Π.Μ.Σ Οικονομική Ανάλυση

Η αξιολόγηση ενεργειακών διαπραγματεύσιμων αμοιβαίων κεφαλαίων μέσω διαφορετικών επενδυτικών στρατηγικών και παραμετροποιήσεων.

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1. Introduction

Exchange-traded funds (ETFs) are variants of mutual funds that first came to life in the early 1990s. ETFs allow market participants to trade index portfolios, similar to how individual investors trade shares of a stock. They seek to track the value and volatility of an underlying benchmark index through the construction of portfolios replicative of the index's constituents.

By owning an ETF, investors get the diversification of an index fund as well as the ability to sell short, buy on margin and purchase as little as one share (there are no minimum deposit requirements). Another advantage is that the expense ratios for most ETFs are lower than those of the average mutual fund. When buying and selling ETFs, you have to pay the same commission to your broker that you'd pay on any regular order

There exists potential for favorable taxation on cash flows generated by the ETF, since capital gains from sales inside the fund are not passed through to shareholders as they commonly are with mutual funds.

The reason for the growth in popularity of ETFs over recent years can be attributed to a number of advantages that they offer over other index-linked products. Tax efficiency and lower expenses are the two most frequently mooted draws for investors, with another being smaller transaction quantities than equivalent futures products, a feature allowing retail investors the opportunity to participate in the market. ETFs provide diversification satisfying broad exposure, be it market wide or sectoral coverage, with sectoral ETFs facilitating hedging requirements. As, Yu (2005) and Alexander and Barbosa (2008) observe, ETFs do not have short selling restrictions in the same manner as regular stocks so they may be more useful for hedging. Lastly, ETFs are not subject to the uptick rule, which Curcio, Lipka and Thornton(2004) suggest as another benefit for shareholders.

The main findings of their study are summarized as follows: First, evidence of significant and asymmetric return spillovers between Chinese new energy and fossil fuel stock prices is found based on daily samples taken from August 30, 2006 to

September 11, 2012. Further, negative news about new energy and fossil fuel stock returns both spill over into higher returns of their counter assets. Second, in terms of volatility spillover, both new energy and fossil fuel stock news spills over into variances of their counter assets. The increases in fossil fuel stock return volatilities are higher for the negative shocks of the fossil fuel stock returns than for the positive ones. Volatility spillovers depend complexly on the respective signs of the return shocks of each asset. (Wen et al., 2014).

Clean energy has several advantages over fossil-type of sources, i.e. it can meet the increasing demand for energy, while it can significantly reduce carbon dioxide (CO2) emissions. Furthermore, its widely use has come as a result of the implementation of a number of clean environmental and energy policies for the reduction of of CO2 emissions and the efficient use of energy.(Paramati et al., 2016)

In this study we examine clean and conventional energy related ETFs and attempt to answer which is more efficient in terms of higher returns and lower risk exposure, and where analysts should shed more light into: A smart selected strategy or a careful parametrization of this strategy ,also if this varies when Clean Energy (CLE) or Convetional Energy(COE) ETFs are included in a portfolio. The rest of the paper is structured as follows: in Section 2 we present the definition of ETF, in Section 3 we present a literature review; in section 4 we present our methodology and investment strategies and the data used in the paper; in Section 5 we present a summary discussion of our results; and Section 6 concludes.

2. Definition of 'Exchange-Traded Fund (ETF)

An ETF, or exchange-traded fund, is a marketable security that tracks an index, a commodity, bonds, or a basket of assets like an index fund. Unlike mutual funds, an ETF trades like a common stock on a stock exchange. ETFs experience price changes throughout the day as they are bought and sold. ETFs typically have higher daily liquidity and lower fees than mutual fund shares, making them an attractive alternative for individual investors.

Because it trades like a stock, an ETF does not have its net asset value (NAV) calculated once at the end of every day like a mutual fund does.

ETF distributors only buy or sell ETFs directly from or to authorized participants, which are large broker-dealers with whom they have entered into agreements—and then, only in creation units, which are large blocks of tens of thousands of ETF shares, usually exchanged in-kind with baskets of the underlying securities. Authorized participants may wish to invest in the ETF shares for the long-term, but they usually act as market makers on the open market, using their ability to exchange creation units with their underlying securities to provide liquidity of the ETF shares and help ensure that their intraday market price approximates the net asset value of the underlying assets. Other investors, such as individuals using a retail broker, trade ETF shares on this secondary market.

An ETF combines the valuation feature of a mutual fund or unit investment trust, which can be bought or sold at the end of each trading day for its net asset value, with the tradability feature of a closed-end fund, which trades throughout the trading day at prices that may be more or less than its net asset value. Closed-end funds are not considered to be ETFs, even though they are funds and are traded on an exchange. ETFs have been available in the US since 1993 and in Europe since 1999. ETFs traditionally have been index funds, but in 2008 the U.S. Securities and Exchange Commission began to authorize the creation of actively managed ETFs.

ETFs offer both tax efficiency as well as lower transaction and management costs. More than US$2 trillion were invested in ETFs in the United States between when they were introduced in 1993 and 2015. By the end of 2015, ETFs offered "1,800 different products, covering almost every conceivable market sector, niche and trading strategy".

2.1 Structure

An ETF is a type of fund. It owns assets (bonds, stocks, gold bars, etc.) and divides ownership of itself into shares that are held by shareholders. The details of the structure (such as a corporation or trust) will vary by country, and even within one country there may be multiple possible structures. The shareholders indirectly own the assets of the fund, and they will typically get an annual report. Shareholders are entitled to a share of the profits, such as interest or dividends, and they may get a residual value in case the fund is liquidated. Their ownership interest in the fund can easily be bought and sold.

ETFs are similar in many ways to traditional mutual funds, except that shares in an ETF can be bought and sold throughout the day like stocks on a stock exchange through a broker-dealer. Unlike traditional mutual funds, ETFs do not sell or redeem their individual shares at net asset value (NAV). Instead, financial institutions purchase and redeem ETF shares directly from the ETF, but only in large blocks (such as 50,000 shares), called creation units. Purchases and redemptions of the creation units generally are in kind, with the institutional investor contributing or receiving a basket of securities of the same type and proportion held by the ETF, although some ETFs may require or permit a purchasing or redeeming shareholder to substitute cash for some or all of the securities in the basket of assets.

The ability to purchase and redeem creation units gives ETFs an arbitrage mechanism intended to minimize the potential deviation between the market price and the net asset value of ETF shares. Existing ETFs have transparent portfolios, so institutional investors will know exactly what portfolio assets they must assemble if they wish to purchase a creation unit, and the exchange disseminates the updated net asset value of the shares throughout the trading day, typically at 15-second intervals.

If there is strong investor demand for an ETF, its share price will temporarily rise above its net asset value per share, giving arbitrageurs an incentive to purchase additional creation units from the ETF and sell the component ETF shares in the open market. The additional supply of ETF shares reduces the market price per share, generally eliminating the premium over net asset value. A similar process applies when there is weak demand for an ETF: its shares trade at a discount from net asset value.

2.2 Investment uses

ETFs generally provide the easy diversification, low expense ratios, and tax efficiency of index funds, while still maintaining all the features of ordinary stock, such as limit orders, short selling, and options. Because ETFs can be economically acquired, held, and disposed of, some investors invest in ETF shares as a long-term investment for asset allocation purposes, while other investors trade ETF shares frequently to implement market timing investment strategies.

By owning an ETF, investors get the diversification of an index fund as well as the ability to sell short, buy on margin and purchase as little as one share (there are no

minimum deposit requirements). Another advantage is that the expense ratios for most ETFs are lower than those of the average mutual fund. When buying and selling ETFs, you have to pay the same commission to your broker that you'd pay on any regular order.

There exists potential for favorable taxation on cash flows generated by the ETF, since capital gains from sales inside the fund are not passed through to shareholders as they commonly are with mutual funds.

Among the advantages of ETFs are the following:

- Lower costs: ETFs generally have lower costs than other investment products because most ETFs are not actively managed and because ETFs are insulated from the costs of having to buy and sell securities to accommodate shareholder purchases and redemptions. ETFs typically have lower marketing, distribution and accounting expenses, and most ETFs do not have 12b-1 fees.

- Buying and selling flexibility: ETFs can be bought and sold at current market prices at any time during the trading day, unlike mutual funds and unit investment trusts, which can only be traded at the end of the trading day. As publicly traded securities, their shares can be purchased on margin and sold short, enabling the use of hedging strategies, and traded using stop orders and limit orders, which allow investors to specify the price points at which they are willing to trade.

- Tax efficiency: ETFs generally generate relatively low capital gains, because they typically have low turnover of their portfolio securities. While this is an advantage they share with other index funds, their tax efficiency is further enhanced because they do not have to sell securities to meet investor redemptions.

- Market exposure and diversification: ETFs provide an economical way to rebalance portfolio allocations and to "equitize" cash by investing it quickly. An index ETF inherently provides diversification across an entire index. ETFs offer exposure to a diverse variety of markets, including broad-based indices, broad-based international and country-specific indices, industry sector-specific indices, bond indices, and commodities.

- Versatility: ETFs are traded throughout the day in the same way as stocks, their prices fluctuating with supply and demand in the market. Investors can sell ETFs short and use all the various order types used with stocks to enter and exit the market. ETFs normally have the same commissions as stocks and can be traded on margin. Additionally, the barriers to entry are low, as an investor can purchase as little as one share of an ETF.

- Transparency: Unlike mutual funds, the holdings of an indexed ETF are readily visible, either in their prospectus or on their website, so you can always know what you own. While mutual funds are only required to disclose their portfolios on a quarterly or semiannual basis, all "actively managed" ETFs must by law disclose their full portfolios every day. Active management refers to the use of a discretionary element, where management actively decides on which assets to include in a fund.

Some of these advantages derive from the status of most ETFs as index funds.

2.3 Types of ETFs

- ***Index ETFs***

Most ETFs are index funds that attempt to replicate the performance of a specific index. Indexes may be based on stocks, bonds, commodities, or currencies. An index fund seeks to track the performance of an index by holding in its portfolio either the contents of the index or a representative sample of the securities in the index. As of June 2012, in the United States, about 1200 index ETFs exist, with about 50 actively managed ETFs. Index ETF assets are about $1.2 trillion, compared with about $7 billion for actively managed ETFs. Some index ETFs, known as leveraged ETFs or inverse ETFs, use investments in derivatives to seek a return that corresponds to a multiple of, or the inverse (opposite) of, the daily performance of the index.

Some index ETFs invest 100% of their assets proportionately in the securities underlying an index, a manner of investing called replication. Other index ETFs use representative sampling, investing 80% to 95% of their assets in the securities of an underlying index and investing the remaining 5% to 20% of their assets in other holdings, such as futures, option and swap contracts, and securities not in the

underlying index, that the fund's adviser believes will help the ETF to achieve its investment objective. There are various ways the ETF can be weighted, such as equal weighting or revenue weighting. For index ETFs that invest in indices with thousands of underlying securities, some index ETFs employ "aggressive sampling" and invest in only a tiny percentage of the underlying securities.

- ***Stock ETFs***

The first and most popular ETFs track stocks. Many funds track national indexes; for example, Vanguard Total Stock Market ETF NYSE Arca: VTI tracks the CRSP U.S. Total Market Index, and several funds track the S&P 500, both indexes for US stocks. Other funds own stocks from many countries; for example, Vanguard Total International Stock Index NYSE Arca: VXUS tracks the MSCI All Country World ex USA Investable Market Index, while the iShares MSCI EAFE Index NYSE Arca: EFA tracks the MSCI EAFE Index, both "world ex-US" indexes.

Stock ETFs can have different styles, such as large-cap, small-cap, growth, value, et cetera. For example, the S&P 500 index is large- and mid-cap, so the SPDR S&P 500 ETF will not contain small-cap stocks. Others such as iShares Russell 2000 are mainly for small-cap stocks. There are many style ETFs such as iShares Russell 1000 Growth and iShares Russell 1000 Value. ETFs focusing on dividends have been popular in the first few years of the 2010s decade, such as iShares Select Dividend.

ETFs can also be sector funds. These can be broad sectors, like finance and technology, or specific niche areas, like green power. They can also be for one country or global. Critics have said that no one needs a sector fund. This point is not really specific to ETFs; the issues are the same as with mutual funds. The funds are popular since people can put their money into the latest fashionable trend, rather than investing in boring areas with no "cachet".

- ***Bond ETFs***

Exchange-traded funds that invest in bonds are known as bond ETFs. They thrive during economic recessions because investors pull their money out of the stock market and into bonds (for example, government treasury bonds or those issued by companies regarded as financially stable). Because of this cause and effect relationship, the performance of bond ETFs may be indicative of broader economic

conditions. There are several advantages to bond ETFs such as the reasonable trading commissions, but this benefit can be negatively offset by fees if bought and sold through a third party.

- ***Commodity ETFs***

Commodity ETFs (CETFs or ETCs) invest in commodities, such as precious metals, agricultural products, or hydrocarbons. Among the first commodity ETFs were gold exchange-traded funds, which have been offered in a number of countries. The idea of a Gold ETF was first officially conceptualised by Benchmark Asset Management Company Private Ltd in India when they filed a proposal with the SEBI in May 2002. The first gold exchange-traded fund was Gold Bullion Securities launched on the ASX in 2003, and the first silver exchange-traded fund was iShares Silver Trust launched on the NYSE in 2006. As of November 2010 a commodity ETF, namely SPDR Gold Shares, was the second-largest ETF by market capitalization.

However, generally commodity ETFs are index funds tracking non-security indices. Because they do not invest in securities, commodity ETFs are not regulated as investment companies under the Investment Company Act of 1940 in the United States, although their public offering is subject to SEC review and they need an SEC no-action letter under the Securities Exchange Act of 1934. They may, however, be subject to regulation by the Commodity Futures Trading Commission.

The earliest commodity ETFs, such as SPDR Gold Shares (NYSE Arca: GLD) and iShares Silver Trust (NYSE Arca: SLV), owned the physical commodity (e.g., gold and silver bars). Similar to these are ETFS Physical Palladium (NYSE Arca: PALL) and ETFS Physical Platinum (NYSE Arca: PPLT). However, most ETCs implement a futures trading strategy, which may produce quite different results from owning the commodity.

Commodity ETFs trade just like shares, are simple and efficient and provide exposure to an ever-increasing range of commodities and commodity indices, including energy, metals, softs and agriculture. However, it is important for an investor to realize that there are often other factors that affect the price of a commodity ETF that might not be immediately apparent. For example, buyers of an oil ETF such as USO might think that as long as oil goes up, they will profit roughly linearly. What isn't clear to the novice investor is the method by which these funds gain exposure to their underlying

commodities. In the case of many commodity funds, they simply roll so-called front-month futures contracts from month to month. This does give exposure to the commodity, but subjects the investor to risks involved in different prices along the term structure, such as a high cost to roll.

ETC can also refer to exchange-traded notes, which are not exchange-traded funds.

- ***Currency ETFs***

In 2005, Rydex Investments launched the first currency ETF called the Euro Currency Trust (NYSE Arca: FXE) in New York. Since then Rydex has launched a series of funds tracking all major currencies under their brand CurrencyShares. In 2007 Deutsche Bank's db x-trackers launched EONIA Total Return Index ETF in Frankfurt tracking the euro, and later in 2008 the Sterling Money Market ETF (LSE: XGBP) and US Dollar Money Market ETF (LSE: XUSD) in London. In 2009, ETF Securities launched the world's largest FX platform tracking the MSFXSM Index covering 18 long or short USD ETC vs. single G10 currencies. The funds are total return products where the investor gets access to the FX spot change, local institutional interest rates and a collateral yield.

- ***Actively managed ETFs***

Most ETFs are index funds, but some ETFs do have active management. Actively managed ETFs have been offered in the United States only since 2008. The first active ETF was Bear Stearns Current Yield ETF (Ticker: YYY). Currently, actively managed ETFs are fully transparent, publishing their current securities portfolios on their web sites daily. However, the SEC indicated that it was willing to consider allowing actively managed ETFs that are not fully transparent in the future, and later actively managed ETFs have sought alternatives to full transparency.

The fully transparent nature of existing ETFs means that an actively managed ETF is at risk from arbitrage activities by market participants who might choose to front run its trades as daily reports of the ETF's holdings reveals its manager's trading strategy. The initial actively managed equity ETFs addressed this problem by trading only weekly or monthly. Actively managed debt ETFs, which are less susceptible to front-running, trade their holdings more frequently.

The actively managed ETF market has largely been seen as more favorable to bond funds, because concerns about disclosing bond holdings are less pronounced, there are fewer product choices, and there is increased appetite for bond products. Pimco's Enhanced Short Duration ETF NYSE: MINT is the largest actively managed ETF, with approximately $3.93 billion in assets as of May 16, 2014.

Actively managed ETFs grew faster in their first three years of existence than index ETFs did in their first three years of existence. As track records develop, many see actively managed ETFs as a significant competitive threat to actively managed mutual funds. However, many academic studies have questioned the value of active management. Jack Bogle of Vanguard Group wrote an article in the Financial Analysts Journal where he estimated that higher fees as well as hidden costs (such a more trading fees and lower return from holding cash) reduce returns for investors by around 2.66 percentage points a year "a huge differential considering that long-term real returns from American equities have been 6.45%." Even without considering hidden costs, high fees negatively affect long-term performance. In another Financial Analysts Journal article, Nobel laureate, Bill Sharpe "calculated that someone who saved via a low-cost fund would have a standard of living in retirement 20% higher than someone who saved in a high-cost fund".

- ***Exchange-traded grantor trusts***

An exchange-traded grantor trust was used to give a direct interest in a static basket of stocks selected from a particular industry. Such products have some properties in common with ETFs—low costs, low turnover, and tax efficiency: but are generally regarded as separate from ETFs. The leading example was Holding Company Depositary Receipts, or HOLDRs, a proprietary Merrill Lynch product, but these have now disappeared from the scene. SPDR Gold Shares is a grantor trust.

- ***Inverse ETFs***

Inverse ETFs are constructed by using various derivatives for the purpose of profiting from a decline in the value of the underlying benchmark. It is a similar type of investment to holding several short positions or using a combination of advanced investment strategies to profit from falling prices. Many inverse ETFs use daily futures as their underlying benchmark.

- ***Leveraged ETFs***

Leveraged exchange-traded funds (LETFs or leveraged ETFs) are a type of ETF that attempt to achieve returns that are more sensitive to market movements than non-leveraged ETFs. Leveraged index ETFs are often marketed as bull or bear funds. A leveraged bull ETF fund might for example attempt to achieve daily returns that are 2x or 3x more pronounced than the Dow Jones Industrial Average or the S&P 500. A leveraged inverse (bear) ETF fund on the other hand may attempt to achieve returns that are -2x or -3x the daily index return, meaning that it will gain double or triple the loss of the market. Leveraged ETFs require the use of financial engineering techniques, including the use of equity swaps, derivatives and rebalancing, and re-indexing to achieve the desired return. The most common way to construct leveraged ETFs is by trading futures contracts.

The rebalancing and re-indexing of leveraged ETFs may have considerable costs when markets are volatile. The rebalancing problem is that the fund manager incurs trading losses because he needs to buy when the index goes up and sell when the index goes down in order to maintain a fixed leverage ratio. A 2.5% daily change in the index will for example reduce value of a -2x bear fund by about 0.18% per day, which means that about a third of the fund may be wasted in trading losses within a year (1-(1-0.18%)252=36.5%). Investors may however circumvent this problem by buying or writing futures directly, accepting a varying leverage ratio.[citation needed] A more reasonable estimate of daily market changes is 0.5%, which leads to a 2.6% yearly loss of principal in a 3x leveraged fund.

The re-indexing problem of leveraged ETFs stems from the arithmetic effect of volatility of the underlying index. Take, for example, an index that begins at 100 and a 2X fund based on that index that also starts at 100. In a first trading period (for example, a day), the index rises 10% to 110. The 2X fund will then rise 20% to 120. The index then drops back to 100 (a drop of 9.09%), so that it is now even. The drop in the 2X fund will be 18.18% (2*9.09). But 18.18% of 120 is 21.82. This puts the value of the 2X fund at 98.18. Even though the index is unchanged after two trading periods, an investor in the 2X fund would have lost 1.82%. This decline in value can be even greater for inverse funds (leveraged funds with negative multipliers such as -1, -2, or -3). It always occurs when the change in value of the underlying index

changes direction. And the decay in value increases with volatility of the underlying index.

The effect of leverage is also reflected in the pricing of options written on leveraged ETFs. In particular, the terminal payoff of a leveraged ETF European/American put or call depends on the realized variance (hence the path) of the underlying index. The impact of leverage ratio can also be observed from the implied volatility surfaces of leveraged ETF options. For instance, the implied volatility curves of inverse leveraged ETFs (with negative multipliers such as -1, -2, or -3) are commonly observed to be increasing in strike, which is characteristically different from the implied volatility smiles or skews seen for index options or non-leveraged ETF options.

2.4 Going Green With Exchange Traded Funds

Exchange traded funds, or ETFs as they are commonly known, are investment funds that are traded on a stock exchange. Investors have a wide variety of ETFs from which to choose, from those that track a major market Index to ETFs that track a basket of foreign currencies. Another type of exchange traded funds are green ETFs, or those that focus on companies that support or are directly involved with environmentally responsible technologies, such as the development of alternative energy or the manufacturing of green technology equipment and devices. Today's investors have access to a growing number of green ETFs, allowing them to incorporate environmentally friendly strategies in their investment decisions.

2.4.1 What Is a Green Investment?

Green investing, whether it pertains to ETFs, mutual funds or individual stocks, refers to investment activity that focuses on companies whose business supports or promotes conservation efforts, alternative energy, clean air and water projects and other environmentally responsible business decisions. The majority of green ETFs focus on companies involved directly or indirectly with the research, development, production and providing of alternative energy. Companies may be distributors of alternative energy or may be manufacturers of parts and equipment needed to produce the energy, such as the photovoltaic cells necessary for creating solar panels. Each ETF has its own criteria for determining the eligibility requirements for assets.

Considerations in Defining Green

Many new businesses are able - with careful planning - to go green from the start. Established companies, however, with years or decades of bad habits have to work extremely hard to turn their routines into environmentally friendly practices. This can leave companies with one foot in the old school, environmentally irresponsible group, and the other foot in the modern, green movement. Automobile manufacturers are good examples: the same company that is making gas-guzzling SUVs might also be on the forefront of developing hybrid and electric cars.

So what makes a company or an ETF green? Currently there are no strict rules regarding which companies or investment instruments are officially "green." Many of the considerations are a matter of opinion. For example, some people consider nuclear energy to be a clean and green energy choice, while others would argue that the toxic waste precludes it from being environmentally responsible. In general, it is up to each investor to decide if an investment instrument is green by his or her standards.

2.4.2 Green ETFs

Although each investor must decide if an investment is green, there are a growing number of ETFs that are based on companies that are actively engaged in the research and development of alternative energy sources; namely broad clean energy, wind, solar and nuclear:

- *Broad Clean Energy ETFs*

Broad clean energy exchange traded funds are involved in the alternative, renewable and clean energy sectors. ETFs based on broad clean energy include:

- **PowerShares WilderHill Clean Energy Portfolio (ARCA:PBW)** : This fund is based on the WilderHill Clean Energy Index and selects companies focused on greener and renewable energy sources and technology that facilitates cleaner energy. The fund has a large focus on holding small cap firms and implements a growth strategy investment approach.
- **iShares S&P Global Clean Energy Index Fund (Nasdaq:ICLN)**: This fund allocates its holdings to alternative energy including solar and wind, and to companies involved in biomass, ethanol and geothermal production. Its top

sector is semiconductors and semiconductor equipment with additional exposure to the utilities sector.

❖ Wind Power ETFs

Wind power converts wind energy into other forms of useful energy. Wind turbines are used to generate electricity, wind mills create mechanical power and giant sails can be used to provide thrust for ships. Energy production of wind power has increased, and more than 80 countries are using wind power on a commercial basis. ETFs based on wind power include:

- **First Trust Global Wind Energy (ARCA:FAN)**: This ETF is based on the ISE Global Wind Energy Index. A security component must be actively engaged in some aspect of the wind energy industry, such as the development of a wind farm, or the distribution of wind-generated electricity. Many of the holdings in this ETF are non-U.S. companies and as a result this ETF contains ADRs, GDRs and EDRs.

❖ Solar Power ETFs

Solar power harnesses the sun's energy and converts it into electricity, either directly using photovoltaic cells or indirectly using concentrated solar power (CSP). Germany, Canada and Spain are among the world leaders for solar innovation. The price drivers for solar ETFs include oil prices (which are generally positively correlated); government subsidies and incentives and technological developments. ETFs based on solar power include:

- **Market Vectors Solar Energy ETF (ARCA:KWT)**: This fund aims to replicate the yield performance of the capitalization weighted index Ardour Solar Energy Index. Domestic and international corporations are represented with significant investments in China, the United States and Germany.
- **Guggenheim Solar ETF (ARCA:TAN)**: This ETF is based on an index (the MAC Global Solar Energy Index) that tracks companies involved in the production of solar power equipment, the production of fabrication products or

services and companies that supply the raw materials that are utilized by the solar power equipment producers.

❖ Nuclear Energy ETFs

Nuclear power is the product of controlled nuclear reactions, and accounts for a rapidly growing percent of global electricity. Despite historical drawbacks such as Chernobyl and The Three Mile Island, utilities and miners have begun to focus their resources on uranium and nuclear energy. ETFs based on nuclear energy include:

- **Global X Uranium (ARCA:URA)**: This fund has a focus to replicate the after fee performance of the Solar Global Uranium Index. The fund's focus is on uranium mining, with a heavy weight on Canadian companies and capitalizing on the demand for the nuclear material.

Many green investments involve newer and smaller companies, which often equates to greater volatility and/or weak performance. That said, as these companies gain traction and the need for alternative energy is further realized and regulated, green investing will likely become an increasingly stable platform for investors.

2.5 Alternative ETFs

An exchange-traded fund (ETF) that invests in companies engaged in industries serving alternative energy production and research. Some companies found within alternative energy ETFs may only receive a portion of their revenues from alternative energy goods and services, while other (typically smaller) companies are wholly engaged in alternative or clean energy production. The underlying group of securities used to passively invest assets within these funds varies widely depending on the issuer. Some include many stocks while others have a narrower focus and are thus less diversified.

ETFs focused on alternative energy stocks represent a strong "green" investment. It's also an increasingly viable one, as countries and corporations pledge to power more and more of their activities with renewable energy, designed to invest broadly in securities that drive or depend on demand for particular kinds of renewable power.

Alternative energy has two important tailwinds funding its growth: the limitation of the world's natural resources and higher demand by environmentally conscientious consumers. Wind and solar usage in the United States and China, the world's two biggest energy consumers, is already increasing steeply.

Nevertheless, most green industries, like wind, solar and hydro energy, are still in their technological infancies, and are still developing profitable business models. Therefore, investors should expect to see high volatility as certain processes and technologies rise to the forefront while others prove to be unsuccessful. ETF's are a safer option than trying to predict the fortunes of individual companies.

Some alternative energy ETF's try to represent clean energy in its broadest sense by diversifying their holdings among many kinds of clean energy. These include the PowerShares WilderHill Clean Energy ETF (PBW), the S&P Global Clean Energy ETF (ICLN), the Nasdaq Clean Edge Green Energy Fund (QCLN), and Market Vectors' Global Alternative Energy ETF (GEX). Most of these funds were launched during a mid-to-late 2000's boom in alternative energy ETF's, and they tend to spread their holdings across wind, hydro and solar power, as well as investing in information technology and renewable electricity. Of these, the WilderHill fund is the oldest (launched in March of 2005 by Invesco) and at just under $100 million, has the most net assets.

Many other alternative energy funds focus on specific alternative energy industries. In terms of net assets, the biggest alternative energy fund in the world, as of 2016, is the Guggenheim Solar Energy ETF (TAN), launched in 2008. Other solar energy options include the Market Vectors Solar Energy ETF (KWT). One of the best options for wind energy is the ISE Global Wind Energy Index Fund (FAN).

Investors looking to gain a stake in clean or alternative energy sources should keep a close eye on developments in the energy sector; technologies are constantly changing, and every year brings new opportunities for investing in clean energy.

3. Literature review

There are a lot of studies which are concerned about energy ETFs but only this one is more focused on the strategy and which parameter is better. Chang et al.(2016) in

their paper investigated the co-volatility spillovers within and across the US energy and financial sectors for both spot and futures markets, from 1998/12/23 to 2016/4/22, by using "generated regressors" and Diagonal BEKK. Their results showed that there is a significant relationship between the Financial ETF and Energy ETF in the spot and futures markets, supporting the construction of a versatile portfolio with financial and energy ETFs together..

The main focus of this paper is to evaluate the financial performance of ETFs, comprised mainly of stocks of energy related firms, in different times of periods with the 2008 financial crisis and the 2014 fall of oil prices included. Towards this direction, we apply nine different strategies with a common set of parametrizations and make an initial comparison across all of them and with the buy & hold for standard ETFs that work as benchmarks. At a second level we select the best two out of the examined nine strategies and make a more comprehensive analysis with them, by applying a kind of sensitivity analysis, with different sets of parametrization in the number of the selected assets for rotation and the examined months as the lookback period. To the best of our knowledge, there has been no research trying to explore the financial performance of COE ETFs or CLE ETFs in the long-run and in shock periods, like the 2008 crisis or the 2014 nosedive of oil prices.

Sabbaghi (2011) in his study examined green exchange-traded funds (ETFs) and propose a market-wide proxy for green returns and a green volatility factor. Using a t-GARCH (1,1) specification model from 2006 to 2008, the author found strong evidence in favor of volatility persistence for the 15 green ETFs identified in his study.

Malinda and Hui (2016), in their study compared the long memory in volatility and asymmetric volatility of renewable and unrenewable ETFs, using three models. They found that renewable and unrenewable ETFs have a long memory in volatility and negative asymmetric volatility.

Wen et al.(2014) in their paper for stock prices of new energy and fossil fuel companies from China used the asymmetric BEKK model for daily data from 2006 to 2012 found that new energy and fossil fuel stocks are generally viewed as competing assets and so on good news about new energy stocks could affect the attractiveness of fossil fuel stocks and that new energy stock investment is more speculative and riskier

than fossil fuel stock investment. Also for China Reboredo and Wen(2015) find out that pre-and post-announcement energy legislation policies dampened price volatility in all sub sector indexes and that economic incentives had a positive policy announcement effect on all subsector index prices as it was expected. In addition, Reboredo (2015) by using copulas identifies systemic risk and dependence between oil and renewable energy markets. He found evidence that oil price dynamics contributes approximately by 30% to downside and upside risk of green energy companies.

On emerging economies Paramati et al.(2016) studied the impact of both FDI inflows and stock market developments on clean energy use across from 1991 to 2012. Their results show that FDI inflows and stock market developments have all a significant positive impact on clean energy consumption. Furthermore the results on heterogeneous panel non-causality tests indicate the presence of unidirectional causality running from FDI to clean energy consumption in the short-run. The findings also urge that both policy makers and governments in these 20 emerging market economies studied on their research should initiate effective public-private-partnership investments in clean energy projects by providing lucrative incentives, which, in turn, will encourage both domestic and foreign investors to invest more in clean energy projects and finally to move these economies to economic growth.

The risk spillovers between crude oil and stock markets were investigated from Du and He (2015). They used daily data of S&P 500 index and WTI crude oil futures returns. Their empirical results reveal that there are significant risk spillovers between S&P and WTI. Extreme movements, in one market may have a significant predictive power for those in the other market. Before the recent global financial crisis, there were positive risk spillovers from stock market to crude oil market, and negative spillovers from crude oil market to stock market. After the financial crisis, bidirectional positive risk spillovers are strengthened markedly.

Last, Reboredo et al. (2017), tested the co-movement and causality between oil and renewable energy stocks by using continuous wavelets and non-linear Granger causality tests in the time frequency domain. Their results suggest that non-linear causality runs from clean energy indices to oil prices.

4. Methodology and data

In this section we present the methodology and the data used. We have carefully selected representative COE and CLE ETFs based on their sectoral coverage. Our selection criterion is to include ETFs, whom underlying assets are energy related and at the same they collectively complement all the activities engaged in the energy industry. The selected ETFs are either from conventional or unconventional energy sources. Hence, we have included stocks of companies engaged in extraction, transformation, also in transportation and marketing of all kinds of energy products. All data have been acquired online (Yahoo finance; ETF.com) and they are dated from 1999 to 2016. Table A in the Annex presents in detail all the selected energy ETFs along with their tickers and a short description of them that works as a rationale for their selection in our research.

Next, we present the methodology which examines these two energy clusters of ETFs in aggregate and in separate. As already mentioned, we apply seven simple but straight forward investment strategies. The strategies or rotation criteria are: the plain Mean (AM), the Mean-Variance (MV), the Minimum Volatility (S), the Skewness (SK), the Kurtosis (KR), the Sharp-Ratio (SR) and the Normality Test (NT). A critical step in our methodology is the constant monthly rebalancing of the selected ETFs included in the examined ETFs groups, according to the predicted signs that came out of our strategies, or in other words the recurrent optimum asset rotation, based in the applied strategy each time

Thus, we first compute the cumulative return for each asset i, as follow:

$$R_{t,i}(m) = \left[\prod_{j=1}^{m-1}\left(1 + R_{t-j,i}\right)\right] - 1 \quad \text{(eq.1)}$$

where m stands for the look-back period. Then we rank all the ETFs (assuming k total assets) according to eq.1 and select the top r of them (highest return) in order to form an equally weighted portfolio return for next month. Therefore we have:

$$R_{t(1)}(m) \leq R_{t(2)}(m) \leq \cdots \leq R_{t(k-1)}(m) \leq R_{t(k)}(m) \quad \text{(eq.2)}$$

Starting from the first strategy, we compute the average return for the AM strategy, as in eq.3 below:

$$\mu_{t,i}(m) = \frac{1}{m}\sum_{j=0}^{m-1} R_{t-j,i} \text{ (eq.3)}$$

In the same way we proceed with the other strategies. Thus we compute the volatility for the S strategy as follows:

$$\sigma_{ti}(m) = \sqrt{\frac{1}{m}\sum_{j=0}^{m-1}\left(R_{t-j,i} - \mu_{t,i}(m)\right)^2} \quad \text{(eq.4)}$$

Furthermore, for the MV strategy we create the mean-variance utility, as in eq.(5) below.

$$U_{t,i}(m) = \mu_{t,i}(m) - \lambda\sigma_{ti}(m)^{\gamma} \text{ (eq.5)}$$

with λ equals to unit allowing risk-taking decisions and γ to 1.5, while for the SR strategy we compute the quotient of eq.3 and eq.4:

$$SR_{t,i}(m) = \mu_{t,i}(m)/\sigma_{ti}(m) \quad \text{(eq.6)}$$

For the MV and SR strategies we rank according to the highest utility and sharp ratio respectively, while for the S strategy we sort according to the highest inverse variance

That is:

$$U_{t(1)}(m) \leq U_{t(2)}(m) \leq \cdots \leq U_{t(k-1)}(m) \leq U_{t(k)}(m) \quad \text{(eq.7)}$$

$$SR_{t(1)}(m) \leq SR_{t(2)}(m) \leq \cdots \leq SR_{t(k-1)}(m) \leq SR_{t(k)}(m) \quad \text{(eq.8)}$$

&

$$\sigma_{t,1}(m)^{-1} \leq \sigma_{t,2}(m)^{-1} \leq \cdots \leq \sigma_{t,k-1}(m)^{-1} \leq \sigma_{t,k}(m)^{-1} \quad \text{(eq.9)}$$

In addition, for the KR, SK and NT strategies, we compute accordingly the statistics of kurtosis, Skewness and Normality.

Hence, we have:

$$SK_{t,i}(m) = \frac{1}{m}\sum_{j=0}^{m-1}\left(R_{t-j,i} - \mu_{t,i}(m)\right)^3 / \sigma_{ti}(m)^3 \quad \text{(eq.10)}$$

$$KR_{t,i}(m) = \frac{1}{m}\sum_{j=0}^{m-1}\left(R_{t-j,i} - \mu_{t,i}(m)\right)^4 / \sigma_{ti}(m)^4 \quad \text{(eq.11)}$$

and

$$NT_{t,i}(m) = SK_{t,i}(m)^3 + (KR_{t,i}(m) - 3)^2 \quad \text{(eq.12)}$$

and select, in similar manner as in eq.2, the highest r assets based in the statistics of eqs.10-12.

As mentioned above, the first step of our analysis includes a horizontal scan through of all the strategies with the same set of parametrization and the same portfolio of ETFs, covering the period 2006-2016. In more detail, we have included COE and CLE ETFs in aggregate, corresponding to the k available total assets for rotation, and select the best 6 out of them, based on the higher returns according to eq.2. The look-back period includes two quarters. Then, as in eq.3 we compute the respective total portfolio returns from all the applied strategies, i.e. $R_{t+1}^{MV}(m)$, $R_{t+1}^{S}(m)$ and so on, for all the examined ETFs group.

The results are then evaluated according to their joint performance of Total Return, Sharpe Ratio and Maximum Drawdown. We rank therefore each combination as follows:

$$TR_{t,S(m,r)} = \sum_{i=1}^{3}\left(p_{i,t,S(m,r)}\right) \quad \text{(eq.13)}$$

With $p_{1,t,S(m,r)}$ being the ranking based on Total_Return, $p_{2,t,S(m,r)}$ the ranking based on Sharpe_Ratio and $p_{3,t,S(m,r)}$ The ranking according to Maximum Drawdowns (MaxDD). Index t refers to the examined period, S stands for the applied strategy, while m and r are for the lookback period and number of the rebalanced assets accordingly. We rank Total Returns and Sharpe Ratios in ascending order and MaxDD in descending order. In essence we use the maximum criterion on absolute values.

In the second part of our analysis, we choose the best two strategies that produced out of the first stage and proceed with a more detailed analysis on them. This further calibration with varying sets of parameters works as a sensitivity analysis. Regarding the look-back evaluation period, we use four, eight and sixteen months back while for the number of the rebalanced assets, we include 2, 4 and 6 assets respectively. In the case of a single asset selection, this would lead to individual assets assessment which is not in the scope of our analysis while a bigger number of selected assets for rebalancing would in essence impair the strategies' main concept of "rotation" since the rebalancing would keep at all times all the available k assets in the portfolio, rendering therefore the rotation itself of minor or even of no utility at all.

We apply all the above combinations on the selected two strategies and in three different time periods: the period 2006-2013 with the financial crisis included, the period 2014-2016 with the great fall of oil prices included, and their junction including both shocks. We repeat all the above assessments using six different groups of ETFs. Namely these are: The Conventional Energy (COE) ETFs, The Clean Energy (CLE) ETFs and All Energy (ALE) ETFs, all of them with and without the bond related ETFs of SHY (Treasury 1-3 year Bond Index), TLT (Treasury 20+ Year Bond Index) and XLE (the energy sector component of S&P500), in their portfolios. In total, the second stage produces a total of 324 different combinations providing a finished analysis with more robust conclusions and less data driven results. The rationale for XLE, SHY and TLT to be included in the Energy portfolios, lies in the fact that on the one hand SHY and TLT are two low risk ETFs[1],, counterbalancing the high volatile nature of Energy ETFs, while on the other hand XLE ETF, works as the "average" of all the energy sector because its underlying assets encompasses the majority of all the activities in the energy industry, from exploration, drilling and refining, until transportation distribution and retail services.. Therefore XLE can potentially smooth out immoderate behaviors rising from one single asset or a small group of energy ETFs. In other words their integration in the examined portfolios might normalize abnormal financial behavior stemming from the dynamic nature that energy assets have by default.

Our results allow us to create clusters of top-5 performances of ETFs according to their Total Rankings. We select those with the lowest five values as resulted from eq.14, since this corresponds to a better rank. We reiterate this procedure separately for each period, varying the number of rebalanced assets, the lookback period, as well as changing the ETF groups (COE, CLE or ALE ETFs with and without SHY, TLT and XLE ETFs in their portfolios). The results are presented in Tables 1 to 5 and Figures 1 and 2. This enables us to have an overall visualization of their joint performances, to examine their sensitivity in different parametrizations and to explore their implications in shock events.

[1] http://www.etf.com/pdf-version/TLT & http://www.etf.com/pdf-version/SHY

5. Summary of results and discussion

In this section we present an extended summary of our results, but a larger capacity of results are available if requested. The contribution of our analysis lies in the identification of the behavioral patterns of clean and conventional ETFs given the existence of two types of shocks: the financial crisis of 2008 and the great fall of oil prices in 2014.

5.1 Horizontal assessment of strategies

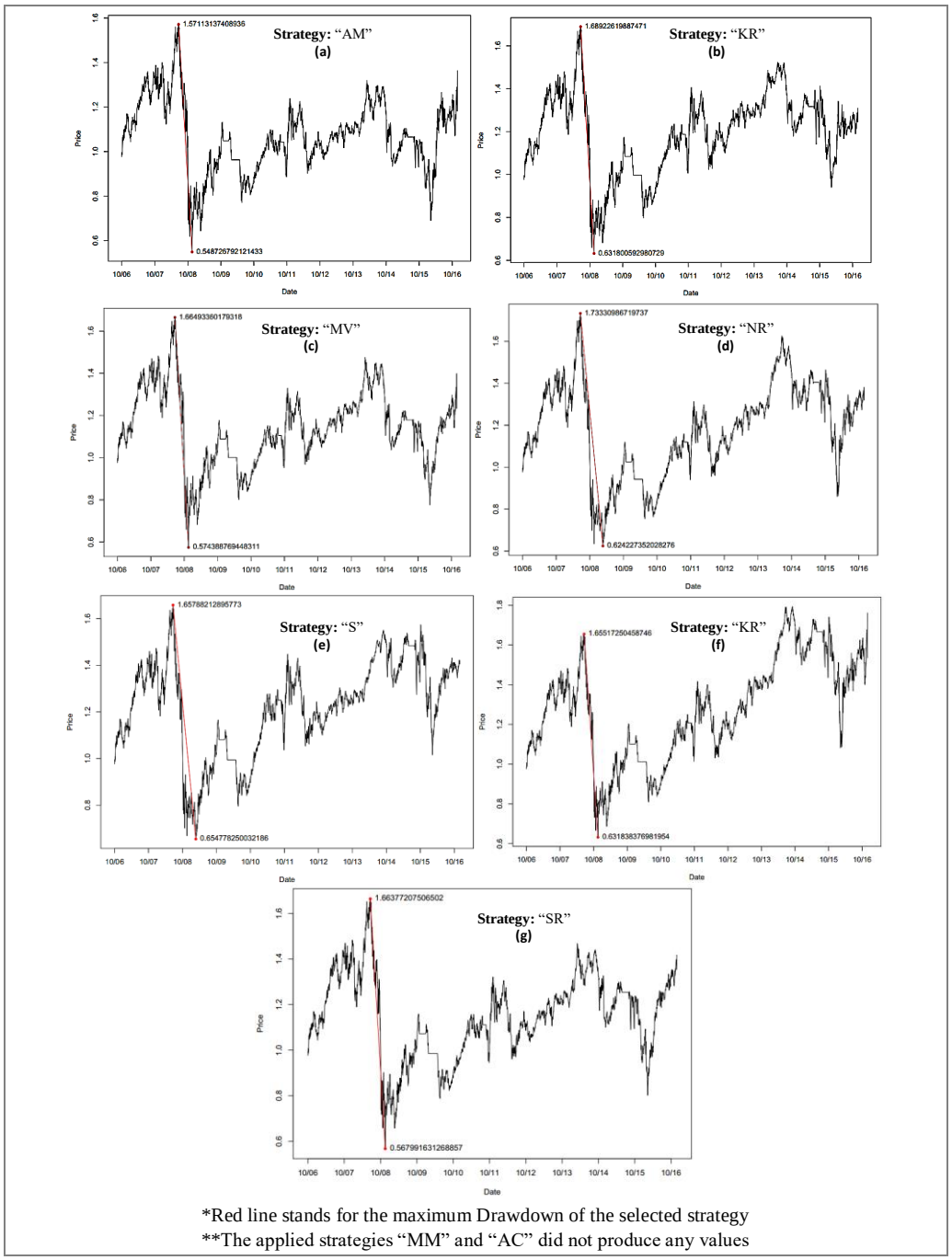
At this stage, we make the first assessment of all the applied strategies for optimum asset rotation. Through the inspection of Table 1, it seems that the criteria of minimum Volatility (S) and maximum Sharp Ratio (SR), outperform the other ones by achieving the best two joint performances respectively according to eq.13. The inherently higher risk, compared to other ETFs, that the energy sector entails and has already been stressed in the literature[2] several times, might be a rationale behind these two best performances.

Table 1. Performance Summary of all strategies and comparison with SPY Benchmark

		Examined Period 2006 -2016			
Energy strategy ETFs*	**Position of Joint Performance****	**Total Return(%)**	**Sharpe Ratio (%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
S	1	42.1%	27.5%	−62.2%	−2.9%
SR	1	76.1%	34.9%	−65.1%	−3%
NR	2	38.1%	26.7%	−63.9%	−3%
SK	2	41.8%	27.7%	−65.1%	−3%
MV	3	39.8%	27.2%	−63.7%	−2.9%
AM	4	36.4%	26.6%	−62.6%	−3%
KR	4	31.0%	24.8%	−64.4%	−3%
Benchmark		**Total Return(%)**	**Sharpe Ratio (%/$)**	**MaxDD(%)**	**0.95_VaR**
Passive Management					
SPY (Buy & Hold)		43.8%	35%	−52%	−1.8%

As already mentioned, at this section we examine the selection criterion for asset rotation *ceteris paribus* all the other parameters; this enables us to conduct direct cross-comparisons among all strategies.

[2] Plourde et Watkins, 1998; Andor et Voss, 2016; Dempster et al., 2013 Allcott, 2011



*Red line stands for the maximum Drawdown of the selected strategy
**The applied strategies "MM" and "AC" did not produce any values

Figure 1.a- 1.g The times series of the indexed price of the portfolio of ALL ETFs for each strategy

Figure 1 above depicts the time series of the indexed price of ALL ETFs portfolio after the implementation of all the examined strategies. Valuable insights are produced when assessing their performances given the presence of the 2008 global financial crisis and the great fall of oil prices in the 4th quarter of 2014. In more detail,

all the strategies seem to be overexposed to the financial crisis of 2008, since all of them produce their maximum drawdowns at that period. Nevertheless there are minor diversifications in their magnitudes with "S" strategy to be the least affected one, having a maximum drawdown of -62,2%. It is worth mentioning, that not all strategies perform well in the 4th quarter of 2014 as shown in Figure 1. Again "S" strategy seems to over-perform the others by sustaining the lower losses. This becomes more obvious when we restrict the sample between 2014 and 2016 with "S", "SR" and "KR" to produce the lower MaxDDs[3] in the fourth quartile of 2014, that is when the great fall of oil prices took place.

5.2 Strategies calibration

In this section we restricted our analysis in the best two strategies as produced from the previous section, i.e. the "S" and "SR". Our focus now has been shifted from the best criterion (or strategy) to the best calibration of the parameters of look back period and number of assets included for rotation.

Roughly speaking, the results support the view that portfolios of Energy ETFs, regardless of the specific composition of their underlying assets and the different type of shock, are investments of high risk and the integration of SHY,TLT and XLE could moderate, in most cases, this danger producing lower MaxDDs and 95% VaRs.

To start with, in the period between 2006 and 2013 (Table 2), we observe that ALE ETFs produce higher returns and Sharpe ratios without SHY, TLT and XLE in their portfolio. At the same time, they record lower MaxDDs and VaRs. Also, the existence of these assets in ALL ETFs portfolio, has minor changes in the optimum parameterization of the applied strategies. On the contrary, when ALE ETFs are disaggregated to CLE and COE ETFs, their existence results in upgraded financial performances. Moreover, the group of CLE ETFs without the exogenous ETFs of SHY, TLT and XLE, is the only group to have recorded losses during this period. Last, we conclude that the 2008 financial crisis, affected more firms related to green energy services and products than it did with the conventional ones and that it is

[3] Results are available for three different periods (2006-2016,. 2006-2013,2014-2016) and they are available upon request.

preferable to encompass non-energy related ETFs when CLE or COE ETFS are separately examined but not when they are used in aggregate.

Table 2. Best performances for each strategy and group of Energy ETFs from 2006 until 2013

ETF group		Energy strategy	Lookback period	# Assets*	Total Return(%)	Sharpe Ratio(%/$)	MaxDD(%)	0.95_VaR(%)
WITH SHY, TLT & XLE	ALE	S	4	6	37%	31%	-40.4%	-2.4%
		SR	4	6	41%	32%	-48.3%	-2.4%
	CLE	S	4	2	41%	49%	-20.8%	-1%
		SR	4	4	17%	21%	-40.6%	-1.6%
	COE	S	4	4	32%	29%	-43.1%	-2.3%
		SR	4	4	42%	32%	-47.7%	-2.3%
ETF group		**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
WITHOUT SHY,TLT & XLE	ALE	S	4	6	47%	35%	-42.7%	-2.3%
		SR	4	2	62%	40%	-44.9%	-2.3%
	CLE	S	16	4	-51.2%	-25.4%	-75.6%	-2.8%
		SR	16	2	-45.1%	-17.1%	-76.1%	-2.8%
	COE	S	4	4	13%	19%	-43.6%	-2.2%
		SR	4	4	26%	26%	-47.7%	-2.1%

* Number of assets for monthly rotation of the selected portfolio

In the period 2014-2016, i.e. when the nosedive of oil prices happened, as shown in Table 3, all the energy groups perform better without the non-energy ETFs included in their portfolios. Furthermore, we observe a change of signs in ALL and COE ETFS from negatives to positives in Total Returns and Sharpe Ratios when SHY, TLT and XLE are excluded, while longer lookback periods are needed in order for this to happen. On a theoretical basis, the 2014 oil crisis should had a major impact on the COE ETFS. Nevertheless, the results of Table 3 indicate that the negative impact stemming from the existence of non-energy ETFs in their portfolio prevail that of the oil crisis, which could be substantiate by the strong underlying nexus between that the energy sector and US bond markets have. As Kang et al. (2014) stress, on average, in the long run shocks to the global crude oil market play an important role affecting the U.S. bond market.. In other words, it seems that the breakdown of oil prices, besides the direct negative effect it has on COE, it affects them also indirectly through its impact on the bond market. the. Last, the CLE ETFs outperform the other two groups, as expected, regardless of the existence or not of SHY, TLT and XLE in their portfolio.

Table 3. Best performances for each strategy and group of Energy ETFs from 2014 until 2016

ETF group		Energy strategy	Lookback period	# Assets*	Total Return(%)	Sharpe Ratio(%/$)	MaxDD(%)	0.95_VaR(%)
WITH SHY, TLT & XLE	ALE	S	4	6	-7.9%	-16.6%	-31.9%	-1.6%
		SR	4	2	-3%	8%	-48.9%	-2.4%
	CLE	S	8	4	12%	72%	-6.7%	-0.8%
		SR	8	4	28%	119%	-6.2%	-1%
	COE	S	4	6	-5.1%	-3.5%	-35.4%	-1.7%
		SR	4	4	-12.1%	-13.9%	-47.8%	-2.3%
ETF group		**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
WITHOUT SHY,TLT & XLE	ALE	S	8	2	15%	40%	-26.3%	-2.5%
		SR	16	6	10%	38%	-35.8%	-2.7%
	CLE	S	8	4	20%	62%	-14.5%	-1.7%
		SR	8	2	34%	94%	-14.2%	-1.7%
	COE	S	4	2	11%	31%	-40.5%	-2%
		SR	16	6	14%	47%	-36.2%	-2.8%

* Number of assets for monthly rotation of the selected portfolio

Concluding, when both shocks are included, i.e. from 2006 until 2016, we find out that COE ETFs are in essence indifferent in the existence of SHY, TLT and XLE in their portfolio, since their financial performance remains unchanged with short lookback period and small number of assets for rotation. ALL ETFs are not as well affected by the existence of the non-energy ETFs in their portfolio, because they also keep their initial parametrization more or less unchanged. Nevertheless, they register increased performance without them included in. Opposite to the prior two ETFs groups stands the group of clean energy ETFs. To be more specific, an augmented portfolio with non-energy ETFs, produces positive returns and high positive Sharpe Ratios. In the case of the "S" strategy, it yields the highest Sharpe ratio of 37%, the lowest MaxDD of -20,8% and the smallest 95%VaR of -0,9%, among all other groups. When the non-energy ETFs are excluded, this group suffers from significant losses and great risk, underpinning therefore the sensitivity in general of new green technology products and services to major shocks of economic or other nature.

Table 4. Best performances for each strategy and group of Energy ETFs from 2006 until 2016

ETF group		Energy strategy	Lookback period	# Assets*	Total Return(%)	Sharpe Ratio(%/$)	MaxDD(%)	0.95_VaR(%)
[illegible]	ALE	S	4	6	44%	28%	-40.4%	-2.1%

	CLE	SR	4	6	32%	24%	-48.3%	-2.2%
		S	4	2	37%	37%	-20.8%	-0.9%
		SR	4	4	15%	17%	-40.6%	-1.4%
	COE	S	4	4	43%	28%	-43.1%	-2.1%
		SR	4	4	32%	24%	-47.8%	-2.2%
ETF group		**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
WITHOUT SHY,TLT & XLE	ALE	S	4	6	64%	34%	-42.7%	-2.1%
		SR	4	2	61%	32%	-49.5%	-2.3%
	CLE	S	16	6	-41.4%	-9.6%	-76.3%	-2.4%
		SR	16	2	-21.2%	4%	-76.1%	-2.4%
	COE	S	4	2	43%	28%	-48.4%	-2.1%
		SR	4	4	30%	23%	-47.7%	-2.1%

* Number of assets for monthly rotation of the selected portfolio

Last, in Table 5 we present the Top-5 joint performances from all the ETF groups and strategies in aggregate, revealing the leaders in each case. A thorough look may assist us to discern, if any, distinctive behavior per examined period..

In the periods 2006-2016 & 2006-2013, the "S" criterion outmatches the "SR" one, while the opposite applies in the period 2014-2016. Furthermore, the "SR" strategy needs to entail longer periods in the past for assessment than the "S" does, while we cannot detect a standard feature regarding the number of selected assets for rotation given the selected strategy, ETF group and examined period. Furthermore, COE ETFs are excluded from the top-5 performances at most times, whether we are examining the financial crisis or the oil crisis, or if non-energy ETFs are included in their portfolio or not. On the contrary CLE ETFs are the best option given the existence of SHY, TLT and XLE in their portfolio, since they are ranked first in all cases. Not only they produce high and positive Total Returns and Sharpe Ratios in every examined period, but they do that with the lowest Maximum Drawdowns and the smallest 0.95 confident Value at Risk. As expected, in the great plunge of oil prices, clean energy ETFs outmatch the rest energy ETFs. Furthermore, a noteworthy result based on Table 5 regarding the period 2006-2013 (i.e. given the financial crisis) is that a portfolio of net energy assets including both clean and conventional ETFs can be considered as a relative safe and at the same time efficient investment decision with high returns and relative low volatility given the market's turmoil. Last, when both crisis are included, i.e. from 2006 until 2016, the results are mixed as to what is the best investment decision. All the groups of energy ETFs: CLE, COE and ALE ETFs,

with and without the ETFs of XLE, SHY, and TLT, are included in the Top-5 joint performances.

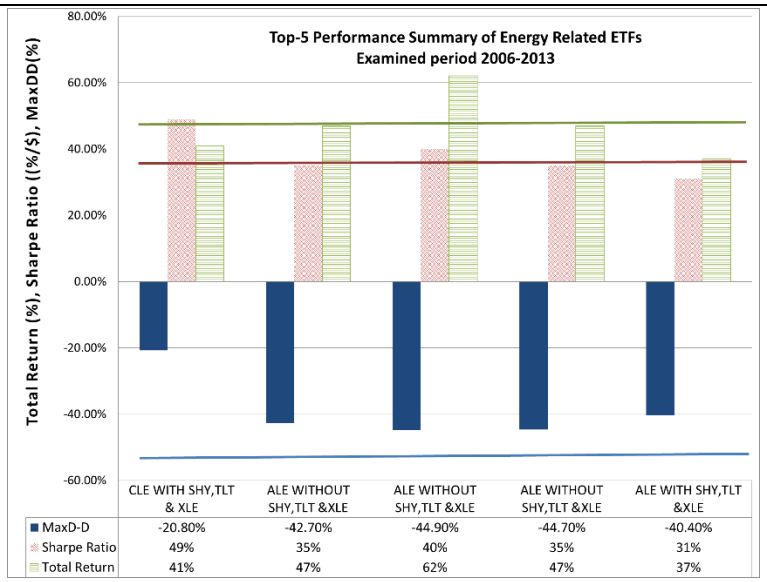
Table 5. The Top-5 joint performances from all ETF groups and strategies per examined period

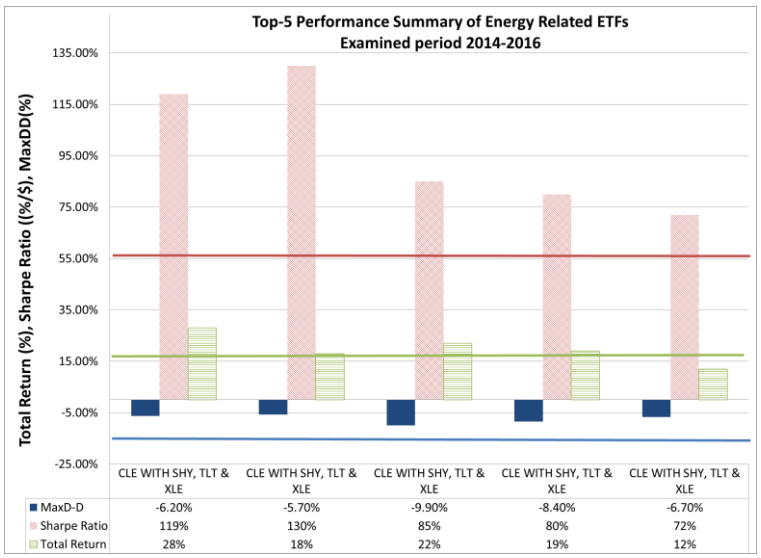
Examined Period 2006-2013								
Rank	**ETF group**	**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
1	CLE WITH SHY,TLT & XLE	**S**	**4**	**2**	41%	49%	-20.8%	-1%
2	ALE WITHOUT SHY,TLT &XLE	**S**	**4**	**6**	47%	35%	-42.7%	-2.3%
3	ALE WITHOUT SHY,TLT &XLE	**SR**	**4**	**2**	62%	40%	-44.9%	-2.3%
4	ALE WITHOUT SHY,TLT &XLE	**S**	**4**	**4**	47%	35%	-44.7%	-2.4%
5	ALE WITH SHY,TLT &XLE	**S**	**4**	**6**	37%	31%	-40.4%	-2.4%
Examined Period 2014-2016								
Rank	**ETF group**	**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
1	CLE WITH SHY, TLT & XLE	**SR**	**8**	**4**	28%	119%	-6.2%	-1%
2	CLE WITH SHY, TLT & XLE	**SR**	**16**	**4**	18%	130%	-5.7%	-0.9%
3	CLE WITH SHY, TLT & XLE	**SR**	**8**	**2**	22%	85%	-9.9%	-1.3%
4	CLE WITH SHY, TLT & XLE	**SR**	**8**	**6**	19%	80%	-8.4%	-1.2%
5	CLE WITH SHY, TLT & XLE	**S**	**8**	**4**	12%	72%	-6.7%	-0.8%
Examined Period 2006-2016								
Rank	**ETF group**	**Energy strategy**	**Lookback period**	**# Assets***	**Total Return(%)**	**Sharpe Ratio(%/$)**	**MaxDD(%)**	**0.95_VaR(%)**
1	CLE WITH SHY, TLT & XLE	**S**	**4**	**2**	37%	37%	-20.8%	-0.9%
2	ALE WITHOUT SHY,TLT &XLE	**S**	**4**	**6**	64%	34%	-42.7%	-2.1%
3	ALE WITH SHY,TLT &XLE	**S**	**4**	**6**	44%	28%	-40.4%	-2.1%
4	ALE WITHOUT SHY,TLT &XLE	**S**	**4**	**4**	65%	34%	-44.7%	-2.2%
5	COE WITH SHY, TLT & XLE	**S**	**4**	**4**	43%	28%	-43.1%	-2.1%

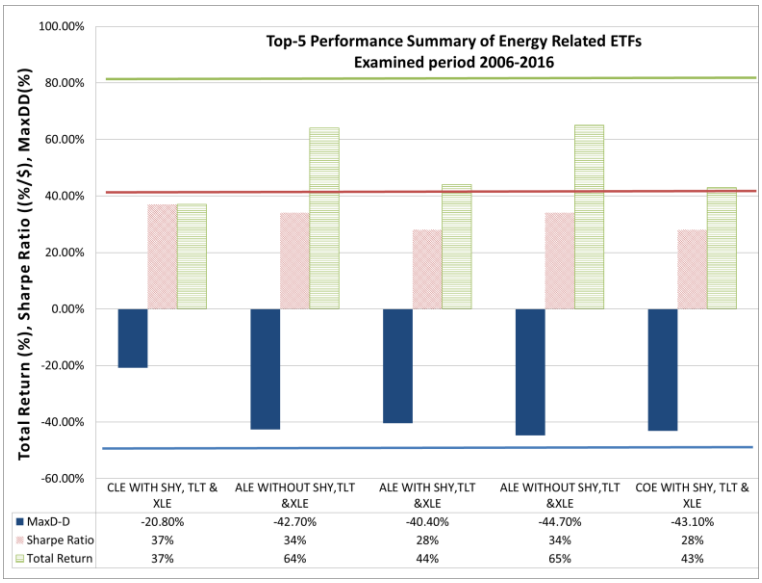
* Number of assets for monthly rotation of the selected portfolio

Figure 2 below presents the Top-5 performances in cross comparison with Spy's performance. It has to be mentioned that the SPY index has registered consecutively positive annual returns in the post financial crisis period. In more detail, besides 2011

Figure 2. The Top-5 joint performances from all ETF groups in comparison with the benchmark index of SPY with passive management of Buy & Hold.







* The Horizontal green, red and blue lines represent the Total return, Sharpe Ratio and Max D-D respectively of the SPY index with passive management of Buy& Hold.

and 2015 when its returns were just below 2%, for the rest period it produced significant returns varying between 15% and 32% (Morningstar, 2016).

As shown, a net portfolio of ALE ETFs outmatches the SPY index in the period 2006-2013. Besides equal or even slightly better Total Returns and Sharpe Ratios, ALL ETFs undergo lower maximum losses in that period. Hence, they are more resilient against the financial crisis of 2008 than SPY was. The case is far better for CLE ETFs in the period 2014-2016, where their portfolio overlies SPY's performance at all the metrics. Last when full period is considered, energy ETFs are underperforming compared to SPY, but they are more robust against both shocks, experiencing lower MaxD-Ds by 10% on average than SPY does.

6. Concluding remarks

Our paper contributes in understanding some important features of portfolios of energy ETFs in aggregate and when disaggregated to clean and conventional energy assets. Also we examine their behavior under two different types of shocks: the 2008 financial crisis and the 2014 oil crisis. To do that we consider their financial performance on a comparative basis in two stages. First we go through a common horizontal analysis for all strategies, *ceteris paribus* the number of rotated assets and the length of lookback period of each portfolio and then we select the best two strategies based on their joint performance (as per Eq.13), and proceed to a vertical calibration of them. Thus, we apply 9 different parametrizations for each strategy by changing the number of assets included for continuous rotation and the lookback period for assessment. This second stage works on a dual axis. On the one hand, it functions as a sensitivity analysis allowing us to determine the robustness of the best two strategies of their real performance when different parametrizations are applied and on the other hand it can reveal, if any, underlying behavioral patterns of these energy ETFs groups and provide guidelines for efficient investment on energy ETFs given also the existence of non-energy related assets.

Our empirical results are summarized below:

- The rotation criteria of minimum Volatility and Sharpe Ratio are more efficient compared to others, in case of energy related portfolios.

- A portfolio including clean and conventional ETFs in aggregate, performs better in terms of higher returns and lower risk than two disaggregated portfolios with clean and conventional ETFs respectively.

- Portfolios of CLE ETFs are more sensitive to the exogenous to the energy sector bond ETFs of SHY and TLT and that of XLE, than conventional energy ETFs are.

- A portfolio of ALL ETFs performs better without exogenous to the energy sector ETFs than portfolios of CLE and COE ETFs do

- The 2008 financial crisis affected more CLE ETFs than the 2014 oil crisis did in COE ETFs.

The scope of this research is to explain potential interactions and variations of the performance of energy related ETFs and provide useful investment guidelines through a comparative study between different portfolios of energy related ETFs. Towards that direction, we applied a framework for optimum asset rotation based in well-established strategies and run a range of diversifications on their parameters. Still further research can be carried out, with additional criteria and metrics in order for more useful insights to be extracted for optimum investment on Energy ETFs.

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Annex

Table A. The energy related ETFs used in our analysis along with a short description

Conventional Energy ETFs	
ETF's Ticker	**ETF's Description***
CRAK	The VanEck Vectors Oil Refiners ETF tracks an index of global stocks issued by firms that earn at least 50% of their revenue from oil refining. The index is market-cap-weighted.
DBE	The PowerShares DB Energy Fund tracks an index of 5 energy-related futures contracts. It selects contracts based on the shape of the futures curve to minimize contango. DBE's top contracts include Brend Crude, Heating Oil, RBoB Gasoline, WTI Crude and ICE Natural Gas
DBO	The PowerShares DB Oil Fund tracks an index of crude oil futures contracts. It optimizes its contract selection based on the shape of the futures curve to minimize contango.
DRIP	DRIP seeks to deliver three time more than the dailperformance of the S&P Oil & Gas Exploration & Production Select Industry Index. The fund uses over-the-counter derivatives to achieve this objective. It is suited for very risk tolerant investors
EMLP	EMLP is an actively-managed ETF which invest in MLPs, Canadian income trusts, pipeline companies, and utilities that generate at least half of their revenues from the operation of energy infrastructure assets including pipelines, storage tanks, and power transmission.
FCG	This ETF gives investors an opportunity to achieve exposure to natural gas, an important fuel for both heating and cooling
FILL	This ETF offers exposure to the global energy sector through a diverse portfolio of domestic and international equities, with exposure spreading across both developed and emerging markets. FILL has a heavy tilt towards mega cap stocks, as this ETF includes a number of the world's biggest oil companies
FRAK	FRAK's portfolio is comprised of stocks engaged in less conventional energy exploration techniques. Specifically, component stocks may operate in sectors of the energy market such as coalbed methane (CBM), coal seam gas (CSG), shALE oil, shALE gas, tight natural gas, tight oil and tight sands)
FXN	FXN's portfolio is comprised of stocks engaged in all activities in oil & gas industry, from exploration and drilling to transportation refining and marketing
GEX	This global ETF invests in companies engaged in various alternative energy industries, giving investors broad exposure to clean energy industries. For investors looking to bet that alternative energy will thrive in coming years, GEX can be a nice choice; this ETF casts a wide net, including exposure to solar power, wind power, and other renewable energy sources
GRID	
GUSH	The Direxion Daily S&P Oil & Gas Exploration & Production Bull 3X Shares ETF provides 3x daily exposure to an equal-weighted index of the largest oil and gas exploration and production companies in the US

HAP	The HAP ETF tracks a multifactor-weighted index of global hard asset firms. It splits the industry into six sectors (agriculture, alternatives, base/industrial metals, energy, forest products and precious metals) with 1/3 of them to be related in the energy sector
ICLN	This fund offers a way to invest in the global clean energy index, including both domestic and international stocks in its portfolio
IEO	This ETF offers exposure to the exploration and production sub-sector of the U.S. industry, a corner of the market that may be appealing for investors bullish on the outlook of the energy sector.
IEZ	This ETF is one option available to investors seeking to bet on the oil equipment and services sector of the domestic energy market, making it appealing to those who believe that increased oil demand will spark a need for the services these companies provide
IGE	This ETF tracks a market-cap-weighted index of US-listed natural-resource-related companies, with 82,56% of them indexed in the conventional energy industry
IPW	This ETF represents exposure to an index that measures the performance the energy industries of developed nations outside of the US, which are included in the S&P Broad Market Index. This fund allocates it assets to giant and large cap companies for the most part,ensuring that investors' assets will remain relatively stable with big name oil firms like British Petroleum and Royal Dutch Shell
IXC	This ETF offers exposure to the global energy industry, splitting exposure between U.S. and domestic stocks. This ETF includes a number of the world's biggest oil companies
IYE	This ETF offers exposure to the domestic energy market, including many of the Big Oil companies that are responsible for significant portions of global energy supply. IYE fund can potentially be useful for those implementing a sector rotation strategy or looking to overweight this corner of the market
KOL	This ETF offers exposure to the global coal industry, making it one option for investors who believe that demand for this fuel source will increase.
MLPA MLPJ MLPX	These funds offer exposure to oil,coal and gas related activities plus they avoid corporate income taxes at both the federal and US state level. By generating at least 90% of income from natural resource-based activities such as transportation and storage, it is qualified as an MLP and not be taxed as a corporation.
NLR	This ETF offers exposure to the nuclear power industry, while also offering a way to invest in stocks of companies engaged in the production of uranium--the key component of nuclear power. Although not a clean energy, it can not be considered as a conventional energy source
PSCE	This ETF tracks an index that is comprised of common stocks of U.S. energy companies that are principally engaged in the business of producing, distributing or servicing energy related products, including oil and gas exploration and production, refining, oil services, pipeline, etc.
PXE	This ETF offers exposure to the exploration and production sub-sector of the domestic energy market, making it a potentially useful tool for those looking to target stocks of companies responsible for discovering and accessing new deposits of oil and gas.
PXI	This ETF offers exposure to the domestic energy market, including many of the Big Oil companies that are responsible for significant portions of global energy supply

PXJ	This ETF offers exposure to the oil services sub-sector of the domestic energy market, making it a potentially useful tool for those looking to target stocks of companies responsible for providing equipment and services to firms engaged in the extraction of oil and gas
RYE	This ETF offers a unique way to access the U.S. energy market of oil and gas with an equal-weight play
VDE	VDE offers broad exposure to US equity stocks engaged in their mojority (more than 99%) in the conventional sources of energy of oil, gas and coal
XES	This ETF offers exposure to the equipment and services sub-sector of the U.S. energy industry. XES can be useful for those seeking exposure to the energy industry without focusing exclusively on major refiners and drillers such as Exxon and Chevron
XOP	This ETF offers exposure to the exploration and production sub-sector of the domestic energy market, making it a potentially useful tool for those looking to target stocks of companies responsible for discovering and accessing new deposits of oil and gas
XOP	XOP offers an equal-weight approach to oil & gas exploration & production. Equal weighting provides diversified exposure to an industry normally dominated by a few big names, but also produces a massive bias to small- and midcaps
YMLI	YMLI, structured as a C-corporation, focuses exclusively on high-yielding infrastructure firms. It holds a basket of about 25 MLPs equally weighted in tiers and more than 97% of its portfolio is comprised of oil and gas related companies
YMLI	This MLP ETF tracks an equally weighted index of 25 MLPs in the infrastructure space. The fund is structured as a C-corporation and is comprised by 96% of companies realted directly and indirectly to oil and gas industry

Clean Energy ETFs

ETF's Ticker	ETF's Description*
GEX	GEX holds a wide spectrum of companies that earn at least 1/2 their revenues from the broader renewable energy industry, which includes solar, wind, biofuel and geothermal players, as well as companies focused on energy effiClEncy.
ICLN	ICLN holds a portfolio of clean energy companies, which it defines as those involved in the biofuels, ethanol, geothermal, hydroelectric, solar and wind industries. Aside from holding the companies that produce energy through these means, ICLN also holds companies that develop technology and equipment used in the process
FAN	This ETF offers exposure to the global wind power industry. Given FAN's narrow focus, it is likely most effective for those looking to establish a tactical tilt towards the wind power industry, either as part of a long term strategy or a shorter term move.
KWT	The cleverly-named KWT delivers targeted exposure to the solar power energy, and as such can be exhibit significant volatility in the short-term. Like many granular ETFs focusing on specific sub-sectors, KWT doesn't offer tremendous diversification; there are only about 30 individual components, including both U.S. and international stocks.
PBD	This ETF offers exposure to the global clean energy index, including both U.S. and international stocks in the underlying portfolio. PBD also diversifies across various types of clean energy--such as wind, solar, and hydro--making it an interesting option for those looking to bet on a clean energy boom but unwilling to make a

	concentrated bet on a specific sub-sector
PUW	PUW is not like any other fund in the Alternative Energy ETFdb Category, as this ETF seeks to replicate an index constructed around a unique investment thesis. PUW's underlying index includes stocks that are significantly involved in transitional energy bridge technologies, with an emphasis on improving the use of fossil fuels
PZD	This ETF is tilted towards the industrials sector, focusing on an index comprised of leading cleantech firms
QCLN	QCLN is a unique member of the Alternative Energy Category, as this ETF invests in companies that are engaged in a variety of different activities related to several green energy sub-sectors. By including companies focused on biofuels, solar energy, and advanced batteries (among others), QCLN casts a wide net of exposure
TAN	TAN delivers targeted exposure to the solar power energy, making it potentially useful for both betting on long-term adoption of this energy source or capitalizing on perceived short-term mispricing

* All information on ETFs have been acquired online[..]