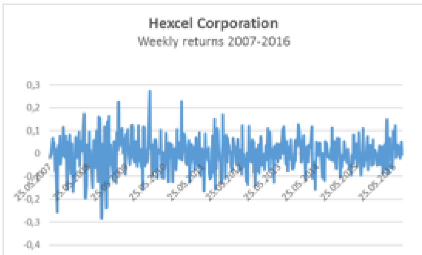
- http://www.hexcel.com
- Price trend 2007-2016

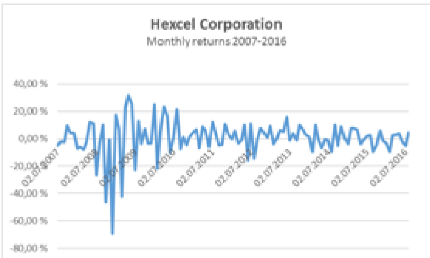


	Hexcel Corporation		
	Daily	Weekly	Monthly
Mean	0,03 %	0,15 %	0,57 %
Standard Error	0,06 %	0,31 %	1,26 %
Median	0,07 %	0,35 %	0,91 %
Standard Deviation	2,84 %	6,70 %	13,22 %
Sample Variance	0,08 %	0,45 %	1,75 %
Kurtosis	7,39	6,75	8,29
Skewness	0,01	-0,44	-1,85
Range	38,69 %	73,13 %	101,00 %
Minimum	-17,44 %	-36,49 %	-69,08 %
Maximum	21,25 %	36,65 %	31,91 %
Count	2331	465	110
Beta S&P 500	1,522	1,441	1,648

Hexcel Corporation







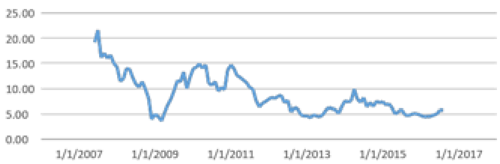
Intevac Inc

•Subsector: subcontractor solar.

"provides production-proven solutions for the application and engineering of thin films for the technology and vacuum coating industries, and highly advanced digital vision sensors and systems for the defense industry. Its advanced applications and engineering solutions meet the ever-evolving performance and cost requirements for customers in the technology and vacuum coating industries, and continue to deliver the increasingly sophisticated sensors and systems that our defense industry customers demand. "

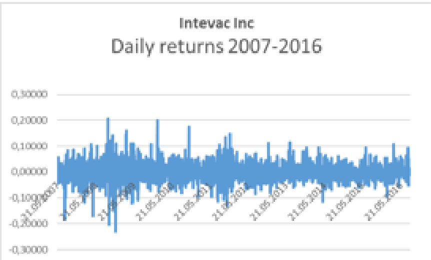
•"Our expertise in thin film deposition and sensor technologies makes Intevac uniquely positioned to serve the needs of these diverse industries. has two business units: Equipment and Photonics. "

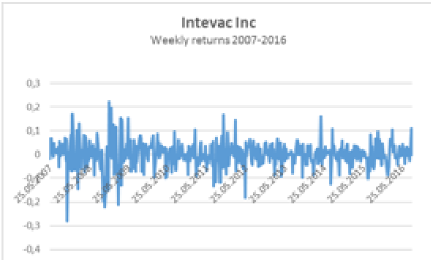
- www.**intevac**.com
- Price trend 2007-2016

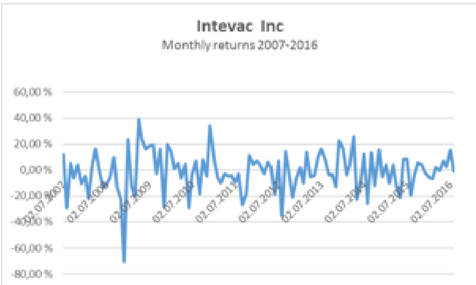


	Intevac Inc		
	Daily	Weekly	Monthly
Mean	-0,05 %	-0,25 %	-1,10 %
Standard Error	0,07 %	0,34 %	1,49 %
Median	-0,14 %	-0,14 %	-1,24 %
Standard Deviation	3,49 %	7,24 %	15,58 %
Sample Variance	0,12 %	0,52 %	2,43 %
Kurtosis	4,07	1,26	2,85
Skewness	0,10	-0,17	-0,73
Range	43,61 %	55,52 %	109,72 %
Minimum	-22,87 %	-28,39 %	-70,58 %
Maximum	20,74 %	27,13 %	39,14 %
Count	2331	465	110
Beta S&P 500	1,351	1,157	1,780

Intevac Inc





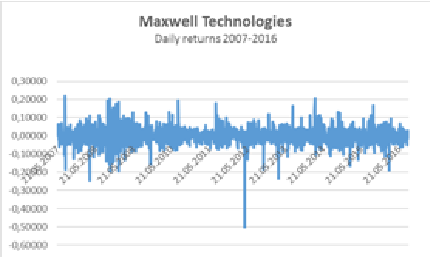


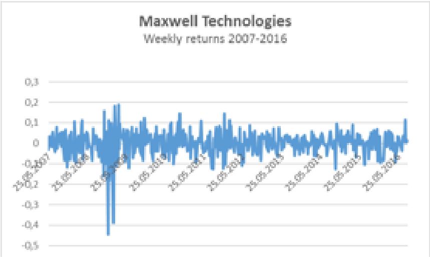
Maxwell Technologies

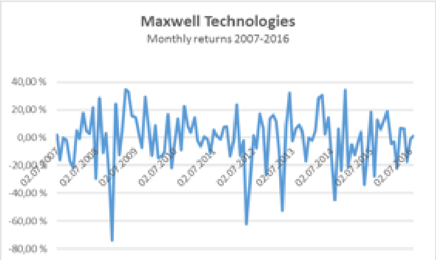
- **Subsector: Electronics. "**Focuses on developing and manufacturing energy storage and power delivery solution-related products for automotive, heavy transportation, renewable energy, backup power, wireless communications and industrial and consumer electronics applications."
- http://www.maxwell.com/
- Price trend 2007-2016

	Maxwell Technologies		
	Daily	Weekly	Monthly
Mean	-0,03 %	-0,17 %	-0,89 %
Standard Error	0,09 %	0,40 %	1,82 %
Median	-0,07 %	-0,10 %	1,28 %
Standard Deviation	4,15 %	8,68 %	19,13 %
Sample Variance	0,17 %	0,75 %	3,66 %
Kurtosis	12,78	3,93	2,08
Skewness	-0,64	-0,36	-0,92
Range	71,84 %	92,50 %	108,62 %
Minimum	-49,82 %	-53,73 %	-74,07 %
Maximum	22,01 %	38,77 %	34,55 %
Count	2331	465	110
Beta S&P 500	1,349	1,266	1,468

Maxwell Technologies





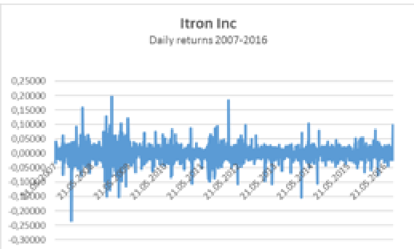


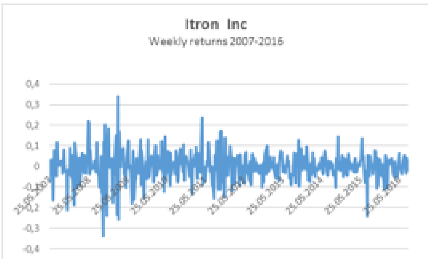
Itron Inc

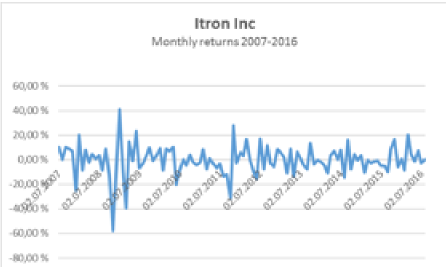
- **Subsector: technology "**is an American technology company that offers products and services on energy and water resource management. offers products and services on energy and water resource management. Its products and services include technology solutions related to smart grid, smart gas and smart water that measure and analyze electricity, gas and water consumption, Its products include electricity, gas, water and thermal energy measurement devices and control technology; communications systems; software; as well as managed and consulting services. "
- http://www.itron.com
- Price trend 2006-2017

	Itron Inc		
	Daily	Weekly	Monthly
Mean	-0,01 %	-0,07 %	-0,44 %
Standard Error	0,05 %	0,26 %	1,19 %
Median	0,03 %	0,00 %	-0,50 %
Standard Deviation	2,56 %	5,68 %	12,49 %
Sample Variance	0,07 %	0,32 %	1,56 %
Kurtosis	10,13	3,13	4,88
Skewness	-0,24	-0,33	-0,78
Range	42,84 %	50,30 %	99,06 %
Minimum	-23,27 %	-28,13 %	-57,90 %
Maximum	19,57 %	22,17 %	41,15 %
Count	2331	465	110
Beta S&P 500	1,058	1,410	1,589

Itron Inc





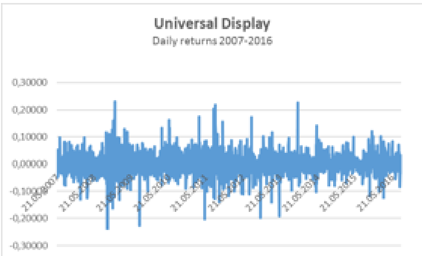


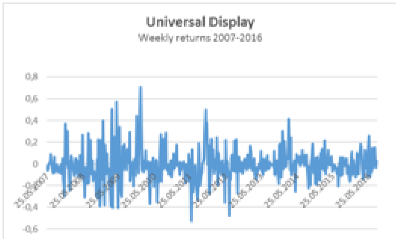
Universal Display

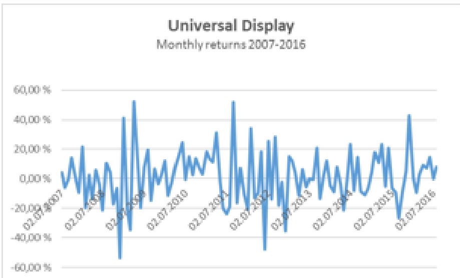
- **Subsector: electronics LED..”** is a developer and manufacturer of organic light emitting diodes (OLED) technologies and materials as well as provider of services to the display and lighting industries”
- http://www.oled.com/
- Price trend 2007-2016

	Universal Display		
	Daily	Weekly	Monthly
Mean	0,06 %	0,29 %	1,43 %
Standard Error	0,08 %	0,41 %	1,73 %
Median	-0,04 %	0,29 %	1,80 %
Standard Deviation	3,88 %	8,75 %	18,11 %
Sample Variance	0,15 %	0,77 %	3,28 %
Kurtosis	4,98	5,62	1,02
Skewness	0,15	0,69	0,06
Range	46,72 %	94,61 %	105,76 %
Minimum	-23,54 %	-32,98 %	-53,47 %
Maximum	23,18 %	61,63 %	52,29 %
Count	2331	465	110
Beta S&P 500	1,491	1,803	1,535

Universal Display







Appendix D: Rolling betas

Appendix E Chow test

	F test	F-krit
8point3 Energy Partners LP	0,786	3,078
Acuity Brands Inc	0,959	3,078
Advanced Energy	2,213	3,078
AVX Corporation	0,474	3,078
Ballard Power Systems	1,726	3,078
Cree Inc	0,353	3,078
EnerNOC Inc	0,997	3,078
Fairchild Semiconductor	4,595	3,078
Green Plains Inc	0,517	3,078
Hexcel Corporation	1,319	3,078
Intevac Inc	1,094	3,078
Itron Inc	0,299	3,078
IXYS Corporation	0,864	3,078
Ja Solar Holdings Co Ltd ADR	1,878	3,078
Maxwell Technologies	0,907	3,078
Microsemi Corp	1,265	3,078
Trina Solar Ltd	1,777	3,078
Universal Display	0,432	3,078
Veeco Instruments	11,534	3,078
Canadian Solar	0,197	3,078
First Solar Inc	0,505	3,078
ON Semiconductor	0,503	3,078
Ormat Technologies Inc	0,379	3,078
Pacific Ethanol	0,165	3,078
Plug Power Inc	0,611	3,078
Power Integrations	0,202	3,078

	Share of fixed tangible assets
Lowest 4 beta companies	18,93 %
Highest 4 beta companies	40,02 %

Appendix F Risk model regression with specification tests

8point3 Energy Partners L				
	Coefficient	Part,R^2	t-value	
Constant	-0,01	0,00	-0,26	
S&P	3,09	0,39	8,15	
R^2	0,39	Adj,R^2	0,38	
AR 1-2 test:	F(2,104)	=	1.4112	[0.2485]
ARCH 1-1 test:	F(1,106)	=	2.5660	[0.1122]
Normality test:	Chi^2(2)	=	1.7524	[0.4164]
Hetero test:	F(2,105)	=	0.17451	[0.8401]
Hetero-X test:	F(2,105)	=	0.17451	[0.8401]
RESET23 test:	F(2,104)	=	0.65848	[0.5198]

Cree INC	Coefficient	Part,R^2	t-value	
Constant	-0,01	0,01	-0,82	
S&P	1,21	0,28	6,19	
NOMINAL INTEREST_1	0,08	0,12	3,71	
REAL INTEREST_1	0,00	0,06	2,46	
CREDIT SPREAD_1	0,29	0,06	2,46	
INTEREST_2	0,00	0,07	-2,72	
CREDIT SPREAD	0,35	0,08	2,96	
Term structure	0,20	0,07	2,77	
R^2	0,43	Adj,R^2	0,39	
AR 1-2 test:	F(2,96)	=	0.16048	[0.8520]
ARCH 1-1 test:	F(1,104)	=	0.32426	[0.5703]
Normality test:	Chi^2(2)	=	0.15025	[0.9276]
Hetero test:	F(14,91)	=	1.0323	[0.4295]
Hetero-X test:	F(35,70)	=	1.0387	[0.4357]
RESET23 test:	F(2,96)	=	0.16808	[0.8455]

EnerNOC	Coefficient	Part,R^2	t-value
Constant	-0,02	0,01	-1,21
S&P	1,18	0,11	3,48
INDUSTRY production_4	-2,50	0,04	-2,06
R^2	0,15	Adj,R^2	0,14
AR 1-2 test:	F(2,99)	= 0.19462	[0.8235]
ARCH 1-1 test:	F(1,102)	=0.0079917	[0.9289]
Normality test:	Chi^2(2)	= 22.837	[0.0000]**
Hetero test:	F(4,99)	= 0.72046	[0.5800]
Hetero-X test:	F(5,98)	= 0.61779	[0.6865]
RESET23 test:	F(2,99)	= 0.63002	[0.5347]

First Solar	Coefficient	Part,R^2		t-value
Constant	-0,01		0,01	-0,87
S&P	1,70		0,25	5,92
R^2	0,25	Adj,R^2		0,24
AR 1-2 test:	F(2,104)	= 2.2617		[0.1093]
ARCH 1-1 test:	F(1,106)	= 0.76441		[0.3839]
Normality test:	Chi^2(2)	= 2.5114		[0.2849]
Hetero test:	F(2,105)	= 0.17937		[0.8361]
Hetero-X test:	F(2,105)	= 0.17937		[0.8361]
RESET23 test:	F(2,104)	=0.0071125		[0.9929]

Maxwell Technologies			t-value
	Coefficient	Part,R^2	-0,77
Constant	-0,01	0,01	4,76
S&P	1,46	0,18	
R^2	0,18	Adj,R^2	0,17

AR 1-2 test:	F(2,104)	=	0.051644	[0.9497]
ARCH 1-1 test:	F(1,106)	=	1.1252	[0.2912]
Normality test:	Chi^2(2)	=	9.5642	[0.0084]**
Hetero test:	F(2,105)	=	1.8148	[0.1679]
Hetero-X test:	F(2,105)	=	1.8148	[0.1679]
RESET23 test:	F(2,104)	=	1.3940	[0.2527]

Ormat Technologies	Coefficient	Part,R^2		t-value
Constant	-0,01		0,01	-1,00
S&P	1,06		0,33	6,99
OIL returns_5	-0,26		0,09	-3,04
NOMINAL INTEREST_2	-0,04		0,05	-2,29
R^2	0,41	Adj,R^2		0,40

AR 1-2 test:	F(2,97)	=	2.4080	[0.0954]
ARCH 1-1 test:	F(1,101)	=	0.043696	[0.8348]
Normality test:	Chi^2(2)	=	2.7151	[0.2573]
Hetero test:	F(6,96)	=	2.4623	[0.0294]*
Hetero-X test:	F(9,93)	=	1.8099	[0.0766]
RESET23 test:	F(2,97)	=	0.48014	[0.6202]

Trina Solar	Coefficient	Part,R^2	t-value	
Constant	-0,03	0,03	-1,64	
S&P	3,02	0,47	9,51	
NOMINAL INTEREST	-0,09	0,06	-2,52	
REAL INTEREST_2	0,00	0,07	-2,80	
R^2	0,49	Adj,R^2	0,48	
AR 1-2 test:	F(2,100)	=	0.097964	[0.9068]
ARCH 1-1 test:	F(1,104)	=	0.046375	[0.8299]
Normality test:	Chi^2(2)	=	6.1323	[0.0466]*
Hetero test:	F(6,99)	=	1505532,00	[0.1544]
Hetero-X test:	F(9,96)	=	3.0515	[0.0030]**
RESET23 test:	F(2,100)	=	0.28207	[0.7548]

Advanced Energy by OLS				
	Coefficient	Part,R^2	t-value	
Constant	0,00	0,00	0,12	
S&P	1,79	0,47	9,70	
R^2	0,47	Adj,R^2	0,47	
AR 1-2 test:	F(2,104)	=	1.7570	[0.1776]
ARCH 1-1 test:	F(1,106)	=	0.30081	[0.5845]
Normality test:	Chi^2(2)	=	0.68456	[0.7101]
Hetero test:	F(2,105)	=	0.15940	[0.8529]
Hetero-X test:	F(2,105)	=	0.15940	[0.8529]
RESET23 test:	F(2,104)	=	0.89265	[0.4127]

Canadian	Solar			
	Coefficient	Part,R^2	t-value	
Constant	-0,01	0,00	-0,34	
S&P	3,21	0,42	8,80	
R^2	0,42	Adj,R^2	0,42	
AR 1-2 test:	F(2,104)	=	1.4502	[0.2392]
ARCH 1-1 test:	F(1,106)	=	5.2791	[0.0235]*
Normality test:	Chi^2(2)	=	3.7059	[0.1568]
Hetero test:	F(2,105)	=	0.036275	[0.9644]
Hetero-X test:	F(2,105)	=	0.036275	[0.9644]
RESET23 test:	F(2,104)	=	0.42001	[0.6582]

Green	Plains				
	Coefficient	Part,R^2		t-value	
Constant	0,00		0,00	0,13	
S&P	2,66		0,37	7,59	
NOMINAL INTEREST	-0,11		0,08	-2,93	
S&P_4	-1,24		0,14	-3,91	
INDUSTRY production_4	2,56		0,05	2,23	
OIL returns_3	0,51		0,08	2,89	
CREDIT SPREAD_2	0,39		0,04	2,03	
R^2	0,44	Adj,R^2		0,40	
AR 1-2 test:	F(2,95)	=		3.9637	[0.0222]*
ARCH 1-1 test:	F(1,102)	=		0.026000	[0.8722]
Normality test:	Chi^2(2)	=		12.545	[0.0019]**
Hetero test:	F(12,91)	=		1.8377	[0.0534]
Hetero-X test:	F(27,76)	=		3.4862	[0.0000]**
RESET23 test:	F(2,95)	=		10.803	[0.0001]**

Fairchild Semiconductor			
	Coefficient	Part,R^2	t-value
Constant	-0,01	0,01	-0,84
S&P	2,37	0,68	14,90
INDUSTRY production_2	-1,85	0,10	-3,31
R^2	0,68	Adj,R^2	0,68
AR 1-2 test:	F(2,101)	= 2.9032	[0.0594]
ARCH 1-1 test:	F(1,104)	=0.00045946	[0.9829]
Normality test:	Chi^2(2)	= 0.92740	[0.6290]
Hetero test:	F(4,101)	= 1.1455	[0.3396]
Hetero-X test:	F(5,100)	= 0.98501	[0.4308]
RESET23 test:	F(2,101)	= 3.5386	[0.0327]*

Ja Solar	Coefficient	Part,R^2		t-value	
Constant	-0,03		0,03	-1,95	
S&P	3,07		0,53	11,00	
R^2	0,53	Adj,R^2		0,53	
AR 1-2 test:	F(2,104)	=		0.39942	[0.6717]
ARCH 1-1 test:	F(1,106)	=		0.069065	[0.7932]
Normality test:	Chi^2(2)	=		6.2306	[0.0444]*
Hetero test:	F(2,105)	=		2.2952	[0.1058]
Hetero-X test:	F(2,105)	=		2.2952	[0.1058]
RESET23 test:	F(2,104)	=		0.47859	[0.6210]
Hetero test:	F(2,105)	=		2.2952	[0.1058]
Hetero-X test:	F(2,105)	=		2.2952	[0.1058]
RESET23 test:	F(2,104)	=		0.47859	[0.6210]

universal display	Coefficient	Part,R^2	t-value	
Constant	0,01	0,00	0,58	
S&P	1,54	0,22	5,42	
R^2	0,22	Adj,R^2	0,21	
AR 1-2 test:	F(2,104)	=	2.6781	[0.0734]
ARCH 1-1 test:	F(1,106)	=	0.36659	[0.5462]
Normality test:	Chi^2(2)	=	8.7020	[0.0129]*
Hetero test:	F(2,105)	=	2.6048	[0.0787]
Hetero-X test:	F(2,105)	=	2.6048	[0.0787]
RESET23 test:	F(2,104)	=	2.1795	[0.1182]

Plug power	Coefficient	Part,R^2		t-value	
Constant	-0,01		0,00	-0,24	
OIL returns_1	1,04		0,08	2,91	
INFLATION_1	-20,42		0,06	-2,43	
REAL INTEREST_5	-0,01		0,13	-3,79	
R^2	0,21	Adj,R^2		0,18	
AR 1-2 test:	F(2,97)	=		0.47992	[0.6203]
ARCH 1-1 test:	F(1,101)	=		0.19385	[0.6607]
Normality test:	Chi^2(2)	=		36.510	[0.0000]**
Hetero test:	F(6,96)	=		0.95766	[0.4581]
Hetero-X test:	F(9,93)	=		0.95713	[0.4805]
RESET23 test:	F(2,97)	=		2.9309	[0.0581]

Power Integrations	Coefficient	Part,R^2	t-value	
Constant	-0,01	0,01	-0,71	
S&P	1,14	0,43	8,57	
REAL INTEREST	0,00	0,10	-3,28	
OIL returns_3	-0,25	0,10	-3,31	
NOMINAL INTEREST_3	-0,05	0,10	-3,22	
VIX_3	-0,12	0,10	-3,31	
NOMINAL INTEREST_4	0,05	0,11	3,36	
Term structure_4	0,13	0,10	3,26	
R^2	0,55	Adj,R^2	0,51	
AR 1-2 test:	F(2,94)	=	0.45097	[0.6384]
ARCH 1-1 test:	F(1,102)	=	0.017496	[0.8950]
Normality test:	Chi^2(2)	=	0.21293	[0.8990]
Hetero test:	F(14,89)	=	0.55676	[0.8911]
Hetero-X test:	F(35,68)	=	0.94763	[0.5596]
RESET23 test:	F(2,94)	=	0.38600	[0.6808]

vecco	Coefficient	Part,R^2	t-value	
Constant	-0,01	0,01	-0,81	
S&P	2,80	0,49	9,82	
VIX	0,18	0,06	2,61	
NOMINAL INTEREST_2	0,06	0,06	2,63	
R^2	0,60	Adj,R^2	0,59	
AR 1-2 test:	F(2,100)	=	0.75306	[0.4736]
ARCH 1-1 test:	F(1,104)	=	2.4838	[0.1181]
Normality test:	Chi^2(2)	=	0.94987	[0.6219]
Hetero test:	F(6,99)	=	2.7597	[0.0160]*
Hetero-X test:	F(9,96)	=	2.6713	[0.0082]**
RESET23 test:	F(2,100)	=	5.0339	[0.0083]**

Appendix G Risk model regressions with robust standard errors

ON Semiconductor	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,01	0,01	-0,74	0,46	0,01
S&P	1,83	0,17	10,80	0,00	0,54
S&P_1	0,41	0,17	2,41	0,02	0,06
sigma	0,10	RSS	0,93		
R^2	0,55	F(2,100) =		62,29	[0,000]**
Adj,R^2	0,55	log-likelihood	96,46		
no, Of observations	103	no, Of parameters	3,00		
mean(Y)	0,00	se(Y)	0,14		
AR 1-2 test:	F(2,98)	=	0,15	[0,8611]	
ARCH 1-1 test:	F(1,101)	=	22,55	[0,0000]**	
Normality test:	Chi^2(2)	=	3,00	[0,2233]	
Hetero test:	F(4,98)	=	11,00	[0,0000]**	
Hetero-X test:	F(5,97)	=	8,78	[0,0000]**	
RESET23 test:	F(2,98)	=	2,48	[0,0886]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,01	0,01	0,01	0,01	0,01
S&P	1,83	0,17	0,16	0,27	0,31
S&P_1	0,41	0,17	0,12	0,25	0,30
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,01	-0,74	-0,74	-0,70	-0,65
S&P	1,83	10,80	11,10	6,83	5,95
S&P_1	0,41	2,41	3,41	1,61	1,37

Hexcel	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	0,00	0,01	-0,05	0,96	0,00
S&P	1,66	0,17	9,58	0,00	0,48
sigma	0,10	RSS	0,99		
R^2	0,48	F(1,101)	=	91,82	[0,000]**
Adj,R^2	0,47	log-likelihood	93,21		
no, Of		no, Of			
observations	103	parameters	2,00		
mean(Y)	0,01	se(Y)	0,14		
AR 1-2 test:	F(2,99)	=	5,61	[0,0049]**	
ARCH 1-1 test:	F(1,101)	=	21,55	[0,0000]**	
Normality test:	Chi^2(2)	=	31,69	[0,0000]**	
Hetero test:	F(2,100)	=	43,21	[0,0000]**	
Hetero-X test:	F(2,100)	=	43,21	[0,0000]**	
RESET23 test:	F(2,99)	=	0,16	[0,8559]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	0,00	0,01	0,01	0,01	0,01
S&P	1,66	0,17	0,19	0,34	0,37
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	0,00	-0,05	-0,07	-0,05	-0,05
S&P	1,66	9,58	8,76	4,87	4,50

Pacific Ethanol	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,05	0,03	-1,69	0,09	0,03
S&P	1,77	0,55	3,20	0,00	0,09
OILr_1	0,70	0,31	2,24	0,03	0,05
sigma	0,29	RSS	8,63		
R^2	0,19	F(2,100)	=	11,81	[0,000]**
Adj,R^2	0,17	log-likelihood	-18,48		
no, Of observations	103	no, Of parameters	3,00		
mean(Y)	-0,05	se(Y)	0,32		
AR 1-2 test:	F(2,98)	=	0,32	[0,7289]	
ARCH 1-1 test:	F(1,101)	=	0,08	[0,7783]	
Normality test:	Chi^2(2)	=	17,28	[0,0002]**	
Hetero test:	F(4,98)	=	0,47	[0,7585]	
Hetero-X test:	F(5,97)	=	0,48	[0,7886]	
RESET23 test:	F(2,98)	=	0,44	[0,6428]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,05	0,03	0,03	0,03	0,03
S&P	1,77	0,55	0,47	0,56	0,58
OILr_1	0,70	0,31	0,26	0,28	0,29
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,05	-1,69	-1,60	-1,64	-1,63
S&P	1,77	3,20	3,78	3,17	3,06
OILr_1	0,70	2,24	2,68	2,48	2,41

AVX Corporation	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	0,00	0,01	-0,58	0,57	0,00
S&P	0,84	0,09	8,86	0,00	0,44
sigma	0,05	RSS	0,29		
R^2	0,44	F(1,101)	=	78,47	[0,000]**
Adj,R^2	0,43	log-likelihood	155,96		
no, Of observations	103	observations	2,00		
mean(Y)	0,00	se(Y)	0,07		
AR 1-2 test:	F(2,99)	=	1,32	[0,2711]	
ARCH 1-1 test:	F(1,101)	=	5,53	[0,0207]*	
Normality test:	Chi^2(2)	=	15,42	[0,0004]**	
Hetero test:	F(2,100)	=	2,13	[0,1243]	
Hetero-X test:	F(2,100)	=	2,13	[0,1243]	
RESET23 test:	F(2,99)	=	2,99	[0,0548]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	0,00	0,01	0,00	0,01	0,01
S&P	0,84	0,09	0,18	0,12	0,13
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	0,00	-0,58	-0,64	-0,56	-0,56
S&P	0,84	8,86	4,57	6,82	6,56

Intevac inc	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,01	0,01	-1,29	0,20	0,02
S&P	1,87	0,21	9,06	0,00	0,46
INDUSTRY R_2	-2,48	0,73	-3,39	0,00	0,10
OILr_2	0,37	0,11	3,26	0,00	0,10
INDUSTRY R_3	-2,59	0,75	-3,47	0,00	0,11
sigma	0,11	RSS	1,19		
R^2	0,53	F(4,98)	=	27,42	[0,000]**
Adj,R^2	0,51	log-likelihood	83,39		
no, Of		no, Of			
observations	103	parameters	5,00		
mean(Y)	-0,01	se(Y)	0,16		
AR 1-2 test:	F(2,96)	=	1,79	[0,1720]	
ARCH 1-1 test:	F(1,101)	=	0,05	[0,8188]	
Normality test:	Chi^2(2)	=	4,94	[0,0847]	
Hetero test:	F(8,94)	=	7,72	[0,0000]**	
Hetero-X test:	F(14,88)	=	5,91	[0,0000]**	
RESET23 test:	F(2,96)	=	0,07	[0,9330]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,01	0,01	0,01	0,01	0,01
S&P	1,87	0,21	0,19	0,21	0,25
INDUSTRY		-2,48	0,73	0,73	0,71
OILr_2	0,37	0,11	0,12	0,13	0,15
INDUSTRY	R_3	-2,59	0,75	0,92	1,04
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,01	-1,29	-1,73	-1,30	-1,24
S&P	1,87	9,06	9,76	8,78	7,58
INDUSTRY R_2	-2,48	-3,39	-3,37	-3,49	-3,33
OILr_2	0,37	3,26	3,18	2,85	2,50
INDUSTRY R_3	-2,59	-3,47	-2,81	-2,50	-2,20

IXYS Corporation	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,01	0,01	-0,42	0,67	0,00
INFLATION	6,78	2,84	2,38	0,02	0,05
VIX	-0,16	0,05	-3,17	0,00	0,09
S&P_3	-0,40	0,21	-1,94	0,06	0,04
sigma	0,12	RSS	1,36		
R^2	0,20	F(3,99) =		8,44	[0,000]**
Adj,R^2	0,18	log-likelihood	76,55		
no, Of observations	103	no, Of parameters	4,00		
mean(Y)	0,00	se(Y)	0,13		
AR 1-2 test:	F(2,97)	=	4,58	[0,0126]*	
ARCH 1-1 test:	F(1,101)	=	0,38	[0,5381]	
Normality test:	Chi^2(2)	=	15,96	[0,0003]**	
Hetero test:	F(6,96)	=	0,68	[0,6677]	
Hetero-X test:	F(9,93)	=	1,14	[0,3400]	
RESET23 test:	F(2,97)	=	0,35	[0,7076]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,01	0,01	0,01	0,01	0,01
INFLATION	6,78	2,84	2,86	3,51	3,74
VIX	-0,16	0,05	0,07	0,06	0,06
S&P_3	-0,40	0,21	0,14	0,17	0,18
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,01	-0,42	-0,65	-0,43	-0,41
INFLATION	6,78	2,38	2,37	1,93	1,81
VIX	-0,16	-3,17	-2,15	-2,76	-2,55
S&P_3	-0,40	-1,94	-2,78	-2,35	-2,24

Microsemi Corp	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	0,01	0,01	1,53	0,13	0,02
S&P	1,09	0,17	6,49	0,00	0,30
OILr	0,37	0,12	3,13	0,00	0,09
INFLATION	-9,33	2,86	-3,26	0,00	0,10
NOMINAL INTEREST_1	0,04	0,02	2,22	0,03	0,05
term structure_2	0,21	0,06	3,31	0,00	0,10
VIX_2	0,02	0,04	0,57	0,57	0,00
sigma	0,09	RSS	0,71		
R^2	0,43	F(6,96)	=	12,10	[0,000]**
Adj,R^2	0,39	log-likelihood	110,13		
no, Of observations	103	no, Of parameters	7,00		
mean(Y)	0,01	se(Y)	0,11		
AR 1-2 test:	F(2,94)	=	1,24	[0,2955]	
ARCH 1-1 test:	F(1,101)	=	28,74	[0,0000]**	
Normality test:	Chi^2(2)	=	16,22	[0,0003]**	
Hetero test:	F(12,90)	=	8,39	[0,0000]**	
Hetero-X test:	F(27,75)	=	12,29	[0,0000]**	
RESET23 test:	F(2,94)	=	0,75	[0,4735]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	0,01	0,01	0,01	0,01	0,01
S&P	1,10	0,17	0,14	0,26	0,31
OILr	0,37	0,12	0,18	0,14	0,16
INFLATION	-9,33	2,86	4,38	3,67	4,34
NOMINAL INTEREST_1	0,04	0,02	0,02	0,03	0,04
term structure_2	0,21	0,06	0,06	0,07	0,08
VIX_2	0,02	0,04	0,05	0,04	0,05
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	0,01	1,53	2,13	1,68	1,50
S&P	1,10	6,49	8,02	4,26	3,52
OILr	0,37	3,13	2,07	2,63	2,26
INFLATION	-9,33	-3,26	-2,13	-2,54	-2,15
NOMINAL INTEREST_1	0,04	2,22	2,10	1,19	0,98
term structure_2	0,21	3,31	3,31	3,06	0,00
VIX_2	0,02	0,57	0,43	0,52	0,45

Acuity Brands Inc	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	0,01	0,01	1,51	0,13	0,02
S&P	1,45	0,12	11,90	0,00	0,59
VIX_3	0,07	0,03	2,28	0,02	0,05
REAL INTEREST_2	0,00	0,00	-2,12	0,04	0,04
INDUSTRY R_2	-1,11	0,44	-2,52	0,01	0,06
sigma	0,07	RSS	0,46		
R^2	0,61	F(4,98)	=	37,96	[0,000]**
Adj,R^2	0,59	log-likelihood	133,06		
no,of observations	103	no, Of parameters	5		
mean(Y)	0,02	se(Y)	0,11		
AR 1-2 test:	F(2,96)	=	2,39	[0,0968]	
ARCH 1-1 test:	F(1,101)	=	0,03	[0,8545]	
Normality test:	Chi^2(2)	=	3,25	[0,1966]	
Hetero test:	F(8,94)	=	0,74	[0,6538]	
Hetero-X test:	F(14,88)	=	1,38	[0,1802]	
RESET23 test:	F(2,96)	=	1,25	[0,2915]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	0,01	0,01	0,01	0,01	0,01
S&P	1,45	0,12	0,16	0,16	0,17
VIX_3	0,07	0,03	0,03	0,03	0,03
REAL INTEREST_2	0,00	0,00	0,00	0,00	0,00
INDUSTRY R_2	-1,11	0,44	0,53	0,50	0,53
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	0,01	1,51	1,81	1,51	1,47
S&P	1,45	11,91	9,37	9,16	8,56
VIX_3	0,07	2,28	2,31	2,07	1,95
REAL INTEREST_2	0,00	-2,12	-5,64	-6,37	-0,54
INDUSTRY R_2	-1,11	-2,52	-2,11	-2,22	-2,12

Ballard Power Systems	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,01	0,02	-0,82	0,41	0,01
S&P	1,40	0,32	4,40	0,00	0,16
sigma	0,18	RSS	3,33		
R^2	0,16	F(1,101)	=	19,37	[0,000]**
Adj,R^2	0,15	log-likelihood	30,57		
no,of observations	103	no, Of parameters	103	2	
mean(Y)	-0,01	se(Y)	0,20		
AR 1-2 test:	F(2,99)	=	1,07	[0,3454]	
ARCH 1-1 test:	F(1,101)	=	0,19	[0,6638]	
Normality test:	Chi^2(2)	=	17,50	[0,0002]**	
Hetero test:	F(2,100)	=	4,68	[0,0114]*	
Hetero-X test:	F(2,100)	=	4,68	[0,0114]*	
RESET23 test:	F(2,99)	=	0,85	[0,4303]	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,01	0,02	0,02	0,02	0,02
S&P	1,40	0,32	0,31	0,35	0,36
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,01	-0,82	-0,88	-0,85	-0,85
S&P	1,40	4,40	4,55	4,05	3,90

Itron Inc	Coefficient	Std,Error	t-value	t-prob	Part,R^2
Constant	-0,02	0,01	-2,49	0,01	0,06
S&P	1,41	0,14	9,77	0,00	0,49
INDUSTRY R	-1,42	0,47	-3,00	0,00	0,08
INFLATION	4,36	1,94	2,24	0,03	0,05
CREDIT SPREAD_3	0,31	0,08	3,76	0,00	0,13
sigma	0,08	RSS	0,56		
R^2	0,64	F(4,98)	=	43,64	[0,000]**
Adj,R^2	0,63	log-likelihood	122,33		
no,of observations	103	no, Of parameters	5		
mean(Itron	Inc)	-0,01	se(Itron	Inc)	0,12
AR 1-2 test:	F(2,96)	=	3,42	[0,0367]*	
ARCH 1-1 test:	F(1,101)	=	0,92	[0,3398]	
Normality test:	Chi^2(2)	=	5,82	[0,0544]	
Hetero test:	F(8,94)	=	9,48	[0,0000]**	
Hetero-X test:	F(14,88)	=	5,52	[0,0000]**	
RESET23 test:	F(2,96)	=	3,72	[0,0278]*	
Robust	standard	errors			
	Coefficients	SE	HACSE	HCSE	JHCSE
Constant	-0,02	0,01	0,01	0,01	0,01
S&P	1,41	0,14	0,17	0,20	0,23
INDUSTRY R	-1,42	0,47	0,39	0,45	0,48
INFLATION	4,36	1,94	2,20	2,83	3,40
CREDIT SPREAD_3	0,31	0,08	0,09	0,10	0,11
	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	-0,02	-2,49	-3,25	-2,24	-1,95
S&P	1,41	9,77	8,36	6,96	6,28
INDUSTRY R	-1,42	-3,00	-3,61	-3,18	-2,99
INFLATION	4,36	2,24	1,98	1,54	1,28
CREDIT SPREAD_3	0,31	3,76	3,53	3,25	2,89

S&P	Coefficient	Std,Error	t-value	t-prob	Part,R^2	
Constant	0,01	0,00	3,28	0,00	0,10	
INDUSTRY R_2	1,03	0,20	5,08	0,00	0,22	
INDUSTRY R_3	0,85	0,20	4,21	0,00	0,16	
OILr_2	0,14	0,04	3,37	0,00	0,11	
VIX	-0,16	0,01	-12,40	0,00	0,62	
INFLATION_2	-4,28	1,08	-3,97	0,00	0,14	
INFLATION_3	2,86	0,86	3,32	0,00	0,10	
INFLATION_5	-4,00	0,76	-5,24	0,00	0,23	
CREDIT SPREAD_2	-0,08	0,03	-2,66	0,01	0,07	
sigma	0,03	RSS	0,08			
R^2	0,76	F(8,94)	=	36,50	[0,000]**	
Adj,R^2	0,74	log-likelihood	223,15			
no,	of	observations	103	no,	of	parameters
mean(S&P)	0,00	se(S&P)	0,06			
AR	1-2	test:	F(2,92)	=	2,46	[0,0907]
ARCH	1-1	test:	F(1,101)	=	2,36	[0,1275]
Normality	test:	Chi^2(2)	=	8,16	[0,0169]*	
Hetero	test:	F(16,86)	=	2,57	[0,0027]**	
Hetero-X	test:	F(44,58)	=	2,96	[0,0001]**	
RESET23	test:	F(2,92)	=	0,73	[0,4862]	
Robust	standard	errors				
	Coefficients	SE	HACSE	HCSE	JHCSE	
Constant	0,01	0,00	0,00	0,00	0,00	
INDUSTRY R_2	1,03	0,20	0,24	0,27	0,30	
INDUSTRY R_3	0,85	0,20	0,26	0,26	0,30	
OILr_2	0,14	0,04	0,03	0,04	0,04	
VIX	-0,16	0,01	0,02	0,01	0,02	
INFLATION_2	-4,28	1,08	1,25	1,21	1,45	
INFLATION_3	2,86	0,86	1,43	1,13	1,39	
INFLATION_5	-4,00	0,76	0,92	1,18	1,51	
CREDIT SPREAD_2	-0,08	0,03	0,03	0,03	0,03	

	Coefficients	t-SE	t-HACSE	t-HCSE	t-JHCSE
Constant	0,01	3,28	4,29	3,50	3,04
INDUSTRYR_2	1,03	5,08	4,27	3,80	3,39
INDUSTRYR_3	0,85	4,21	3,32	3,28	2,83
OILr_2	0,14	3,37	4,53	3,61	3,12
VIX	-0,16	-12,40	-8,63	-10,81	-9,43
INFLATION_2	-4,28	-3,97	-3,41	-3,54	-2,96
INFLATION_3	2,86	3,32	1,99	2,53	2,05
INFLATION_5	-4,00	-5,24	-4,34	-3,40	-2,65
CREDIT SPREAD_2	-0,08	-2,66	-3,10	-3,31	-2,86

Appendix H Summary Specification tests

Normality test: A common test to explore whether residual are normal distributed, is the Jarque Bera[14] test. If residuals are not normally distributed, the t and f- statistics becomes less reliable, and hypothesis testing becomes uncertain. If the t and f values are not normally distributed, the significance level of the parameters becomes uncertain. The p-values for the test statistics show normally distributed residuals for 15 of the companies, while 11 shows signs of a distribution that is not normally distributed. [15]

Heteroscedasticity test is a test that measures if the variance of the residuals is stable. In the presence of heteroscedasticity, the hypothesis-testing is not reliable, raising the possibility of misleading conclusions. 10 of our companies initially showed signs of heteroscedasticity. To deal with the heteroscedasticity, the 10 companies were regressed with robust standard errors. The results from the regression with robust standard errors, is included in the appendix. The heteroscedasticity problem was severely reduced when the regression was run with robust standard errors. . When

[14] The description of the Jarque Bera test is included in the section with descriptive statistics.
[15] Table with all specification tests are included in Appendix E

heteroscedasticity occur, OLS estimators are still linear and unbiased, but they are no longer efficient. Hypothesis testing with t and f values becomes

AR 1-2 Tests for autocorrelation in the residuals. It is a test to see if residuals are correlated over time. $E(u_i, u_j) = 0,\ I \neq J$. If residuals are correlated over time, the effect from one observation, might spill over to other observations and the presence of autocorrelation blurs the picture about the correlation between the independent variables and the dependent variable. 4 out of 26 firms showed some signs of autocorrelation when a 5% significance level was used.

ARCH test, tests if the residuals are correlated with explanatory variables. 4 of the 26 companies showed signs of time varying variance in the residuals. AVX, Hexcel, Itron and On Semiconductor fails the ARCH test.

Reset test whether a linear specification is valied. OLS regression is a linear regression model. The reset test detect omission of variables and/or wrong functional form. Fairchild semiconductor, Green plains, Hexcel, Microsemi and Veeco showed failed the Reset test.

Appendix I Numeric tables for figures

Table for figure 7 and figur 8

	difference	Adj R^2(1)	Adj R^2(2)
Universal Display	-0,08 %	21,04 %	20,96 %
Canadian Solar	-0,06 %	41,72 %	41,66 %
Ballard Power Systems	0,00 %	14,92 %	14,92 %
AVX Corporation	0,00 %	43,44 %	43,44 %
8point3 Energy Partners LP	0,00 %	38,01 %	38,01 %
Advanced Energy	0,00 %	46,60 %	46,60 %

Maxwell Technologies	0,00 %	17,06 %	17,06 %
ON Semiconductor	0,00 %	55,00 %	55,00 %
Hexcel Corporation	0,00 %	46,59 %	46,59 %
First Solar Inc	1,80 %	22,36 %	24,16 %
Ja Solar Holdnings	2,68 %	49,98 %	52,66 %
EnerNOC Inc	2,96 %	10,64 %	13,60 %
Fairchild Semiconductor	3,53 %	64,20 %	67,72 %
IXYS Corporation	4,49 %	14,98 %	19,47 %
Veeco Instruments	5,95 %	52,66 %	58,61 %
Trina Solar Ltd	6,73 %	41,00 %	47,73 %
Acuity Brands, Inc	7,27 %	51,08 %	58,34 %
Plug Power Inc	8,65 %	9,66 %	18,31 %
Ormat Technologies Inc	9,18 %	30,40 %	39,58 %
Pacific Ethanol	9,76 %	13,47 %	23,23 %
Itron Inc	10,03 %	48,58 %	58,60 %
Intevac Inc	13,97 %	38,98 %	52,95 %
Green Plains Inc	19,85 %	20,62 %	40,47 %
Cree Inc	19,92 %	18,83 %	38,76 %
Power Integrations	20,12 %	31,22 %	51,35 %
Microsemi Corp	21,39 %	26,47 %	47,86 %

Monthly descriptive statistics 2007-2016										
	Mean	andard Err	Median	dard Devia	Kurtosis	Skewness	Range	Minimum	Maximum	Count
S & P 500	0,36 %	0,44 %	0,95 %	4,61 %	2,047	-0,912	28,79 %	-18,56 %	10,23 %	110
8point3 Energy Partners LP	0,50 %	2,61 %	-1,15 %	27,40 %	0,775	-0,145	159,18 %	-87,80 %	71,38 %	110
Acuity Brands Inc	1,48 %	1,01 %	2,49 %	10,54 %	1,218	-0,273	63,54 %	-31,41 %	32,13 %	110
Advanced Energy	0,44 %	1,38 %	0,09 %	14,51 %	1,166	-0,231	84,40 %	-44,66 %	39,74 %	110
AVX Corporation	-0,25 %	0,67 %	0,04 %	7,03 %	-0,278	-0,194	31,31 %	-18,20 %	13,10 %	110
Ballard Power Systems	-0,74 %	1,85 %	-4,31 %	19,38 %	2,002	0,998	116,29 %	-43,85 %	72,44 %	110
Cree Inc	0,13 %	1,31 %	0,48 %	13,73 %	-0,314	-0,135	62,37 %	-29,04 %	33,32 %	110
EnerNOC Inc	-1,47 %	1,94 %	-0,52 %	20,33 %	2,983	-0,805	135,02 %	-85,92 %	49,10 %	110
Fairchild Semiconductor	0,05 %	1,47 %	-0,24 %	15,40 %	2,450	-0,237	109,24 %	-57,98 %	51,26 %	110
Green Plains Inc	0,09 %	2,14 %	0,75 %	22,48 %	4,920	0,994	155,09 %	-59,70 %	95,39 %	110
Hexcel Corporation	0,57 %	1,26 %	0,91 %	13,22 %	8,286	-1,851	101,00 %	-69,08 %	31,91 %	110
Intevac Inc	-1,10 %	1,49 %	-1,24 %	15,58 %	2,846	-0,729	109,72 %	-70,58 %	39,14 %	110
Itron Inc	-0,44 %	1,19 %	-0,50 %	12,49 %	4,881	-0,781	99,06 %	-57,90 %	41,15 %	110
IXYS Corporation	0,15 %	1,23 %	-0,03 %	12,89 %	1,890	0,038	85,79 %	-36,87 %	48,92 %	110
Ja Solar Holdings Co Ltd ADR	-1,51 %	2,25 %	-0,42 %	23,57 %	1,855	-0,660	142,51 %	-84,35 %	58,16 %	110
Maxwell Technologies	-0,89 %	1,82 %	1,28 %	19,13 %	2,079	-0,919	108,62 %	-74,07 %	34,55 %	110
Microsemi Corp	0,46 %	1,04 %	0,81 %	10,96 %	1,916	-0,862	65,31 %	-42,39 %	22,92 %	110
Trina Solar Ltd	-0,66 %	2,21 %	-0,22 %	23,18 %	2,436	-0,610	158,83 %	-97,27 %	61,55 %	110
Universal Display	1,43 %	1,73 %	1,80 %	18,11 %	1,018	0,060	105,76 %	-53,47 %	52,29 %	110
Veeco Instruments	-0,07 %	1,58 %	0,61 %	16,61 %	3,477	0,023	118,26 %	-55,69 %	62,58 %	110
Canadian Solar	0,40 %	2,59 %	-2,07 %	27,19 %	0,728	-0,072	159,18 %	-87,80 %	71,38 %	110
First Solar Inc	-0,33 %	1,81 %	0,01 %	18,98 %	0,077	-0,082	105,01 %	-51,54 %	53,47 %	110
ON Semiconductor	-0,07 %	1,34 %	0,85 %	14,07 %	4,552	-0,947	104,65 %	-68,94 %	35,70 %	110
Ormat Technologies Inc	0,23 %	1,03 %	1,24 %	10,82 %	1,168	-0,815	57,98 %	-32,83 %	25,15 %	110
Pacific Ethanol	-4,87 %	3,02 %	-5,22 %	31,70 %	2,946	0,788	198,70 %	-81,99 %	116,71 %	110
Plug Power Inc	-2,60 %	2,70 %	-3,01 %	28,29 %	4,897	-0,041	209,40 %	-105,57 %	103,84 %	110
Power Integrations	0,58 %	0,98 %	1,26 %	10,32 %	0,447	-0,178	58,81 %	-29,94 %	28,88 %	110

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