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Title: **Global Cleantech**

Quantifying its place in your portfolio

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Synopsis: Cleantech is a sector which is attracting growing interest from institutional investors, governments, corporations and publics around the world. The achievement of commitments to reduce carbon emissions under the Copenhagen Accords will require a transition to a low-carbon economy. This has the potential to significantly reduce the world's reliance on fossil fuels while providing cheaper and cleaner energy. But should investors make an allocation to cleantech and, if so, how much? We present breakeven analysis which provides a quantitative framework for investors deciding whether to allocate to global equity sectors.

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Global Cleantech: Quantifying its place in your portfolio

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INTRODUCTION

In contemporary institutional investment portfolios it is not uncommon to find a number of exposures to global equity sectors which are considered to be asset classes in their own right. The elevation of global equity sectors within institutional investors' portfolios is a relatively recent phenomenon and has generally occurred because of the increased interest in alternative investments over the last decade. As a result, institutional investors have increased exposure to some global equity sectors which are considered to provide liquid exposure to alternative assets, e.g. global listed property securities and global listed infrastructure securities.

When global equity sectors are considered to be individual asset classes it becomes more likely that institutional investors will make separate allocations to them which are overweight positions relative to their market capitalisation weights within the global equity market. Often this arises simply because naïve portfolio optimisation routines are employed by investors (or their investment consultants!). However, it is Russell's view that investors must be cautious when considering elevating a sector of the global equity market to an asset class because, even in an efficient market, there will always be arguments in favour and against exposures to various sectors.

In this paper we show how institutional investors can use breakeven analysis to provide a quantitative framework for deciding whether making separate allocations to specialist sectors of the global equity market will likely enhance portfolio efficiency. In an investment environment where political and economic risks are significant and weighing on global financial markets, portfolio managers can potentially increase portfolio efficiency by allocating to sectors in the global equity market where the economic and political risks are deemed less significant.

We use global 'clean technology' or 'global cleantech' to illustrate breakeven analysis. The first half of this paper defines and reviews global cleantech and discusses the general investment thesis for making investments in global cleantech and their risks. We briefly touch on the different ways institutional investors can make allocations to global cleantech.

In the second half of this paper we introduce breakeven analysis, a quantitative method which can be used by institutional investors to inject rigour when determining allocations to global equity sectors, as well as alternative asset classes more generally. We discuss allocating to global cleantech and then consider the expected return and volatility assumptions required by global cleantech when it is added to sample Australian conservative, balanced and growth diversified portfolios.

SECTION I: WHAT IS CLEANTECH?

Cleantech is a sector which is attracting growing interest from institutional investors, governments, corporations and publics around the world. Global investment in cleantech continues to increase dramatically, with investments in renewable energies, including wind and solar power, increasing by 32% in 2010 to a record $211 billion (nearly five and a half times the commensurate value in 2004) largely "due to wind development in China and small-scale solar [photovoltaic] installation on rooftops in Europe" (Bloomberg New Energy Finance, 2011). There is also increasing investment in other areas of the cleantech sector such as materials, water and transportation.

GROWING INTEREST

Interest in cleantech is growing because many countries are attempting to diversify their energy portfolios away from traditional fossil fuels and into non-carbon based renewable energy sources in order to prolong the life of existing fossil fuel reserves, reduce future energy costs and decrease geopolitical risk. The ongoing diversification of the global energy portfolio, combined with improvements in energy efficiency, is generally known as the 'transition to a low-carbon economy' and it has the potential to significantly reduce the world's reliance on fossil fuels, to create employment, while at the same time providing cheaper and cleaner energy. Russell has noted previously that "the rapid pace of development has heightened the awareness of many regulatory bodies about environmental risks, the attractiveness of improving efficiency, and a need for clean, efficient, and renewable energy sources. Investors are becoming savvy to the value-added in finding the associated technologies that will dominate the marketplace as a response to both government intervention and the forces of market demand." (Smith, Ross, & Pearce, 2008).

Interest in the cleantech sector also arises from public concern regarding climate change, sustainable economic development and environmental conservation. However, while many governments acknowledge the renewable energy sector as a key component to greening their economies, fewer focus on renewables in their central policies to address climate change (Bloomberg New Energy Finance, 2011).

Investing in cleantech research is also a priority for the Australian Government. As part of its Clean Energy Future package of legislation which introduced a price on carbon emissions, the Government established the Australian Renewable Energy Agency (ARENA) which will manage A$5 billion in grant-based funding to support the research, development and demonstration of low-emission energy technologies, and the A$10 billion Clean Energy Finance Corporation (CEFC) which will invest in renewable energy and energy efficiency technologies, with the aim to de-risk and facilitate large-scale private sector investment.

CAREFUL, LONG-TERM APPROACH

Russell believes that the case for elevating the cleantech sector of the global equity market is strengthening as the sector could potentially be a significant beneficiary of the transition to a low-carbon economy. Many companies within the sector are producing goods and services which have revenue streams that will benefit from the continued diversification of the global energy portfolio. However, Russell cautions that "as governments attempt to impose market-based and other initiatives to move to a low-carbon economy, it is expected that there will be financial winners and many financial losers" (Liddell, 2009). In other words, while it is likely that there will be notable winners within the cleantech sector, it is also likely that there will be numerous losers. This means that security selection will also be very important when making allocations to global cleantech.

We note that a long-term perspective is required for investing in global cleantech as these investments are likely to fall in and out of favour with short-term investor sentiment over time. Indeed, “at the start of this century, clean energy was all the rage. The revolution may still be happening, but it’s taking its time...” (Huck, 2011). Thus, in the absence of a post-Kyoto, global legally binding agreement on carbon reduction, the transition to a low-carbon economy is not going to occur in the next few years, but rather in the coming decades. Given the long timeframe of the transition, this may mean that sentiment surrounding cleantech will add to the sector’s volatility.

DEFINITIONS

While there is no formal definition of cleantech, definitions have been proposed by research houses such as the Cleantech Group LLC and Clean Edge, Inc. Cleantech “should not be confused with the terms environmental technology or ‘greentech’ popularized in the 1970s and 80s. Cleantech is new technology and related business models that offer competitive returns for investors and customers while providing solutions to global challenges” (Cleantech Group LLC). Clean Edge defines clean technology as "a diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and significantly cut or eliminate emissions and wastes. Clean technologies are competitive with, if not superior to, their conventional counterparts. Many also offer significant additional benefits, notably their ability to improve the lives of those in both developed and developing countries” (Makower, 2001).

Companies within the cleantech sector generally fall into one of four sub-sectors:

- Energy
- Transportation
- Water
- Materials

The cleantech sector includes companies which are developing technologies such “solar photovoltaics, wind power, biofuels, bio-based plastics, advanced lithium-ion batteries, and large-scale reverse-osmosis water desalination. It also includes such emerging technologies as tidal power, silicon-based fuel cells, distributed-hydrogen generation, plug-in hybrid vehicles, and nano-technology-based materials” (Pernick & Wilder, 2008). To this list, Russell would add various technologies under the broad headings of energy efficiency, utilities and transmission.

Therefore, cleantech is first and foremost a play on a specialist technology sector which includes both those technologies which are in the process of being commercialised, such as solar power, and emerging high-technologies such as nanotechnology. As a result, Russell believes that because cleantech is a highly specialised, highly technical sector of the global equity market and therefore specialist cleantech fund managers are more likely to generate higher excess returns than generalist fund managers promoting cleantech funds. A good cleantech manager will have both an in-depth understanding of competing technologies as well as be able to assess and evaluate the commercial opportunities. Investors in the space should consider diversifying manager specific risk by adopting a multi-manager approach.

OPPORTUNITIES WITHIN GLOBAL CLEANTECH

Investors are increasingly taking notice of the cleantech sector because of the significant potential for commercial opportunities and developments. Based on analysis from *The Clean Tech Revolution* (Pernick & Wilder, 2008), we believe the following areas should be watched by investors:

- Solar Power
- Wind and Tidal Power
- Biofuels
- Green Building
- Electric Vehicle Technology
- Smart Electric Grids
- Mobile Cleantech
- Clean Water
- Energy from Waste

Solar Power. Invented in the 1950s at Bell Labs, further developed and funded by NASA during the 1960s as it deployed solar-powered satellites, and then commercialised from the 1970s, solar power is seeking to be cost competitive with conventional (coal and gas fired) electricity generation. While solar has already achieved very substantial cost reductions, continued developments in solar power technology (including incremental improvements in silicon-based photovoltaic (PV) as well as non-silicon forms of solar electric generation and thin-film nanotechnology-based innovations), offer the potential for further reductions in the cost of solar power through increased efficiency in converting sunlight to electricity. Also, as the solar industry continues to adapt technologies used in traditional semiconductor manufacturing and apply them to large-scale solar production, manufacturing costs may continue to decrease. Concentrating solar power for large-scale desert-based applications is also gaining traction in the attempt to reduce the cost of solar power.

The opportunity for solar is growing as "in the past two years, solar PV cell prices have plummeted by more than half, and total installation costs by about 30 percent. Solar deployment in the U.S., from residential rooftops to utility-scale PV power plants, has soared. Grid-connected PV grew 69 percent (over 2010) in the second quarter to 314 megawatts. Six states installed at least 10 MW in the quarter; that's more than all but three states added in 2007 for the entire year" (Wilder, 2011). Solar also received the "biggest share of worldwide R&D spending on renewable energy, and was up 8% at $3.6 billion" in 2010 (Bloomberg New Energy Finance, 2011).

The growth of solar is not only confined to overseas markets as a number of solar projects have been announced in Australia. Examples include the 150MW Moree Solar Flagship project and the 250MW Solar Dawn project at Chinchilla, Queensland. On a smaller scale, Verve Energy and GE Energy Financial Services are currently installing the 10MW Greenough River Solar Farm in Western Australia (Verve Energy, 2011).

Wind and Tidal Power. Of all the widely available renewable sources of electricity, utility-scale wind power is currently the most cost-competitive with conventional coal, natural gas, or nuclear generation today. This is the key reason as to why wind power will be an increasing part of the electricity mix of large and small utilities worldwide. In addition, wind power allows utilities to add more emissions-free power to their electricity mix. Developments in wind power technology also continue with innovations in components such as gearboxes and turbine blades as well as small turbines that can be integrated within a building's design. Wind-turbine manufacturers are also looking at nanotechnology advancements for their blade and tower materials; nanocomposites offer the potential of improved strength and durability of turbine blades, gears and other components.

Wind was the dominant renewable energy sector in terms of new investment in 2010, with a rise of 30% to $95 billion, reflecting decisions to invest in large projects from China to the U.S. and South America. There was also a rise in offshore wind infrastructure investment in the North Sea, with the UK government awarding €100bn of licences to develop 18GW of offshore wind capacity by 2020. In November 2010 the initial public offering of Italy's Enel Green Power, an onshore wind and solar utility operating in Italy, Spain and the US, was the largest specialist renewable energy company to list since 2007 (Bloomberg New Energy Finance, 2011).

Tidal power offers additional opportunities for clean energy production as this technology is refined and commercialised.

Biofuels. A new carbohydrate-based economy – one built on energy crops that can be harvested and wastes that can be recovered – may begin to displace the hydrocarbon economy and the reliance on the drilling and refining of carbon-intensive fossil fuels. Biofuels such as ethanol and biodiesel, coupled with electric hybrids, high-efficiency diesels, and other alternative-fuel vehicles, offer the great promise of significantly reducing the need for imported oil supplies. In addition, biofuels offer the potential for quieter engines, extended engine life, less engine maintenance and reduction in carbon emissions and tailpipe fine particulate matter. Technologies related to biofuels include those that turn carbohydrates into plastics and other biomaterials. After solar, biofuels were the next largest sector for research and development in renewable energies in 2010 due to a large increase in public sector spending (Bloomberg New Energy Finance, 2011).

Green Building. The growth in the construction of green buildings which are based on energy efficiency is resulting in developers and builders moving towards using more cost-effective efficiency techniques. Environmentally sustainable property design and operation can encompass a number of measures, including solar hot water systems, rainwater harvesting, efficient lighting with motion detectors, use of recycled building and outfitting materials, maximisation of natural light, use of high-performance double glazed windows, provision of bicycle facilities, etc. Russell believes that "the marketing advantages of highly-rated green buildings have been empirically demonstrated and... [landlords] are investing in green building technology primarily as a way to ensure the relevance of their buildings in the future" (Lamb, 2011).

Electric Vehicle Technology. The revival of electric vehicle technology and the continued development of hybrid electric vehicles, including airplanes, automobiles and light vehicles (motorbikes, scooters, mopeds, etc.) offers continued investment opportunities. Related cleantech opportunities include the supply of efficient batteries (such as lithium-ion batteries) and carbon-composite materials to reduce vehicle weight. Future developments in plug-in hybrid electric vehicles, pure plug-in electric vehicles or hydrogen fuel-cell vehicles could potentially revolutionise the personal transportation industry.

Smart Grids. The potential development of current energy distribution and generation systems into smart electric grids ("smart grids") offers new opportunities for investors. Smart grids can generate and distribute electricity on a large-scale and will look and feel more like the Internet. A range of smart-grid appliances, including new smart meters, remote sensors, energy-management systems, better transmission lines (potentially involving breakthroughs in superconductivity), and advanced storage technologies will optimise electricity generation, dissemination and usage. The transformation of our current electric grids into smart grids will allow homes and businesses to buy and sell electricity generated from solar, wind, fuel cells and other distributed clean-energy sources. As a consequence of its more decentralised nature, it is postulated that no single terrorist attack, accident, natural disaster, or heat wave could bring down a smart grid – a system in which almost all households and businesses are producing, storing, distributing and forming a more competitive and efficient marketplace for electricity.

A key benefit with the use of smart grids is the movement to time-of-use pricing and demand response management leading to load balancing and the hence the avoidance of some of the massive capital expenditure that would otherwise be required given the age and poor quality of much of the current distribution network infrastructure.

Clean Water. While approximately three quarters of the Earth's surface is water, 97% of this water is salty, making it undrinkable and unusable in most commercial and industrial applications. Water requires vast amounts of energy to pump, filter, purify, distribute, and recycle and in many localities around the world, the water system is among the largest consumers of energy. Hence, increasing the efficiency of clean water production can yield significant savings in energy consumption and also increase the supply of high-quality water for manufacturing and industry. In both the developing and developed world, a range of new clean water technologies are being developed, including desalination, reverse osmosis, nano-based membranes, and ultra-filtration. In addition, clean water technologies can be pared with clean energy sources, for example in Australia the WA Water Corporation, which is building the Southern Seawater Desalination Plant, has committed to purchase 100 percent of the power generated by Greenough Rover Solar Farm (Verve Energy, 2011).

We note that there is also growing interest in water recycling, such as the conversion of municipal sewage into potable water, for agricultural irrigation and space applications. Opportunities for investment also exist in water-monitoring and water-saving techniques.

Mobile Cleantech. While consumer electronic devices and military applications offer great potential for mobile cleantech, it is also finding growing application in disaster recovery and relief as well as off-grid power in the rural villages of the developing world. Mobile cleantech includes high efficiency solar cells, and mobile solar rechargers, portable fuel cells, portable water filtration devices and advanced nano-based batteries.

Energy from Waste. Landfill from waste garbage is a massive issue worldwide, as is the methane emissions which have twenty times the global warming impact as carbon dioxide. A tonne of landfill creates a tonne of CO2 equivalent. Energy from Waste is a huge opportunity and, if properly constructed, it creates electricity, steam, boosts recycling and massively reduces landfill. China expects Energy from Waste to produce three gigawatts by 2020. The European Union has issued directives to prevent landfill waste disposal by 2020.

RISKS WHEN INVESTING IN GLOBAL CLEANTECH

As with any investment, there are many risks to investing in global cleantech. Some of these include:

- Technology Risks
- Political and Regulatory Risks
- Variable Raw Material Costs
- Fossil Fuel Price Dynamics
- Increased Competition
- Intellectual Property Piracy/Industrial Espionage
- Macroeconomic Risks
- Environmental Impact
- Climate Change
- Financing Risks
- Military Funding Risks

Technology Risks. As already noted by Russell, cleantech is primarily a play on specialised technologies which in some cases are unproven. Therefore, there exists the real risk that cleantech ventures which appear fantastic in theory have unexpected issues when it comes to practical application and commercialisation. In addition, there is also the risk of technological displacement, in which a proven technology is superseded by an even better technology.

For example, in the race to mass produce cellulosic ethanol, entrepreneurs and governments across the globe are considering using biofuel feedstocks such as corn stover, forestry wastes, wood residues, switchgrass, cassava, sweet sorghum, sugar cane, sweet potatoes, and the jatropha tree. However, it is unlikely that all of these biofuel feedstocks while eventually be used in the mass production of cellulosic ethanol. On the other hand, other potential avenues to cellulosic ethanol include the use of a combination of algae, microbes, enzymes and fungi to break down cellulosic materials, and this only adds to the number of potential possibilities for cellulosic ethanol production. Finally, we note that biobutanol, a bio-based fuel similar to ethanol, may prove more popular with consumers as it can be used in regular internal-combustion engines with no retrofitting and provides more energy than ethanol (Pernick & Wilder, 2008).

Another example of technological risk is occurring in the race to produce clean automobiles. While most entrepreneurs and established automotive companies are generally attempting to transition away from petroleum (traditional gasoline and diesel) to a combination of electricity and petroleum or biofuels as the primary source of power for vehicles, there remains the possibility of resurgence in the use of hydrogen fuels cell technology in the production of clean automobiles (Pernick & Wilder, 2008).

Therefore, the technological risk with cleantech means that there is potentially significant downside for investors who invest in the wrong technologies. However, investors can minimise technology risk by diversifying their global cleantech portfolio and also by employing skilled investment managers.

Political and Regulatory Risks. The political environment will have a huge influence on the success of cleantech in the future. However, Russell has noted that "significant too are the impacts on the economy from changes in [environmental] regulation... experience suggests that the consequences of government measures are not always intuitively obvious" (Liddell, 2009).

The unexpected withdrawal of political and regulatory support for a particular cleantech industry, or equally the unexpected political and regulatory support for a competing cleantech industry (e.g. the political adoption of hydrogen fuel cells over biofuels), due to political lobbying by interested parties could result in currently promising cleantech investments facing significant headwinds in the future.

For example, in 2010 "moves by Spain and the Czech Republic to make retroactive cuts in feed-in tariff levels for already-operating PV projects damaged investor confidence. Other governments, such as those of Germany or Italy, announced reductions in tariffs for new projects..." (Bloomberg New Energy Finance, 2011). These types of political and regulatory changes were attributed as contributing factors to the politicised bankruptcy on 31 August 2011 of Solyndra LLC, the American manufacturer of cylindrical solar systems for commercial roof tops that received a $535 million loan guarantee from the U.S. Department of Energy. Solyndra's president and CEO Brian Harrison stated "regulatory and policy uncertainties in recent months created significant near-term excess supply and price erosion. Raising incremental capital in this environment was not possible. This was an unexpected outcome and is most unfortunate" (Solyndra LLC, 2011).

Unfortunately, even in Australia regulatory and political uncertainty has impacted the solar industry. Solar Shop, one of Australia's largest sellers of solar panels, was placed in receivership in September 2011 and put up for sale after state and federal governments cut feed-in tariffs for solar panels (Manning, 2011).

Variable Costs of Raw Materials. While cleantech is often associated with electricity production from renewable and free energy sources, such as the sun, the wind or the tide, this does not mean that the resultant electricity is costless to produce. For instance, raw materials such as silicon and steel are required to manufacture solar photovoltaic panels and wind turbines. Many cleantech production processes use rare earths like neodymium which, as the name suggests, are in short supply and have a limited number of producers. Consequently, shortages in raw materials required for the production of cleantech can lead to significant increases in manufacturing costs and therefore the competitiveness of cleantech products and processes relative to their contemporary, fossil fuel-based counterparts (Pernick & Wilder, 2008).

It also should be noted that cleantech competes for raw materials like any other industry, and therefore the cost of raw materials is dependent upon demand from other industries or sectors of the global economy and not simply shortages in their supply. For instance, biofuels which currently rely on corn, soybeans and canola for their production, must compete with consumers and agriculture for these food crops. Additionally, the rapid economic expansion in China, India and other developing economies is raising the cost of raw materials more generally.

Fossil Fuel Price Dynamics. The transition to a low carbon global economy could lead to potentially unpredictable and unusual behaviour in the prices of fossil fuels, such as oil and coal. This is because, from the perspective of demand, consumers of electricity and petroleum will likely substitute for electricity and fuel produced from cleantech when sufficient increases in the price of oil and coal make them economically competitive. However, as this substitution effect will result in decreased demand for oil and coal, this could result in the removal of upward pressure on their prices and even lead to consumers switching back to energy produced from coal and oil as these fossil fuels become cost competitive once again. Evolution in the supply of oil and coal and cleantech products, such as solar PV cells, biofuels and wind power, could also potentially impact the price of coal and oil in unexpected ways.

Therefore, the potential for a non-uniform adoption of cleantech during the transition to a low carbon global economy could lead to cleantech investments with more volatile revenue streams than first anticipated.

Note that the price dynamic for existing coal and gas electricity power stations could be even more pronounced. Time-of-use pricing and use of smart grids could make peak demand gas capacity largely redundant. The Merit Order Effect also means base load coal power becomes the high marginal cost supplier, and this has seen low demand periods result with negative wholesale electricity prices (in Germany, Ireland and South Australia).

Increased Competition. As the global cleantech sector grows there will likely be increased competition as latecomers to the sector seek to establish themselves and compete for market share. There will also be mergers, acquisitions and consolidation within the cleantech sector as industries attempt to grow scale in order to reduce manufacturing costs and increase efficiencies from the centralisation of administration and corporate functions (Pernick & Wilder, 2008).

We note that an additional side-effect of the growth of the cleantech sector could be the so-called ‘greening’ or ‘cleaning’ of the global equity market, in which a large number of corporations whose shares are listed in global equity indices adopt and incorporate cleantech into their businesses. In this case, the cleantech sector could come to represent a significant proportion of the global equity market and, on average, earn market-like returns.

On the other hand, we note that a competitive response from sectors and industries which stand to lose economically from the future potential success of cleantech could lead to increased downside for cleantech investors. Cleantech has to compete with established industries which will very likely seek to protect the return on their investments in existing infrastructure. This could result in delays in the adoption of cleantech and revenue streams being realised later than expected.

Increased competition in the cleantech sector is also likely to come from corporations based in emerging markets. As these economies develop and modernise they are likely to increase their demand for energy, and due to their lack of fossil fuel-based legacy infrastructure, will likely be more predisposed to investing in cleantech. Indeed, “during 2010 the centre of gravity for global renewables investment continued to shift to the developing world. New financial investment (asset finance, plus capital raising by companies from venture capital, private equity and public market investors) in developing countries outstripped that in the developed world for the first time, with developing countries receiving $72.2 billion versus $70.5 billion for the developed world” (Bloomberg New Energy Finance, 2011).

As a result of their relatively cheap labour forces, cleantech ventures created by entrepreneurs from emerging markets could and are becoming significant competitors for cleantech companies based in the developed markets such as the United States, Europe, Japan and Australasia. The supply side effect has been material – the Chinese, Taiwanese and Koreans have built significant capacity ahead of demand, resulting in double digit deflation in prices of wind turbines, poly silicon, solar modules, LEDs etc. This underpins rapid new technology take-up, but destroys corporate profitability. For companies, cash flow management can become problematic. Heavy capital expenditure demands combined with increasing revenue but declining margins can drain working capital and make debt servicing difficult, evidenced in part by the recent collapses in the United States of Solyndra, Ener1 and Beacon Power. Such sentiment has been echoed by U.S. President Obama when discussing the $535 million loan guarantee to Solyndra LLC he noted that “if we want to compete with China, which is pouring hundreds of billions of dollars into this space... we’ve got to make sure that our guys here in the United States of America at least have a shot” (Wall Street Journal, 2011). In addition, Brian Harrison, president and CEO of Solyndra noted that they “could not achieve full-scale operations rapidly enough to compete in the near term with the resources of larger foreign manufacturers.” (Solyndra LLC, 2011).

Intellectual Property Piracy/Industrial Espionage. As with all businesses involving research and development (R&D), protection of intellectual property is a major issue. Many developing countries require foreign corporations to joint-venture with local corporations when accessing their markets, resulting in an increased risk of piracy of cleantech business secrets in those jurisdictions with weak records in upholding intellectual property rights. SMA Solar, a global leader in the solar inverter market that spends €100 million on R&D annually announced in October 2011 they would not go into China for this reason. American Superconductor suffered a 90% drop in market capitalisation after an employee sold proprietary software used to control wind turbines to Chinese firm Sinovel Wind Group (Smith R. , 2011).

Macroeconomic Risks. While all sectors of the global equity market are subject to macroeconomic risks, the cleantech sector is particularly sensitive to shocks in global economic growth. This is because downturns in economic activity are likely to result in decreased energy use and this will likely reduce demand for cleantech and also lead to lower prices for conventional, fossil-fuel based energy. In addition, slowdowns in global economic growth may also lead to reduced public and government support for cleantech initiatives, as “governments, facing economic hardship, might go back on previously promised deals for existing projects, damaging returns for equity investors and banks” (Bloomberg New Energy Finance, 2011). Also, support for issues such as climate change and environmental conservation tend to lose government priority to concerns regarding employment and business growth in recessions. Finally, poor global economic management and higher inflation could retard the development of cleantech due to inefficient resource allocation.

Environmental Impact. There is still some debate over the likely environmental impact from the adoption of cleantech despite its aim to harness renewable materials and energy sources while dramatically reducing the use of natural resources and productions of emissions and wastes. For example, with regard to the production of biofuels, there are concerns about energy needs competing with food crops, the level of greenhouse gas emissions in the production of biofuels, deforestation resulting from biofuel crop production and the use of genetically modified organisms to optimise biofuel crops (Pernick & Wilder, 2008). There are also environmental concerns with desalination, such as how to dispose of the salts extracted from sea water and even the safety of birds and bats with regard to wind power (Pernick & Wilder, 2008). There is also considerable debate in the community over the impact of low vibration noise from wind turbines on human health. A 2006 expert panel review in North America found no evidence that audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effect (Rogers, Manwell, & Wright, 2006). Nevertheless, such issues have the potential to negatively affect the development of cleantech if public sentiment wavers or government support is withdrawn.

Climate Change. Despite the allure of cleantech because of its potential to counteract climate change through lower carbon emissions, global or local climate change has the potential to significantly affect cleantech, particularly because of cleantech's high reliance on the regularity of environmental processes. For example, local climate change has the potential to affect the efficiency of wind farms which generally need the wind to be blowing steadily. As wind farms are generally not mobile, investors need to be aware that the wind patterns may change and this could significantly affect the profitability of their investment. Climate change will not only effect the production of wind power, but also could affect the generation of other cleantech such as solar power, biofuels and water desalination. Increased cloud cover, increased storm activity and higher sea levels could all impact returns for cleantech investors.

Financing Risks. The high capital cost to build large-scale cleantech utilities or manufacturing plants can become an increasing liability in the face of tightening credit markets. Given that financial institutions will likely perceive cleantech to be a nascent sector for some time to come, investors should be aware of the risk that financing for cleantech ventures could be withdrawn during times of economic or regulatory uncertainty.

Military Funding Risks. Many militaries around the world have realised that they need to be leaders in energy efficiency and cleantech if they are to remain competitive. Their objective is to keep remote, on-foot soldiers powered in the field for days at a time. Their focus is on fuel reduction, weight reduction and efficiency using mobile cleantech. However, while military funding is often substantial and lucrative, companies which have military funding may have issues with protecting their intellectual property and navigating the military's extensive bureaucracy. Additionally, companies which are too reliant on military funding may have issues securing finance in the private sector should the military reallocate its funding budget (Pernick & Wilder, 2008).

SECTION II: INVESTING IN GLOBAL CLEANTECH

There are three general ways of allocating to global cleantech:

- Listed equities
- Venture capital and private equity
- Mezzanine debt financing

Listed Equities. These are shares listed on recognised global stock exchanges. These include major stock exchanges such as the New York Stock Exchange (NYSE), the NASDAQ Stock Market, the London Stock Exchange (LSE), comparatively minor stock exchanges such as the Australian Stock Exchange (ASX), the Hong Kong (HKEX) and the New Zealand Stock Exchange (NZX) and exchanges in emerging markets such as Sao Paulo Brazil (BM&FBOVESPA). Allocating to cleantech by investing in listed cleantech shares provides exposure to the asset class, some liquidity and also daily pricing of the market value of the securities. Furthermore, as listed cleantech shares are potentially priced by thousands, or even millions of investors, their prices reflect a wide number of valuation methods for a sector in which it can be difficult to price the potential investment returns. While investing in global listed cleantech shares is a complex undertaking because of the number of stock exchanges on which cleantech shares are listed, there are a number of fund managers which can provide access to portfolios of global cleantech shares, either actively or passively managed, for a reasonable cost.

Venture Capital and Private Equity. These offer investors exposure to cleantech ventures before they list on stock exchanges, allowing earlier points of entry and exit for value creation. Venture capital focuses generally on finding entrepreneurs in the cleantech sector who need capital to further grow and develop their nascent cleantech ventures. Venture capitalists frequently have informal or formal relationships with the research departments of major universities.

Private equity typically refers to investments in established cleantech ventures which are privately held and are seeking to expand or list on a public exchange. While somewhat related, we note venture capital and private equity have very different risk and return characteristics.

Mezzanine Debt Financing. This focuses on taking a debt position rather than an equity position in a developing cleantech venture and is also known as 'bridging finance'. Because of the elevated credit risk in developing cleantech ventures, investors providing such finance can earn reasonably high yields as compensation and, should a venture fail, will at least have claim to the venture's assets before equity holders.

Given that providers of mezzanine debt financing may provide financing through hybrid debt-equity structures, this type of financing is often found within venture capital and private equity funds. A commonality between venture capital, private equity and mezzanine debt financing is that these investments are usually priced with a monthly or quarterly lag, and are not very liquid. While they may be able to be traded on a secondary market, this can be difficult and may involve realising a discount to net asset value.

HOW HAVE GLOBAL LISTED CLEANTECH SHARES PERFORMED?

In this report, we focus the discussion on allocating to the global cleantech sector using listed equities, rather than through venture capital and private equity or mezzanine debt financing. This is not because we feel that venture capital and private equity or mezzanine debt financing are not appropriate for cleantech investing, or that breakeven analysis cannot be applied to these investments, but rather because listed equities are the most liquid and transparent method for allocating to global cleantech.

A number of index providers have established global benchmark indices for the clean technology sector. Well-known global clean technology indices include the Cleantech Index (CTIUS), the Wilderhill Clean Energy Index and the Wilderhill-New Energy Global Innovation Index, the Ardour Global Index Composite and the FTSE Environmental Opportunities All-Share Index. A common theme across all clean technology indices is their bias to small capitalisation stocks. Performance differentials between the indices mainly result from differing levels of diversification, index methodologies, stock inclusion criteria (e.g. minimum market capitalisation, liquidity and percentage of cleantech revenue requirements), weights to cleantech sub-sectors (e.g. solar) and the subjectivity of the committees which oversee their construction.

Ardour Global Alternative Energy Indexes. The Ardour Global Index^{SM} Composite ("Ardour Composite") is a capitalisation weighted, float adjusted equity index designed to serve as an equity benchmark for globally traded stocks which are principally engaged in cleantech. The Ardour Composite is global and includes 130 stocks selected from a universe of equity securities traded on recognised stock exchanges in North America, South and Central America, Europe, Middle East and Africa (EMEA) and Asia-Pacific and was incepted on 31 December 1999. The Ardour Composite is calculated and maintained by Dow Jones Indexes, a business unit of index provider Dow Jones & Company (Ardour Global Indexes LLC, 2011).

Figure 1: Rolling Five-Year Annualised Return in US Dollars of Global Listed Cleantech, Global Equities and Global Fixed Income since 31 December 2004

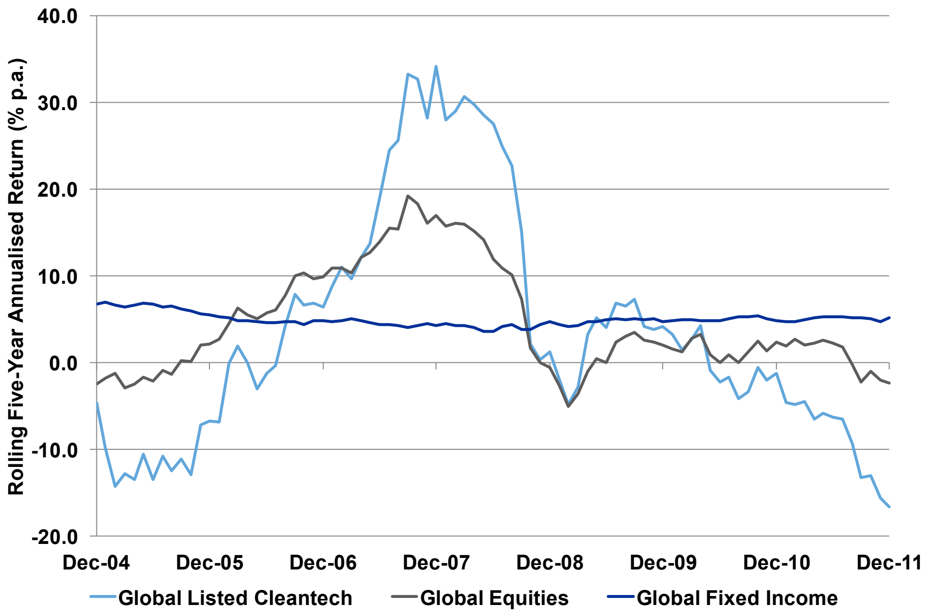
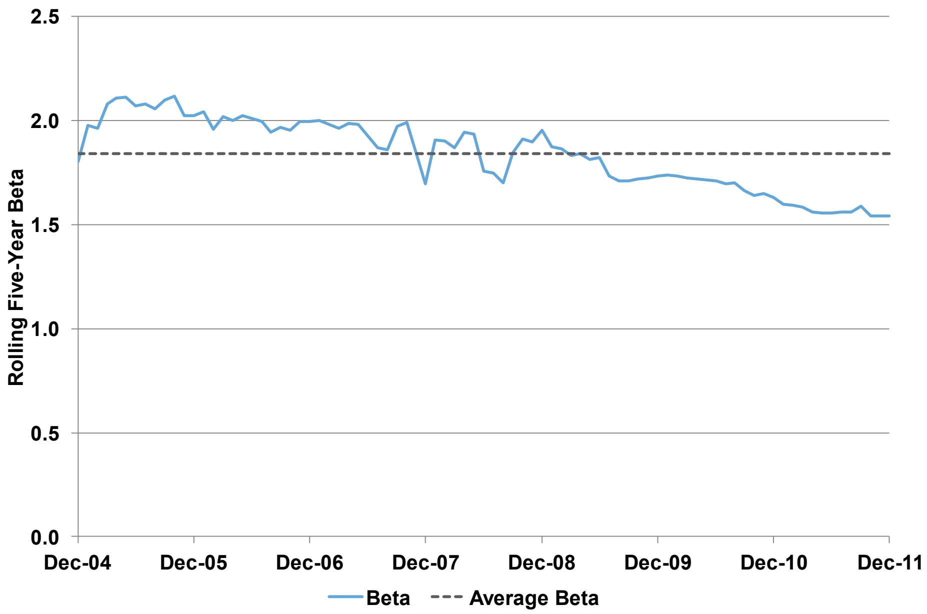


Figure 1 shows the rolling five-year annualised return in U.S. dollars since 31 December 2004 for global listed Cleantech represented by the Ardour Composite, global equities represented by the MSCI World Net Dividend Index, and global fixed income represented by the Barclays Capital Global Aggregate Index fully hedged to the US dollar. It can be seen from Figure 1 that:

- The performance of the global listed cleantech has been more similar to the performance of global equities than it is to the performance of global fixed income. This is expected as the global listed cleantech is a sector of the global equity universe.
- There has been significant divergence between the performance between global listed cleantech and global equities over time. In general, it appears that global listed cleantech tends to outperform when returns from global equities are positive and underperform when returns from global equities are negative. This suggests that the global cleantech sector has a high beta relative to global equities.
- Global listed cleantech has underperformed the global equity market more recently due to the failure to forge an internationally binding agreement at the Copenhagen Climate Change Conference and "investor concerns about industry over-capacity, cutbacks in subsidy programmes and competition from power stations burning cheap natural gas" (Bloomberg New Energy Finance, 2011). The recent poor returns and lower valuations may provide new investors with a good opportunity to access the global listed cleantech asset class.

In Figure 2 we show the rolling five-year beta of global listed Cleantech represented by the Ardour Composite with global equities represented by the MSCI World Net Dividend Index. Beta is a measure of systematic risk and it reflects the tendency of a security or sector's returns to respond to the broad market.

Figure 2: Rolling Five-Year Beta of Global Listed Cleantech since 31 December 2004



As can be seen from Figure 2, the global listed cleantech sector has a very high five-year beta relative to the global equity market which has ranged between 1.5 and 2.2 since 31 December 2004. The average five-year beta is 1.84. The trend for the beta to decrease over time perhaps reflects the maturing of the global listed cleantech sector.

In addition to global equities, commodities are also a related asset class to global listed cleantech. This is because commodities are required as the raw materials in the production of many cleantech products, and also the price dynamics of fossil fuels such as oil and coal affect the cost competitiveness of cleantech.

Since the early 2000s, global listed cleantech has become increasingly correlated with commodities. For example, the correlation between monthly returns on the Ardour Composite and the S&P Goldman Sachs Commodity Total Return Index was 0.10 over the five-year period from 2000 to 2004, but over the five-year period from January 2007 to December 2011 the correlation increased to 0.65. Figure 3 shows how the rolling five-year correlation of monthly returns between global listed cleantech and commodities has increased since the early 2000s. Figure 3 also shows the correlation between commodities and global equities.

Figure 3: Rolling Five-Year Correlations between Commodities, Global Equities and Global Listed Cleantech since 31 December 2004

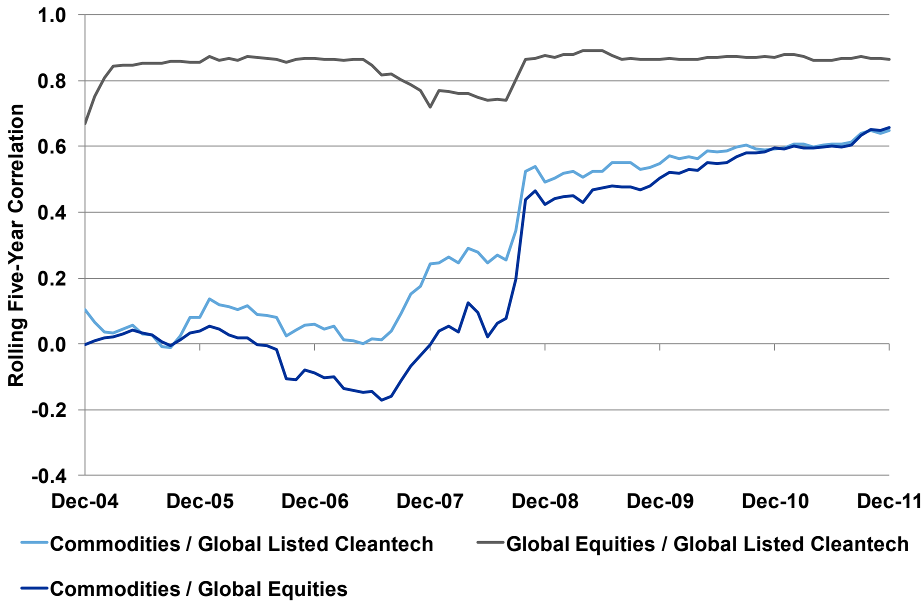


Figure 3 shows that global equities have also become more correlated with commodities over time. Hence, while the relatively poor recent performance of global listed cleantech may have resulted because the recent fall in commodity prices, such as oil, led to fossil fuel energy sources remaining cost competitive with clean energy, Figure 3 suggests that the recent poor performance is more likely due to its high correlation with the global equity market. That is, the poor performance of global equity markets led to poor returns for global listed cleantech as well as for commodities.

VOLATILITY AND CORRELATION ASSUMPTIONS FOR GLOBAL LISTED CLEANTECH

In order to conduct breakeven analysis for global listed cleantech, estimates are first required for the volatility of global listed cleantech as well as its correlations with other asset classes. As Russell uses five-year asset class assumptions when undertaking asset allocation studies, we will consider rolling five-year volatilities and correlations.

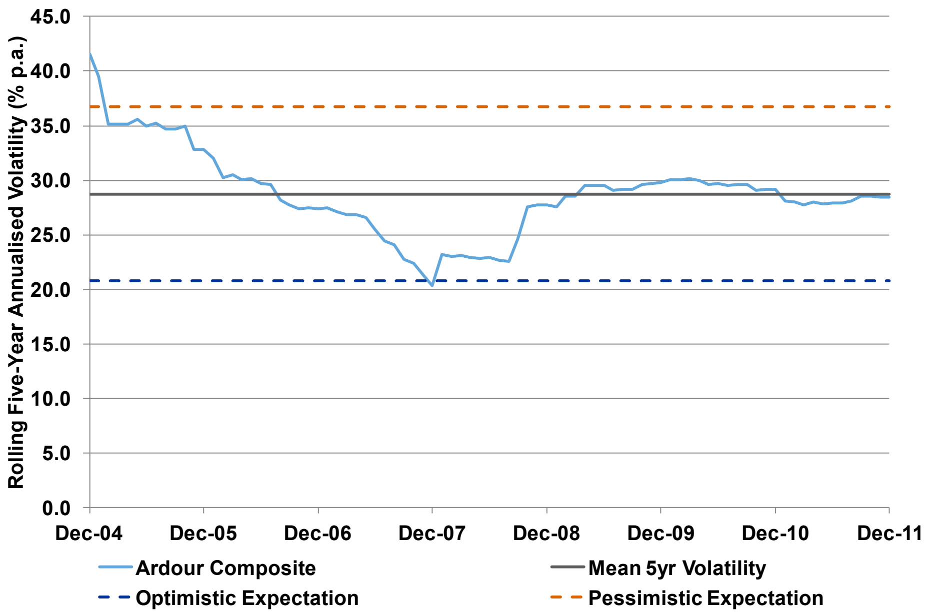
However, before volatilities and correlations for global listed cleantech can be estimated it must be decided whether Australian investors are better served by investing in global listed cleantech on a hedged or unhedged basis. As a general principle Russell recommends that, subject to liquidity constraints, investors separate foreign asset and currency decisions. That is they invest on a fully hedged basis and consciously determine how much and to what currencies they wish to be exposed (Toner, 2011). However, current practice does not typically isolate the asset and hedging decision.

Investing on a hedged basis means that Australian investors will receive the local return of global listed cleantech shares as well as the forward carry, which is known in advance. On the other hand, unhedged investors receive the local return of global listed cleantech shares and the return of the currency basket of their global listed cleantech portfolio. While investing on an unhedged basis in global listed cleantech exposes investors to the risk that currency returns erase returns from global listed cleantech shares, investing on a hedged basis is potentially difficult because it introduces issues of liquidity management. Currency hedging typically requires monthly (or quarterly) cash flows to roll the hedges, which, in the absence of other sources of liquidity, requires investors to either buy or sell the underlying shares. Given global listed cleantech portfolios are relatively biased to smaller capitalisation stocks and maybe even emerging markets, they are likely to exhibit poor liquidity, increased spread costs and market impact.

In Russell's view, all other things being equal, the poor liquidity of global listed cleantech shares is reason to invest on an unhedged basis. We also note that as global listed cleantech will only form a small part of most investors' global equity portfolios, it can be allocated to the unhedged portion of the portfolio. Hence, we now consider unhedged returns for global listed cleantech.

Figure 4 shows the rolling five-year annualised volatility of global listed cleantech, represented by the Ardour Composite since 31 December 2004, in unhedged Australian dollars.

Figure 4: Rolling Five-Year Annualised Volatility of Global Listed Cleantech in Australian dollars since 31 December 2004



From Figure 4 it can be seen that the volatility for the Ardour Composite in unhedged Australian dollar terms is very high, having ranged between approximately 20% to 40% per annum. The mean, or average, five-year volatility from December 2004 to September 2011 has been 28.7% per annum. Using two-standard deviation bands around the mean five-year volatility, 'optimistic' and 'pessimistic' assumptions for the volatility of global listed cleantech over a five-year period can be formed. We summarise this analysis of the Ardour Composite for unhedged global listed cleantech returns in Australian in Table 1 and note that we have rounded our volatility assumptions to 1% per annum.

Table 1: Five-Year Volatility Assumptions for Global Listed Cleantech		
Optimistic	Base Case	Pessimistic
21% p.a.	29% p.a.	37% p.a.

Using a similar procedure, we determined five-year assumptions for the correlations between global listed cleantech and other asset classes. Correlation estimates for global listed cleantech and growth asset classes were derived using historical rolling five-year correlations; they were conservatively set equal to the average rolling five-year correlation plus one standard deviation of the five-year rolling correlation. Correlation estimates for global listed cleantech and defensive asset classes (cash, Australian fixed income and global fixed income) were taken to be equal to those correlations between unhedged global equities and these asset classes in our five-year before-tax, but including franking, asset class assumptions. Five-year assumptions for the correlations between global listed cleantech and other asset classes for Australian investors are shown in Table 2.

Table 2: Optimistic Five-Year Correlation Assumptions between Global Listed Cleantech and other Asset Classes for Australian Investors	
Asset Class	Correlation
Australian Cash	0.0
Australian Equities	0.7
Australian Fixed Income	0.2
Australian Listed Property	0.5
Global Equities (Unhedged)	0.8
Global Equities (Hedged)	0.8
Global Fixed Income (Hedged)	0.2
Global Property (Hedged)	0.6

SECTION III: BREAKEVEN ANALYSIS FOR GLOBAL CLEANTECH

Breakeven analysis has previously been used by Russell (Ansley, Will Alternative Investments Improve Your Portfolio?, 2007) to illustrate whether alternative investments such as private equity, hedge funds, infrastructure and commodities are able to increase portfolio efficiency. In this paper, we extend the use of breakeven analysis to illustrate whether allocating to the global listed cleantech sector of the global equity market is likely to improve portfolio efficiency for sample Australian portfolios.

Breakeven analysis transforms the standard asset allocation question of *"how much of a portfolio should be allocated to an asset class?"* to *"what risk and return characteristics must a new asset class have to maintain portfolio efficiency?"* In other words, breakeven analysis finds the risk and return characteristics which a new investment needs to have in order for a new portfolio including the investment to 'breakeven' in terms of its efficiency[1] relative to an existing portfolio.

The power of breakeven analysis is that it allows investors an alternative to optimisation programs when allocating to investment opportunities which have expected return and volatility estimates that are more susceptible to uncertainty. To provide reliable insights, optimisation programs require precise information about the behaviour of asset classes; if there are even modest errors in expected return and volatility estimates, the usefulness of optimisation-based asset-liability modelling is substantially diminished (Ansley, How to Make Prudent and Profitable Decisions, 2005).

A breakeven contour (which generally appears linear) can be determined which shows the expected returns and volatilities required for an investment opportunity if a portfolio including the new investment is to have the same efficiency as an existing portfolio. A breakeven contour is shown in Figure 5 and it has been calculated for a new conservative portfolio derived from a sample Australian conservative portfolio shown in Table 3 with a 3% allocation to global listed cleantech (i.e. 10% of growth assets is allocated to global listed cleantech) at the expense of unhedged global equities. The breakeven contour shows expected return and volatility assumptions for global listed cleantech which would ensure that the new conservative portfolio has the same Sharpe ratio as the existing sample conservative portfolio.

Figure 5: Breakeven Contour for the Sample Conservative Portfolio and Global Listed Cleantech

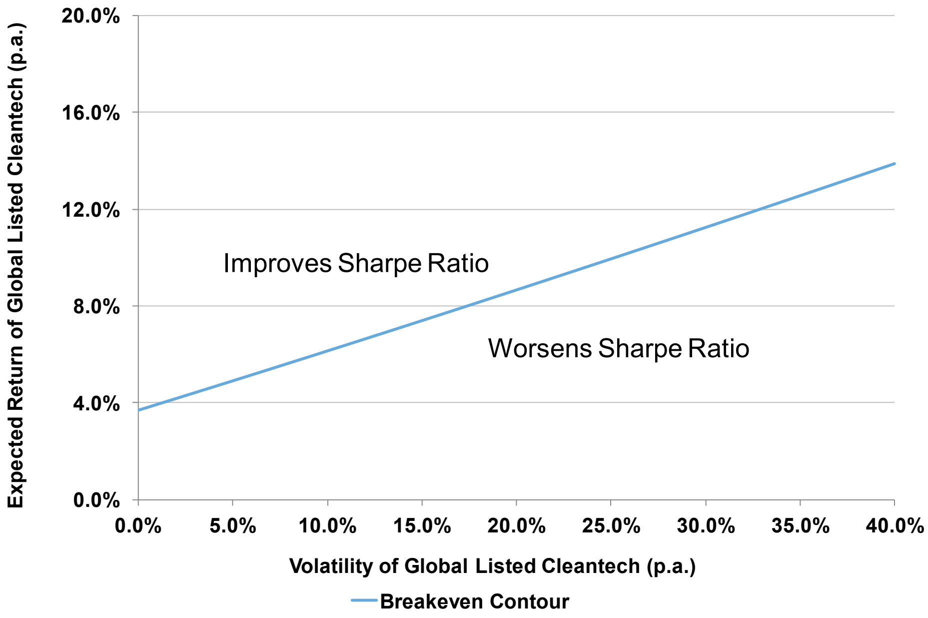


Figure 5 shows that the breakeven contour is approximately straight and divides the space of expected return and volatility assumptions for global listed cleantech into two areas. Assumptions for global listed cleantech which lie in the area above the breakeven contour result in the Sharpe ratio of the new conservative portfolio increasing relative to the sample conservative portfolio. On the other hand, assumptions for global listed cleantech which lie in the area below the breakeven contour result in the Sharpe ratio of the new conservative portfolio decreasing relative to the sample conservative portfolio

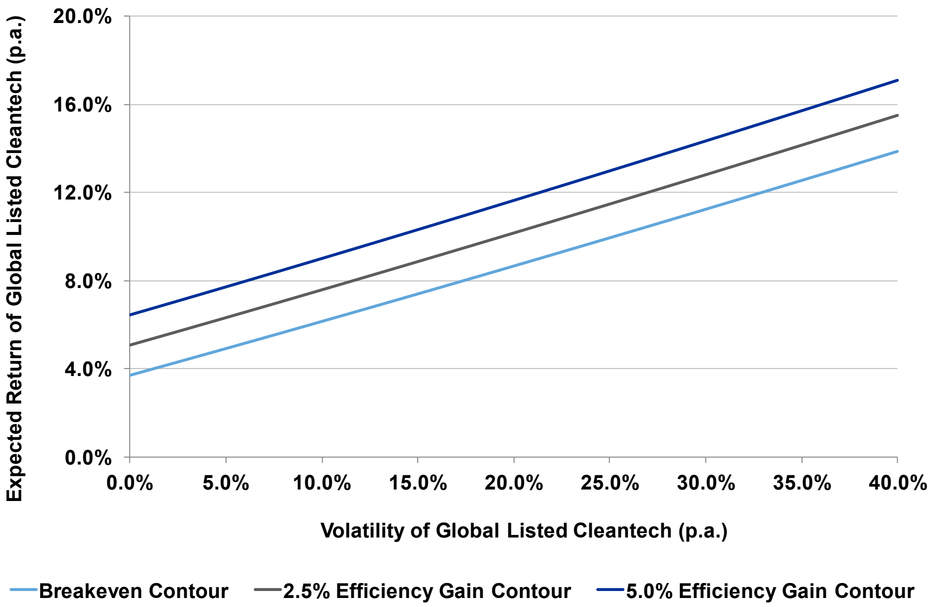
The breakeven contour can be used to check whether candidate assumptions for global listed cleantech are likely to result in an increase in portfolio efficiency. For example, if

[1] As measured by the Sharpe Ratio (more details in the discussion around Table 3).

we assume that global listed cleantech will have a volatility of approximately 30% over the next five years (based on the analysis from Table 1) then the expected return of global listed cleantech must be greater than 11.2% per annum – the expected return for the breakeven contour at a volatility of 30% per annum – in order for the new conservative portfolio to be more efficient than the sample conservative portfolio. On the other hand, if we are more optimistic and assume that global listed cleantech will have a volatility of 20% per annum over the next five years, then the breakeven contour indicates a required expected return for global listed cleantech of 8.7% per annum in order for the new conservative portfolio to be at least as efficient, in terms of the Sharpe ratio, as the sample conservative portfolio. Portfolio strategists can then argue the case as to whether these expected returns and volatilities for global listed cleantech are reasonable.

We note, however, that adding an asset class or investment to a portfolio is usually a costly exercise and is unlikely to be undertaken unless there is likely to be a material gain in portfolio efficiency; portfolio managers are unlikely to allocate to new asset classes if they will not increase portfolio efficiency sufficiently. Breakeven analysis can account for this through contours which indicate increases in portfolio efficiency. Figure 6 shows contours in addition to the breakeven contour which indicate assumptions for global cleantech resulting in the new conservative portfolio having a Sharpe ratio 2.5% and 5.0% greater than the Sharpe ratio of the sample conservative portfolio.

Figure 6: Efficiency Contours for the Sample Conservative Portfolio and Global Listed Cleantech



From Figure 6 it can be seen that the contours which detail 2.5% and 5.0% increases in portfolio efficiency for the Sharpe ratio lie in the area above the breakeven contour, as expected. These efficiency contours can then be used to check what expected returns are needed for global listed cleantech if increases in portfolio efficiency by 2.5% and 5.0% are to be achieved. For example, if global listed cleantech is assumed to have a volatility of approximately 30.0% per annum over the next five years, then in order for a 3% allocation to global listed cleantech within the conservative portfolio at the expense of unhedged global equities to increase portfolio efficiency by 2.5% and 5.0%, the expected return for global listed cleantech must be 12.8% per annum and 14.3% per annum respectively.

Breakeven analysis can also be used to show graphically under what circumstances allocations to global listed cleantech are able to improve sample balanced and growth portfolios for Australian investors. Table 3 shows the sample Australian portfolios which we have used in our analysis; these are loosely based on the June 2011 Chant West Strategic Asset Allocation Survey and, we note, do not represent advice by Russell on strategic asset allocation. These portfolios have a 50/50 split between Australian equities and global equities and also assume a strategic currency hedge ratio of 33% for global equities.

Table 3: Sample Conservative, Balanced and Growth Portfolios for Australian Investors

Asset Class	Conservative	Balanced	Growth
Australian Cash	25.0%	10.0%	5.0%
Australian Fixed Income	30.0%	25.0%	15.0%
Global Fixed Income (Hedged)	15.0%	15.0%	10.0%
DEFENSIVE ASSETS	*70.0%*	*50.0%*	*30.0%*
Australian Equities	10.0%	20.0%	30.0%
Australian Listed Property	5.0%	5.0%	5.0%
Global Equities (Unhedged)	6.7%	13.3%	20.0%
Global Equities (Hedged)	3.3%	6.7%	10.0%
Global Property (Hedged)	5.0%	5.0%	5.0%
GROWTH ASSETS	*30.0%*	*50.0%*	*70.0%*
Expected Return (p.a.)	**6.5%**	**7.3%**	**8.1%**
Volatility (p.a.)	**5.6%**	**9.0%**	**12.3%**
Sharpe Ratio	**31.9%**	**29.5%**	**27.6%**

The expected return, volatility and Sharpe ratio estimates shown in Table 3 have been derived using five-year before-tax, but including franking, asset class assumptions. We note that the Sharpe ratio is a widely used measure of risk adjusted performance, or portfolio efficiency, which states the expected excess return over the risk-free rate per unit of portfolio volatility. If a portfolio change increases the Sharpe ratio, then the portfolio is improved in the sense that it can either be combined or levered with the risk-free asset to produce a new portfolio with the same risk but higher expected return than the original, or alternatively with the same return but lower risk. We note that in practice there is no risk free asset, and cash usually serves as a proxy.

Figure 7 and Figure 8 show the efficiency contours for the sample balanced and growth portfolios with allocations to global listed cleantech of 5% and 7% to global listed cleantech respectively.

Figure 7: Efficiency Contours for the Sample Balanced Portfolio and Global Listed Cleantech

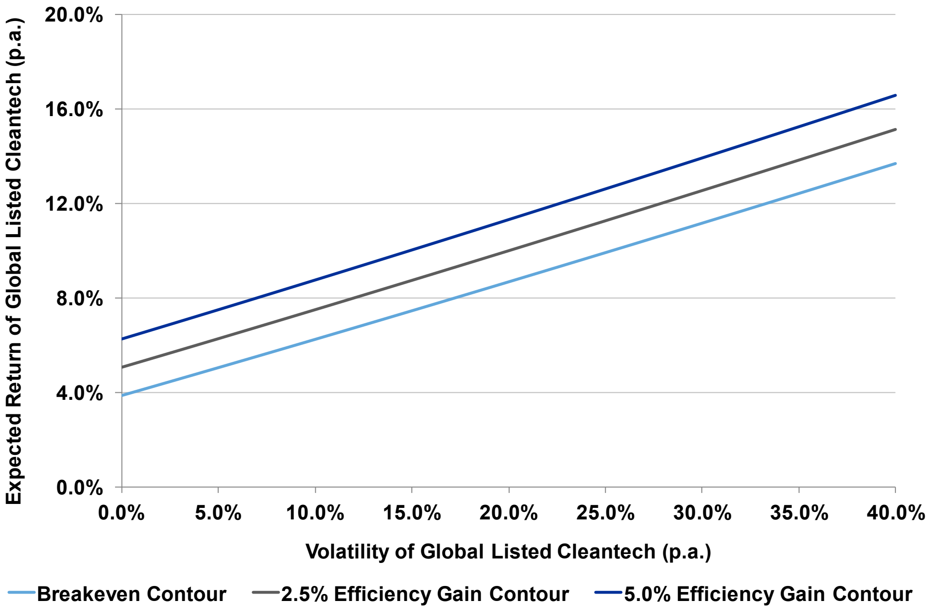


Figure 7 indicates that if global listed cleantech is assumed to have a volatility of approximately 30.0% per annum over the next five years, then in order for a 5% allocation to global listed cleantech within the balanced portfolio (at the expense of unhedged global equities) to increase portfolio efficiency by 2.5% and 5.0%, the expected return for global listed cleantech must be 12.5% per annum and 13.9% per annum respectively.

Figure 8: Efficiency Contours for the Sample Growth Portfolio and Global Listed Cleantech

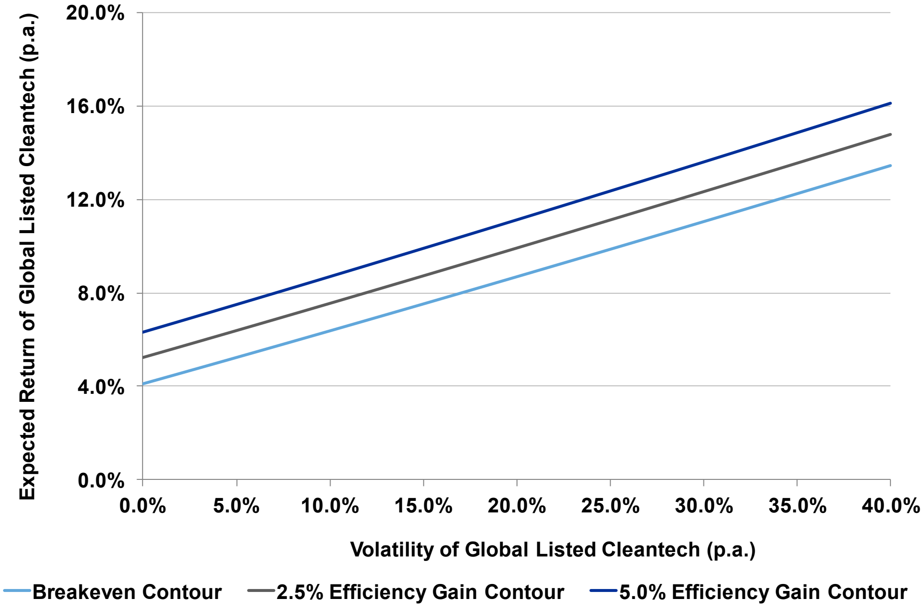


Figure 8 indicates that if global listed cleantech is assumed to have a volatility of approximately 30.0% per annum over the next five years, then in order for a 7% allocation to global listed cleantech within the growth portfolio (at the expense of unhedged global equities) to increase portfolio efficiency by 2.5% and 5.0%, the expected return for global listed cleantech must be 12.3% per annum and 13.6% per annum respectively.

We note from Figure 6 to Figure 8 that the 2.5% and 5.0% efficiency contours move closer to the breakeven contours as the allocation to growth assets increases in the sample portfolios, i.e. as we moved from conservative to growth. This has occurred because the volatility of global listed cleantech is more similar to the volatility of the sample growth portfolio than the sample conservative portfolio, and therefore the increase in portfolio volatility arising from the substitution of global listed cleantech for unhedged global equities is more significant for the sample conservative portfolio than the sample growth portfolio.

Using the optimistic, base case and pessimistic estimates for the volatility of global listed cleantech, we can summarise the results of the breakeven analysis shown in Figure 6 to Figure 8 for adding global listed cleantech to the sample conservative, balanced and growth portfolios. Table 4 shows the expected return required by global listed cleantech for breakeven efficiency, a 2.5% increase in efficiency and a 5.0% increase in efficiency under the optimistic, base case and pessimistic volatility assumptions outlined in Table 1 for the sample portfolios from Table 3.

Table 4: Breakeven Analysis Summary for adding Global Listed Cleantech to Sample Portfolios for Australian Investors

Sample Portfolio	Volatility Assumption	Volatility (p.a.)	Expected Return		
			Breakeven Efficiency	2.5% Efficiency	5.0% Efficiency
Conservative (3% allocation to Cleantech)	Optimistic	21%	8.9%	10.4%	11.9%
	Base Case	29%	11.0%	12.5%	14.1%
	Pessimistic	37%	13.1%	14.7%	16.3%
Balanced (5% allocation to Cleantech)	Optimistic	21%	8.9%	10.2%	11.6%
	Base Case	29%	10.9%	12.3%	13.7%
	Pessimistic	37%	12.9%	14.4%	15.8%
Growth (7% allocation to Cleantech)	Optimistic	21%	8.9%	10.1%	11.4%
	Base Case	29%	10.8%	12.1%	13.4%
	Pessimistic	37%	12.7%	14.0%	15.4%

Table 4 shows that as the volatility assumption increases for the conservative, balanced and growth sample portfolios, the expected return required by global listed cleantech to increase portfolio efficiency also increases. It can also be seen from Table 4 that the expected returns required by global listed cleantech are less for the growth portfolio than the conservative portfolio under all volatility assumptions and efficiency increases; in addition, the expected returns required by global listed cleantech for the balanced portfolio under all volatility assumptions and efficiency increases lie between those for the growth and conservative portfolios. This suggests that adding global listed cleantech to portfolios with higher allocations to growth assets is more likely to increase portfolio efficiency.

Table 4 can also be used in conjunction with an expected return estimate for global listed cleantech to check under what circumstances global listed cleantech will add value to a portfolio. For example, if global listed cleantech is assumed to have an expected return of 12.4% per annum, based on a beta relative to global equities of 1.84 (which is the average of the rolling five-year betas shown in Figure 2), then Table 4 shows that global listed cleantech will increase the efficiency of the conservative, balanced and growth sample portfolios under the base case volatility assumption. This is because the expected return of 12.4% per annum for global listed cleantech is greater than the expected returns required for breakeven efficiency under the base case volatility assumption for each of these portfolios.

It can also be seen from Table 4 that if the expected return for global listed cleantech is 12.4% per annum, then this will increase the portfolio efficiency of the growth portfolio by more than 2.5%, the balanced portfolio by approximately 2.5% and the conservative portfolio by less than 2.5%. Hence, under the base case volatility assumption and assuming an expected return of 12.4% per annum, adding global listed cleantech to the growth and balanced portfolios is more likely to add value. We note that under the optimistic volatility assumption, global listed cleantech with an expected return of 12.4% per annum will increase the efficiency of the conservative, balanced and growth portfolios by over 5.0% whereas under the pessimistic volatility assumption adding global listed cleantech to these portfolios will detract from portfolio efficiency.

CONCLUSION

In contemporary institutional investment portfolios it is not uncommon to find a number of exposures to global equity sectors which are considered to be asset classes in their own right. When global equity sectors are considered to be asset classes, it becomes more likely that institutional investors will make separate allocations to them which are overweight positions relative to the global equity market. However, it is Russell's view that investors must be cautious when considering elevating a sector of the global equity market to an asset class because, even in an efficient market, there will always be arguments in favour and against exposures to various sectors.

In this paper we have shown how institutional investors can use breakeven analysis to provide a quantitative framework for deciding whether making separate allocations to specialist sectors of the global equity market will likely enhance portfolio efficiency. In an investment environment in which political and economic risks are significant and weighing on global financial markets, investors can potentially increase portfolio efficiency by allocating to sectors in the global equity market where the economic and political risks are less significant.

We considered the global listed cleantech sector to illustrate breakeven analysis. Cleantech is a sector which is attracting growing interest from institutional investors, governments, corporations and publics around the world. This is predominantly because many countries are attempting to diversify their energy portfolios away from traditional fossil fuels and into non-carbon-based, renewable energy sources in order to prolong the life of existing fossil fuel reserves, reduce energy costs, improve energy security and thereby decrease geopolitical risk and reduce greenhouse gas emissions.

We discussed the significant potential for commercial opportunities and developments in cleantech, in particular with regard to solar power, wind and tidal power, biofuels, green building, electric vehicle technology, smart electric grids, mobile cleantech, clean water and energy from waste. However, as with any investment, there are many risks to investing in cleantech and we noted that some of these include technology risks, political and regulatory risks, the variability of raw material costs, the price dynamics of fossil fuels, increased competition, macroeconomic risks, environmental impact, climate change, financing risks and even risks relating to military funding.

We briefly outlined three ways investors can access cleantech investments: listed equities, venture capital and private equity and mezzanine debt financing. We then focussed on listed equities in particular because it is the most liquid and transparent method of allocating the global cleantech sector.

The performance of the Ardour Composite, a global listed cleantech index, was then analysed and we showed that the performance of the global listed cleantech has been similar to the performance of global equities, but there has been significant divergence between the performance between global listed cleantech and global equities over time. Global listed cleantech has a high beta relative to the global equity market and therefore it tends to outperform when returns from global equities are positive and underperform when returns from global equities are negative.

Global listed cleantech has recently underperformed the global equity market due to the failure to forge an internationally binding agreement at the Copenhagen Climate Change Conference and "investor concerns about industry over-capacity, cutbacks in subsidy programmes and competition from power stations burning cheap natural gas" (Bloomberg New Energy Finance, 2011). We noted that the recent poor returns and lower valuations may provide new investors with a good opportunity to access the global listed cleantech asset class.

We then discussed whether Australian investors should invest in global listed cleantech on an unhedged or hedged basis. We concluded that the poor liquidity of global listed cleantech shares is reason to invest on an unhedged basis and as global listed cleantech will only form small part of most investors' global equities portfolios, it can be allocated to the unhedged part of the global equity portfolio. Consequently, we outlined optimistic, base case and pessimistic volatility assumptions as well as correlations for unhedged Australian dollar returns for global listed cleantech.

Breakeven analysis was introduced and this finds the risk and return characteristics which a new investment opportunity needs to have in order for a new portfolio including the investment to 'breakeven' in terms of its efficiency relative to an existing portfolio. We discussed breakeven contours as well as contours which show the expected return and volatility assumptions required by global listed cleantech to improve sample conservative, balanced and growth portfolios for Australian investors.

We showed that as the volatility assumption for global listed cleantech increases, the expected return required by global listed cleantech to increase the portfolio efficiency of the sample conservative, balanced and growth portfolios also increases. We also showed that adding global listed cleantech to portfolios with higher allocations to growth assets, such as growth portfolios, is more likely to increase portfolio efficiency than adding global listed cleantech to portfolios with low allocations to growth assets, such as conservative portfolios. Finally, we showed that if investors expect global listed cleantech to return 12.4% per annum over the next five years, it would increase the efficiency of conservative, balanced and growth portfolios. However, under base case volatility assumptions, portfolio managers were more likely to achieve gains in portfolio efficiency by allocating to global listed cleantech in growth or balanced portfolios.

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