Meteos

Systems Not Silos:
Investor Perspectives on the Energy System

Report of the Energy Futures Dialogue

Contents

EnergyFutures

EnergyFutures is an on-going investor-led dialogue about long-term value drivers in the energy sector. Specifically it looks at the role of societal and environmental considerations in shaping the ability of energy-related companies to create value. *EnergyFutures* is convened by Meteos, and participants include financial analysts, fund managers and senior company executives. The dialogue takes a system-wide perspective, looking at how events in one part of the energy system can affect what happens elsewhere. The most recent dialogue explored recent supply and demand trends, and examined how a combination of new technologies, political will and market forces came to transform parts of the system in a surprisingly short time-frame. It asked what early signals may herald further shocks to the system, and best soccer predictions pecifically whether and how responses to climate change could become material in a similarly transformational way.

The *EnergyFutures* dialogue took place over two years. It began in January 2011 with a dialogue between institutional investors and senior executives from companies within the energy system. It continued with a second dialogue, between May and August 2013, which was limited to participants from the investor community. For a full list of participants see *EnergyFutures* Participants page 21. The *EnergyFutures* report reflects the investors' conclusions from this second dialogue.

Executive Summary

***EnergyFutures* was created to support a group of institutional investors to supplement their research on the energy system through a structured dialogue amongst peers. Specifically, the dialogue permitted a system-wide discussion of long-term political, social and economic drivers of value for energy-related stocks and how they might play out across and between asset classes over time.**

A Resilient Energy System?

The energy system is deeply entrenched in the social, economic and political fabric of most societies. It is largely characterised by the extraction of high energy-density fossil fuels used for heat, power and transport. Despite supply-side complexity, the demand for gas, oil and coal that is relatively cheap to produce, and easy to store and transport, has led to a remarkably resilient energy system. Standards of living all over the world are today reliant on maintaining access to cheap, readily available fossil fuels. Consequently there is a great deal of political will to keep them flowing, which takes the form of government support for production, and in some places subsidised consumption.

The fact that energy contributes so much both to economic activity and political stability often leads analysts to conclude that the main characteristics of today's fossil fuel-reliant system are immutable. *EnergyFutures* investors do not necessarily all share this view. There is a risk, they argue, that the energy system contains the seeds of its own destruction. Climate change – ironically a by-product of today's system resilience – has the potential to result in a radical system overhaul. Such an overhaul, these investors argue, could present significant risk to valuations, as well as provide alternative investment opportunities.

Supply Shock: the Advent of Shale

The global energy map has been redrawn by the introduction of shale gas as a major primary energy source. Worldwide, it has been estimated that recoverable reserves in shale gas could boost world gas resources by 40%. The most dramatic and immediate impact has been in North America, where, in just over ten years shale gas has come to account for a quarter of US domestic natural gas production. Shale gas could also take off elsewhere with China, Argentina, Algeria, Canada, Mexico, Australia, South Africa, Russia and Brazil all having significant quantities of technically recoverable reserves.

US shale gas has had massive repercussions across the energy system. It has led to a collapse in US natural gas prices, with significant economic consequences: natural gas as a cheap feedstock has been a huge competitive boost to the US petrochemical industry and US manufacturers enjoy wholesale electricity prices that are half those of their European competitors. Changes in supply have also had significant impacts on the price dynamic between primary energy sources. The collapse in US gas prices, for instance, destroyed the domestic market for US coal-mining companies, which were then forced to export or close. In turn, these exports have far-reaching price implications of their own: from falling coal prices in Asia, through to gas plants being taken off the grid in favour of coal plants in Europe. Low gas prices have also changed the economics of energy-related project development, particularly those planned with a higher commodity price in mind. Finally, the sudden supply shock of a lot more gas coming on stream has made it harder to make the case for investment in renewables and nuclear because there is less chance of a fossil fuel shortage. These dynamics would be amplified if big discoveries in shale oil were also brought to market.

European Utilities and Declining Demand

Energy demand has also been affected by significant structural changes. The recent history of European utilities illustrates how these changes, combined with the price implications of increased supply, can result in dramatic value destruction and a crisis of the sector's business model. European energy utilities have seen a significant fall in demand, driven by a secular trend towards greater efficiency, as well as a cyclical knock-on from austerity and depressed economic growth. Public policy has also played a role, as did the sector's poor capital allocation and over-leveraged balance sheets.

Another sector facing threats from secular changes to demand is coal, with slowing of demand in China of particular significance. For the past decade forecasters have predicted on-going growth in Chinese thermal coal demand, such that it could overtake oil as the leading global fuel by 2030. To the surprise of many this appears to be changing rapidly. Efficiency improvements, slowing economic growth and aggressive pollution abatement measures are combining with competition from alternatives to lead some analysts to predict an absolute decline in Chinese coal consumption by 2016. The size and importance of the Chinese market means that the slowdown has global ramifications.

Early Signals of System Change

A number of other trends could significantly disrupt the energy system. *EnergyFutures* investors consider the market to be underestimating the potential for climate-related changes to the energy system, in part because there is no agreement on how to quantify any damage or negative impacts. They recognise that the immediate prospects of full decarbonisation programmes are slim due to the recent structural increase in the supply of fossil fuels and the political difficulties of absorbing related costs. Nevertheless, the economic costs of mitigating climate change through decarbonisation are expected to be higher the longer it is delayed – something the market is currently choosing to ignore.

Some *EnergyFutures* participants argued that at some point the disruptive economic impacts of climate change will come to outweigh the benefits of business as usual, and that this will eventually lead to a concerted effort to constrain how much carbon is put into the atmosphere. Consequently, they sought to answer the question as to what mix of market and policy moves should be construed as early signals on carbon pricing or carbon constraints. A number of signals were highlighted:

- The growing body of broker research reviewing the potential impact of climate change on portfolios, and in particular the risk of being saddled with "stranded" high-carbon assets
- Important policy or regulatory changes made by influential countries
- The continuation and scale up of moves to promote energy efficiency, now evident in Europe, China and the US
- Government support for the "gasification" of transport in response to the availability of abundant shale gas, which could precipitate a massive scale-up in the use of LNG and CNG
- Significant changes in public opinion, such as the public concerns about smog in China, which contributed to environmental concerns being addressed in the 2011-15 Five Year Plan, and predictions of structural decline in demand for coal
- The cumulative impact of highly unpredictable extreme weather events and in particular the impacts these events could have on food prices and water scarcity

In addition, investors identified a range of policy measures which could serve as powerful market signals, such as binding targets on energy efficiency, an overhaul of the European Emissions Trading Scheme, the introduction of taxes on coal or energy end use, or a global UN level agreement on climate change in 2015.

Conclusions

The energy system has changed significantly over the past decade raising the prospect that the apparently immutable energy system may be capable of more change, more quickly than had previously been thought possible. This being the case the *EnergyFutures* dialogue raised the question as to what investors should do to identify and prepare for potentially transformative changes in future.

One clear conclusion was that investors – and other stakeholders – need to engage in a much more systematic analysis of the energy system in order to understand different sources of risk embedded in their portfolios. This is likely to require a shift from a traditional asset-driven paradigm to one that looks across sources of risk. It will require investee companies

to be more transparent about their price assumptions, their scenario findings and their long-term investment strategies. Once these risks are clearer, investors can construct portfolios to take them into account. And there will be opportunities, not just risks, as a result of energy changes. Regulatory change may lead to interesting new business models, representing a much bigger proportion of the market as demand for their services grows. This type of portfolio construction may well look very different in its weighting of different asset classes compared to more conventional models.

To undertake a more systemic analysis of the energy system *EnergyFutures* identified a number of recommendations, which are as applicable to governments and companies as to the investment community:

1. To bridge internal siloes across geographic regions, asset classes and investment styles in order to improve understanding of energy risks in supposedly uncorrelated asset classes.
2. To expand risk horizons in acknowledgement of the fact that today's investable timeframes may prevent understanding of long-term risk.
3. To build price and demand scenarios to enhance understanding of systemic energy risk in their portfolios.
4. To commission more climate-related research in order to enhance understanding of risk.
5. To require greater transparency and disclosure from investee companies.
6. To improve understanding of public policy and regulation, and their investment implications.

A small but growing group of investors is going further to ask whether there is scope for investors to start moving from more analysis to action. Due to their concerns about the potential value destruction of failing to adequately manage climate risk, they argue that investors should actively seek to invest in such a way as to contribute to climate change mitigation. Any such investor action would have to be managed to avoid any increase in the short term risk profile of portfolios. This is likely to be best achieved by introducing improved systemic analysis of the energy system. There is growing government and public interest in responsible capitalism and concern about future investment performance. Investors may well come to be judged on how well they manage such systemic risk.

Introduction: The *EnergyFutures* Dialogue

This report summarises the findings and implications of the *EnergyFutures* dialogue. The dialogue was convened by Meteos at the request of a number of institutional investors who wished to supplement their traditional research capabilities with face-to-face discussions about how the different parts of the energy system influence one another. They were motivated by concern that current approaches may be insufficient to fully understand future risks to the energy system. Specifically they recognised that assumptions about growth projections in one sector may have a direct bearing on stock valuations in another, but that cross-referencing between them is all too rare. Consequently, they created a dialogue that would enable them to explore long-term political, social and economic drivers of value for energy-related stocks.

The dialogue had two parts. First was a conversation between institutional investors and senior executives from companies within the energy system that took place between January and June 2011. The second dialogue, which took place between May and August 2013, was limited to participants from the investor community.

This report reflects the main conclusions from the second, investor, dialogue. It is divided into six sections:

Section One introduces the energy system and asks how resilient it will prove in the face of future challenges.

Section Two looks at how the shale revolution has recently transformed energy supply, the lessons this holds for understanding how quickly the energy system can change and its future implications.

Section Three explores changes on the demand side of the equation, and highlights the examples of European utilities and coal to demonstrate how changes in different parts of the system can have an impact on value creation.

Section Four asks whether other transformative changes to the energy system may be in the making. It asks how investors should identify and prepare for such changes, which may be driven by climate change or other environmental concerns, such as water stress or air pollution. It highlights the disruptive effect that significant moves by governments or markets could have on valuations as a result, and asks what early signals could signify a move in this direction.

Section Five asks what investors can do to ensure they are exercising due diligence to protect and encourage long-term value creation. This involves taking a systems approach which looks more broadly at how the different economic sectors are influenced by changes to the energy system. It also involves looking at the implications of growing expectations that capital market actors should assume greater responsibility for the long-term societal impact of their investment behaviours. It identifies six recommendations on how investors could improve their understanding of the risks and opportunities in the energy system.

Section Six summarises the report's conclusions and recommendations.

Section One: A Resilient System?

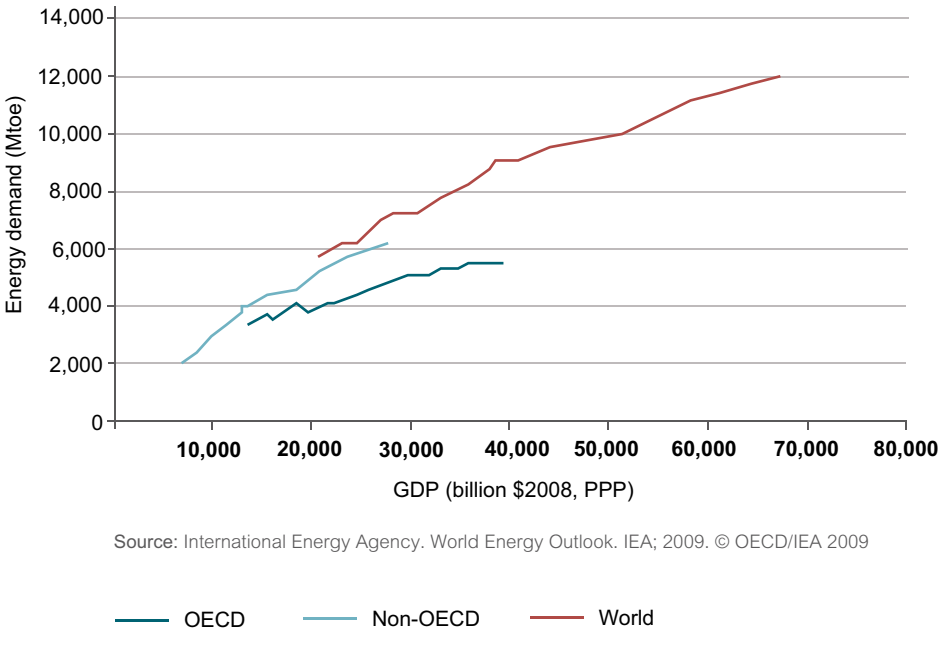
The energy system is deeply entrenched in the social, economic and political fabric of most societies. It is largely characterised by the extraction of high energy-density fossil fuels used for heat, power and transport. Despite supply-side complexity, the demand for gas, oil and coal that is relatively cheap to produce, and easy to store and transport, has led to a remarkably resilient energy system.

This resilience results in part from the belief in the indissoluble link between energy and economic growth. Energy has been described as the "oxygen of the economy and the life-blood of growth" (see Fig. 1). In the US alone, the share of GDP that is energy related is roughly 8%, or over $1 trillion. The energy industry supports around 9m jobs (directly or indirectly) – 5% of total employment in the country. OPEC meets 97% of its energy needs via home-produced cheap oil and gas. Worldwide, it is hard to think of any good or service that does not need energy as an input.[1]

Standards of living all over the world are heavily reliant on maintaining access to cheap, readily available fossil fuels. Consequently there is a great deal of political will to keep them flowing. Everywhere governments seek to avoid changes that could have negative impacts on lifestyles and increase costs for consumers. This has led many of them to support fossil fuel production, and in some places to subsidise consumption. Support for production includes price controls, trade measures, tax breaks, risk transfers and direct financial transfers. In the OECD such government measures are estimated to have an annual value of $55-90bn per year, and 29% of them are directed at subsidising production.[2]

Figure 1:

Primary energy demand and GDP, 1971-2007



Source: International Energy Agency. World Energy Outlook. IEA; 2009. © OECD/IEA 2009

The most recent targets of these policies are producers of shale oil and gas, particularly in countries whose governments – seeing importance of tax breaks and other government support in the success of US shale gas – have moved fast to provide similar support.[3]

In some places – particularly non-OECD countries – subsidies are also extended to consumers. Despite widespread calls for their removal, the heavy political cost of this – such as the recent wave of unrest in the Middle East, and riots in Indonesia and Nigeria – proves to be a major disincentive. In the West, although consumers are not subsidised in this way, the cost of energy is highly politicised, making government an unpredictable ally for energy providers.

The fact that energy contributes so much to economic activity and political stability often leads analysts to conclude that the main characteristics of today's fossil fuel-reliant system are immutable. There are various reasons for this: long-term projections of seemingly insatiable energy demand; persuasive economic arguments about the links between energy and economic development; apparently boundless technical ingenuity to tap new energy sources; and the ability of industrial users to switch between different feedstocks when one becomes cheaper than the other. Little wonder that many analysts conclude that for the foreseeable future there is little political or economic incentive to change.

EnergyFutures investors do not wholeheartedly share the conviction that the energy system will retain the core characteristics it has today.

Despite this, *EnergyFutures* investors do not wholeheartedly share the conviction that the energy system will retain the core characteristics it has today. Though most agree that compelling economic arguments will hold the system together in the short and even medium term, they consider these arguments to be potentially unsafe in the long run. There is a risk, they argue, that the energy system contains the seeds of its own destruction. Climate change – ironically a by-product of today's system resilience – has the potential to result in a radical system overhaul. And such an overhaul, these investors argue, could present significant risk to valuation, as well as provide alternative investment opportunities, in energy efficiency, low-carbon electricity generation and storage, as well as for new more service-related business models. *EnergyFutures* investors asked what disruptive forces could lead to radical changes and how the investment community could best prepare for them.

> "We are now at a point where the system is exquisitely intertwined and tremendously complex, from decades of evolution of a social and technological nature.[i]"

i. Direct, unattributed quotes drawn from conversations and interviews during the course of the *EnergyFutures* dialogue.

Section Two:
Supply Shock – The Advent of Shale

The global energy map has been redrawn by the introduction of shale gas as a major primary energy source. Not since the oil shocks of the 1970s – which led to the replacement of oil with gas in the industrial power generation sector – has there been a comparable change. The advent of shale gas and oil demonstrates how quickly the combination of new technologies, political will and market forces can transform the energy system.

Worldwide, it has been estimated that recoverable reserves in shale gas could boost world gas resources by 40%.[4] The pace of change has been astonishing. Recent concerns about resource scarcity and the related rise in the cost of energy have given way to a sharp focus on the pace and magnitude of the change brought about by shale, now and in future. The scale of this revolution took many people by surprise, and exemplifies how a shift in one part of the energy system can have massive repercussions for value in others. This section explores the extent of the change that has occurred, and its knock-on effects across the energy system.

The most dramatic and immediate impact has been in North America, where shale gas production got underway first. US shale gas production has developed remarkably quickly. It is taking months rather than years to drill and proving low cost, at US$3 per MMBtu (US$20-30 in oil terms). These characteristics mean it has had a dramatic impact on the energy cost curve. In just over ten years shale gas, at 34Bcf/d, has come to account for a quarter of US domestic natural gas production, and could reach annual production of 48Bcf/d by 2025.[5]

The advent of shale gas and oil demonstrates how quickly the combination of new technologies, political will and market forces can transform the energy system.

What's more, there is a potential that shale gas could also take off elsewhere. China has the highest quantity of technically recoverable shale gas reserves worldwide, at 31.6 trillion cubic metres, although a number of challenges would need to be overcome first.[6]

Even without Chinese production (or for that matter, shale gas from the other top ten potential producers – Argentina, Algeria, Canada, Mexico, Australia, South Africa, Russia and Brazil), US shale gas discovery and development has had massive repercussions across the energy system. Not only has it had a direct impact on prices, it has also displaced other fuel sources and raised the very real prospect of North American energy independence – with all

"There's a theory saying that they (China) won't unlock gas ... I disagree with that. Very smart people will figure out how to get this gas out of the ground. The implications for China of being more energy independent make it a huge priority. And they will try to find the most environmental sustainable solutions."

the geo-political implications this carries.

Energy Prices

US shale production has led to a collapse in US natural gas prices (from over $10 per MMBtu in mid-2008 to under $5 per MMBtu by 2013), with significant economic consequences: natural gas as a cheap feedstock has been a huge competitive boost to the US petrochemical industry and US manufacturers enjoy wholesale electricity prices that are half those of their European competitors.[7]

Changes in supply have also had significant impacts on the price dynamic between primary energy sources. The collapse in US gas prices, for instance, destroyed the domestic market for US coal-mining companies, who were then forced to export or close. In turn, these exports have far-reaching price implications of their own: from falling coal prices in Asia, through to gas plants being taken off the grid in favour of coal plants in Europe.[8] Furthermore, the US is exporting modern shale gas technology. This is not only boosting export income today, it also has the potential to increase global energy supply in future, which could further depress fossil fuel prices on global markets.[9]

Low gas prices have also changed the economics of project development from conventional and unconventional sources, raising questions about the return on investment on developments that were originally planned with a higher commodity price in mind. In addition, the sudden supply shock of a lot more gas (and oil) coming on stream makes it harder to make the case for investment in renewables and nuclear because there is less chance of a fossil fuel shortage.

Low gas prices have also changed the economics of project development from conventional and unconventional sources

Shale Oil and Collapsing Energy Prices

The shale story is not limited to gas. Energy prices could suffer further dramatic shocks if the big discoveries in shale oil in the US are brought to market. The top ten countries with technically recoverable oil reserves are sitting on 345 billion barrels of shale oil. Worldwide, the forecasts are dramatic: shale oil could be producing as much as 14m barrels per day by 2035, or 12% of total oil supply.[10] This anticipated jump in supply is already having an impact on price forecasts, both short- and long-term. Barclays cut their oil price forecast for 2014 and 2015 by US$20 a barrel,[11] while PwC estimates that, by 2035, the advent of shale oil could mean oil prices are 25-40% lower (US$83-100 in real terms) than baseline International Energy Agency (IEA) forecasts. If the full potential of shale oil were to be realised, the price impact would far outweigh those of shale gas.

EnergyFutures participants did not all share this perspective. They cautioned that shale oil is unlikely to have such a dramatic effect on price because gas is a local commodity, while oil is global. The floor price for shale oil – at around US$60-80 per barrel is not as disruptive as that of shale gas – where prices could come down to around US$3 per MMBtu (the oil equivalent of US$20-30). Although bulls for shale oil claim that this range could come down as the technology gets better, a more bearish perspective argues that the first wells have benefited from the best geology. Second, it is likely that the Middle East (and Saudi Arabia in particular) will act as a stabilising force on oil prices. Although Saudi is a low cost producer (at around US$10 per barrel) it needs a stable oil price of around US$90 per barrel to meet societal expectations. Saudi Arabia is only likely to stabilise oil prices, however, if demand is high – not a foregone conclusion.

> "There's no way to predict how long shale gas will last but it is true that decline rates are always faster than predicted and extraction costs higher. The oil industry requires a high oil price for many of the new unconventional sources of oil and gas. And this is also true of service companies – they're not making significantly higher margins than 20 years ago – despite oil prices rising five fold since 1993."

A third uncertainty hanging over the prospects for shale oil concerns the very significant variations in projections for shale oil production (for 2030).

Shale Expansion?

Whether shale oil will take off is only one of the many uncertainties about the future shale story. Even on the supply side, in order for China's shale gas to be exploited, huge infrastructure requirements need to be met, including the availability of rigs, crews and service companies to extract the natural gas, and extensive pipelines to transport it to distant centres of demand. Other obstacles include geological and technical difficulties in applying horizontal drilling technology. Furthermore, social and legal challenges of entrepreneurship and land ownership of mineral rights would all need to be overcome. And even if this were achieved, some analysts argue that the greatest constraint will prove to be water scarcity.

In Europe, where there has been considerable public opposition to shale gas, questions remain about whether public and regulatory opinion can be won over to allow for the development of shale gas at scale.

Finally, the extent to which the US will export shale gas in meaningful volumes – which could reduce the large price differences in natural gas that exist in different regions – is still unclear.

… changes to one part of the energy system can reverberate elsewhere in the system

The intense interest in how the shale revolution is shaping supply-side economics of energy investing is understandable. It may, however, obscure another important lesson it holds: that of how changes to one part of the energy system can reverberate elsewhere in the system, with significant implications for value creation and destruction. The following section explores how recent changes have affected demand.

> "Recent years have seen huge amounts of shale oil – not gas – which have added to supplies and that has kept oil price lower than expected. GDP [economic growth] has also been subdued and that has kept the oil price lower than expected."

Section Three: European Utilities and Declining Demand

To understand how energy-related stocks are likely to perform requires an understanding of the supply-side, but also – and as significantly – of the trends that will shape demand. How will energy be used for power, industry, transport and buildings, and what are consumers and citizens likely to want? Although the economics of shale make it likely that government support for the technology will continue to be forthcoming, these same governments face counter pressures that investors would do well to fully understand.

The recent history of European utilities illustrates how structural changes in energy demand, combined with the price implications of increased supply, can result in dramatic value destruction and a crisis of the sector's business model. The fortunes of this troubled sector ably demonstrate the value of taking a systems approach to energy analysis and also hold interesting lessons for the coal industry, facing what some have described as "peak coal" – a structural decline in demand – led by events in China.[12]

The recent history of European utilities illustrates how structural changes in energy demand, combined with the price implications of increased supply, can result in dramatic value destruction

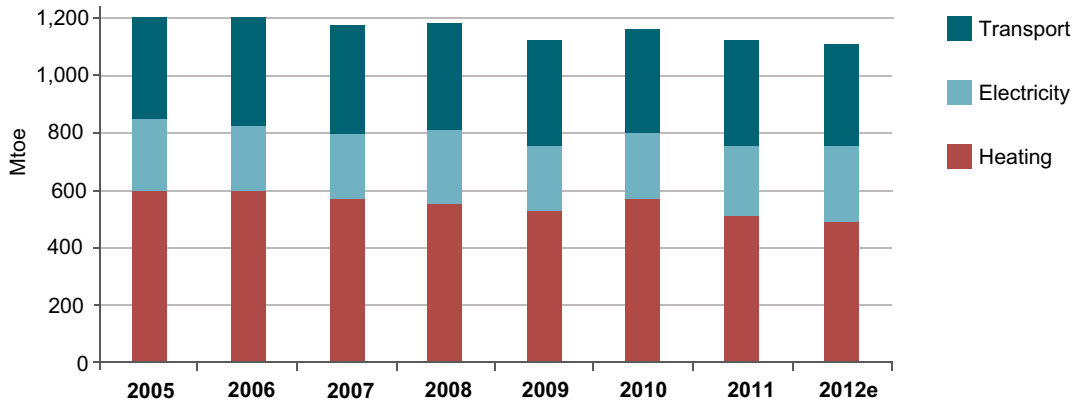
The Demise of the European Utilities

A recent HSBC report highlights the continuing woes of European energy utilities, driven by predictions of a continued fall in EU energy demand (by 10% between 2012 and 2020).[13] *EnergyFutures* investors analysed this sector as an example of what can happen if you get caught by the double whammy of unpredictable policy and negative moves in the commodity cycle. European energy utilities have seen a significant fall in demand (see Fig. 2). This is driven by a secular trend towards greater efficiency, spurred by the EU's Energy Efficiency Directive, as well as a cyclical knock-on from austerity and depressed economic growth. Public policy has also played a role in the form of the heavy subsidy of renewables, e.g. of solar in Germany, which hit the most profitable part of the utilities' business. A third contributor was the sector's poor capital allocation and over-leveraged balance sheets, resulting in part from a failure to anticipate the impact the shale revolution would have on prices. Dramatic price falls destroyed the economics of the heavy investments that the companies had made. The result has seen a dramatic fall in valuations not only for utilities, but also for energy efficiency and service providers.

"About ten years ago (the utilities) made investment decisions that wouldn't have seemed unreasonable at the time. But they ended up with massive over capacity, spending commitments to meet their partnership with government – when governments ended up not being their partner at all – and a collapse in commodity prices. No-one is earning the cost of capital and they continue to be painted as public enemy number one."

Figure 2:

EU's energy demand on decline with electricity share of energy mix increasing and heat declining.



Source: HSBC Global Research. European Energy Utilities: Energy demand to lag GDP by a widening margin. HSBC; 2013.

"Peak Coal?"

Another sector facing threats from secular changes to demand – linked but not confined to the trend towards greater energy efficiency – is coal. This is most significant in China. For the past decade forecasters have predicted on-going growth in Chinese thermal coal demand, such that it could overtake oil as the leading global fuel by 2030.[14] To the surprise of many – and partly driven by the increasing availability of imported natural gas – this appears to be changing rapidly. Efficiency improvements, slowing economic growth and aggressive pollution abatement measures are combining with competition from alternatives (particularly hydro and nuclear) to lead some analysts to predict an absolute decline in Chinese coal consumption by 2016.[15] The scale of the Chinese market means that the slowdown has global ramifications, with clear and significant negative implications for coal producers, significant price impacts for utilities and potential upside opportunities for others, including renewables, distributed generation and transmission.[16]

"Gasification" of Transport

Also at the demand end of the energy system the "gasification" of transport could be a game-changer. Some analysts point to the enormous opportunity the shale revolution presents to substitute oil for liquid natural gas (LNG) as a transport fuel for trucks and marine shipping and compressed natural gas (CNG) for passenger cars. This is already evident in the introduction of a new tax regime in the US to encourage a switch of fleet buses and long-haul trucks to natural gas. A more widespread "gasification" of transport would have very big implications. This would be particularly true if home refuelling kits that allow US consumers to fuel their cars via the existing natural gas system take off when they enter the market in 2017/18. [17]

These current and potential structural changes in demand hold interesting lessons for companies and investors about how the combination of policy, economic and market drivers can work together to generate unexpected outcomes. Although many assume a continuing story of demand-side growth – despite the recent dip – *EnergyFutures* investors highlighted the importance of stress-testing assumptions and exploring all trends that could have a material impact on either supply or demand in the energy system.

Section Four: Early Signals of System Change

A number of other trends could significantly disrupt the energy system. In particular *EnergyFutures* investors were interested to explore whether and how governments might introduce environmental policies – particularly in relation to climate change – such as emissions reductions targets or market incentives to promote energy efficiency, alternative energy and climate-related measures.

Climate Change and Market Disruption

EnergyFutures investors consider the market to be underestimating the potential for climate-related changes to the energy system. They recognise that the immediate prospects of full decarbonisation programmes are slim – particularly in the light of the shale revolution, which has structurally increased the supply of fossil fuels. Such decarbonisation programmes would require governments to commit to long-term policy changes – well in excess of the electoral cycle. This is unlikely to happen without strong and rising public support for them to do so. Even so policies will only work – and gather political support – if governments can persuade the public that energy costs can be managed.

Recent retrospective action to reduce previously agreed subsidies paid to promote generation from renewables in Southern Europe has strengthened investor scepticism about whether governments will stick to long-term commitments. Furthermore, investors are concerned about the pressure on governments when consumers face the cost of decarbonisation, whether as individuals through their utility bills, or more broadly, as sectors of the economy risk becoming uncompetitive because of increased environmental costs and regulation. But the economic costs of mitigating climate change through decarbonisation are expected to be higher the longer it is delayed – something the market is currently choosing to ignore.

> "Business as usual is not a choice. Either we are looking at a 5-6°C degree world, so we need to adjust our assumptions, or there is policy action, so we need to adjust our assumptions."

Finally, there is no agreement about how to quantify the damage and negative impacts of climate change. Efforts to do so, most notably the *Stern Review*, have not yet succeeded in establishing agreed metrics.[18] Until they do, industry, governments and investors are likely to remain reluctant to acknowledge the negative economic impacts. It is notable, however, that this reluctance is not expressed when the impacts may lead to commercial opportunities that could arise from climate change (e.g. the ability to open shipping lanes in the Arctic as a result of thinning sea ice).

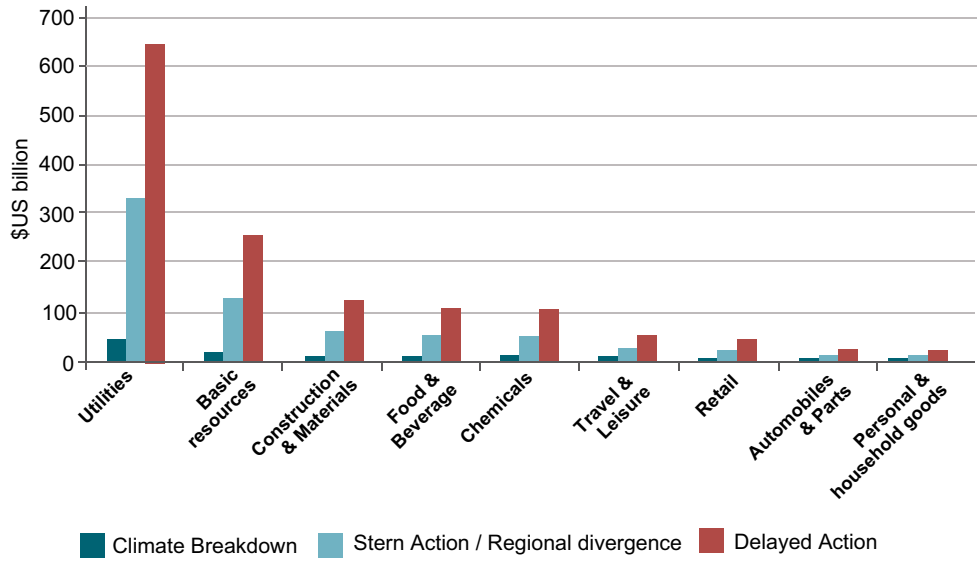
Despite these caveats, *EnergyFutures* participants argue that at some point the disruptive economic impacts of climate change will come to outweigh the benefits of business as usual, and that this will eventually lead to a concerted effort to constrain how much carbon is put into the atmosphere. Consequently, they sought to answer the question as to what mix of market and policy moves should be construed as early signals on carbon pricing or carbon constraints.

Broker Interest

Recent broker research has begun to review the potential impact of climate change on portfolios – particularly energy stocks. There is growing interest in the risk to fossil fuel producers (and their investors) of being saddled with high-carbon assets that they will not be able to exploit – either because of a carbon price or regulation of emissions.

Figure 3:

Cost of carbon adjustment by sector



Source: Mercer. Climate change scenarios: Implications for strategic asset allocation. Mercer; 2011.

The most detailed report on the topic, HSBC's *Value at Risk from Unburnable Reserves* builds on analysis of Carbon Tracker and the IEA to explore the ramifications of a low-carbon world for quoted stocks.[19, 20] Another study undertaken by financial consultants, Mercer, has attempted to quantify the capital market impact of various climate change scenarios and the policy responses they could generate (see Fig. 3). It seeks to compare the outcomes for equities with the outcome for other asset classes, ranging from fixed income to private equity and infrastructure.[21]

Country Level Moves

Policy moves in critical countries are likely to be significant indications of change. On climate change, policy and regulatory moves in China or the US, for example, may ultimately be more important (and indeed more likely) than achieving a global deal. In June 2013 President Obama introduced plans to tackle climate change, with a series of mitigation measures including stringent emissions controls on power plants, legislation to improve energy efficiency standards and a concerted effort to reduce other greenhouse gases, such as methane and hydrofluorocarbons (HFCs). Whether the plan will be successfully implemented remains to be seen. These moves are more than matched in China, which introduced ambitious environmental targets in its 12th Five Year Plan (2011-15), driven largely by growing concerns about local air pollution.[22] The Chinese government has introduced mandatory cuts in sulphur dioxide and nitrogen oxide emissions from coal-fired plants.

> "The policy framework on climate has become more complicated. On the one hand there has been a reversal in the cautious optimism that 2015 will bring a policy breakthrough at the international level. At a more granular level in individual countries, there have been significant pro-climate moves in China and the US, and reversals in other countries like Australia."

Important triggers that investors should watch therefore include the extension of China's Emissions Trading Scheme nationally, or the scaling up of US-regulated greenhouse gas (GHG) emissions. Importantly, investors should note that the trigger for such action may not be climate change directly, but other issues such as local air pollution, food shortages or water stress.

***EnergyFutures* participants were clear that the single most important lever signalling a move on climate change would be predictable public policy**

The third government initiative worth mentioning – for its sheer ambition if not global reach – is the German government's *Energiewende*. This ambitious plan aims to shift the country's energy mix away from fossil fuels and nuclear towards renewables, which are to account for 35% of power supply by 2020. In 2011, the already bold plan was made even more challenging following Germany's immediate closure of seven nuclear reactors in response to Japan's Fukushima disaster. The plan also faces technical challenges of how to store wind, solar and biomass power, plus the political challenge of combining top-down legislation with bottom-up industry and – importantly – community buy-in. Despite this, the German government shows no sign of back-tracking on the plan.

EnergyFutures participants were clear that the single most important lever signalling a move on climate change would be predictable public policy (see Box 1). However, they do not see this as likely in the near future. Instead they predict ongoing policy instability as governments flip-flop between short-term concern to keep the lights on, questions of affordability and longer-term concerns about climate disruption.

Box 1: **Other Government Triggers**

***EnergyFutures* investors identified a number of policy measures which could indicate to the market that the global energy system may be subject to significant change:**

1. The widespread adoption of binding targets on energy efficiency.
2. An overhaul of the discredited European Emissions Trading Scheme, building on lessons of what has not worked to date. These include the need to introduce standards to restrict or prevent the use of dirty coal.
3. The establishment of independent energy policy capabilities, similar to the Bank of England's Monetary Policy Committee, which permits the separation of energy policy from government imperatives.
4. The introduction of a tax on coal, though investors did highlight the danger that this may disincentivise investment into carbon capture and storage.
5. The introduction of taxation on energy end use (a tax on CO_2 for instance, though this risks driving up power prices and could place businesses at a competitive disadvantage internationally).
6. Significant government support for investment in new technologies to tackle climate change, including electricity storage, better use of waste streams, combined heat and power initiatives, and potentially marine power and carbon capture and storage.
7. A global UN level agreement on carbon emissions in 2015.

Energy Efficiency

Linked to government regulatory efforts to reduce emissions and contain energy costs to consumers are moves to promote energy efficiency. Across the OECD, energy consumption has fallen while the economy has grown; for instance, in 2012 energy consumption fell 1.2% while the economy grew 1.4%. As with transportation and utilities, bringing these initiatives to scale is dependent on public policy. The EU's Energy Efficiency Directive and the UK's policy on electricity reduction both materially affected investment decisions. The Energy Efficiency Directive aims to result in an overall reduction in energy demand of 20% by 2020, which, according to HSBC, could translate into a 16% and 17% decline in electricity and heating demand, respectively.[23] China too has developed targets to reduce the energy intensity of the economy, and emissions per unit of GDP, and set targets for CO_2 and energy savings for the top industrial consumers.[24] In the US, the drive to new efficiency standards for appliances, air conditioners, refrigerators, with the overall intent to double energy productivity by 2030, is likely to boost those companies with products to match these ambitions. It is little wonder that *EnergyFutures* participants are interested in those companies that are likely to prove able to respond to demands for "smart", distributed energy, energy efficiency and other goods and services that help reduce energy consumption.[25]

An energy system perspective allows investors to explore knock-on impacts these developments might have on value creation in other sectors. For instance, a broad move by consumers to micro-generation or to disconnect from their utility could spark a phenomenon described as the "utility death spiral": as more customers leave, fewer utility customers are left to finance an expensive infrastructure. This in turn drives up utility prices, leading to more customers leaving their utility, and so on.

> "Climate change policy moves in quantum changes. One risk is that policy makes a huge shift after 2015 with much tougher regimes coming into play."

Transport

Another inflexion point could be in transportation. Vehicles are already considerably more energy efficient than they were ten years ago, but other changes could be on the way. The abundance of shale gas could precipitate government support for a massive scale-up in the use of LNG and CNG to "gasify" transport, as outlined in the previous section. To have an impact on climate change, however, this would have to be accompanied by measures to reduce the production and consumption of coal. This is already happening. Although coal consumption continues to rise – and has hit its highest share of primary energy consumption at just under 30% (compared with oil at 33%) some believe coal demand has already peaked (see Section Three).[26] Likewise, the electrification of transport would need to ensure that the power generation was not relying on high carbon-emitting fossil fuels.

Public Opinion

Although many analysts believe that economic interest will override other considerations when it comes to energy supply, it is worth noting recent impacts of public opinion on energy policy. This is perhaps most evident in China, where public concerns about smog – a mix of carbon monoxide, sulphur dioxide and nitrogen oxide, are seen to have – at least partially – been behind the government's decision to address environmental concerns in its 12th Five Year Plan. The smog in Chinese cities is contributing to a rise in respiratory problems, asthma and lung disease. The World Health Organisation states that there were a staggering 1.2 million premature deaths in China in 2010 due to outdoor pollution.[27] Government response to these health concerns in China is one of the reasons that some analysts are predicting "The Beginning of the End of Coal."[28]

The shale gas revolution, too, has had a visible impact on public opinion – because it involves the controversial technology of hydraulic fracturing (fracking) – and also because of fast decline rates. Shale gas wells are exhausted relatively quickly, leading to the need for frequent drilling of new wells to maintain production flows – at times quite close to people's homes and land. Fracking sites can be up to the size of two football pitches, resulting in significant impacts on the quality of life of local residents, particularly as it is accompanied

> "Public opinion is starting to revolve around exploration in sensitive environmental areas which was not the case so much a few years ago. There's a tipping point in that regard."

by significant site traffic of industrial trucks and vehicles.

Public concern is not limited to nimbyism. The process of fracking – horizontal (and sometimes vertical) drilling that allows for the injection of highly pressurized fracking fluids into the shale rock – has generated strong criticism of its environmental impact. Critics are concerned about the huge amounts of water used in the fracking process, which requires jets of water, chemicals and sand to be blasted into the shale rock. And this is a particular source of concern in places of existing water scarcity. In addition, some people are worried that during the procedure the potentially carcinogenic chemicals used may escape and contaminate groundwater around the fracking site. Finally, many object to fracking on climate change grounds, arguing that we do not need yet more fossil fuel technology and that investment should rather be spent on renewables.

Food and Water

The final spur that could result in dramatic changes to the policy framework – with all the implications this could have for stock valuations – is the cumulative impact of highly unpredictable extreme weather events. Despite government agreed targets to limit global warming to 2°C by stabilising atmospheric CO_2 at 450ppm, last year atmospheric CO_2 increased by 2.7ppm, to reach 400ppm. At this rate of increase, the 450ppm target will be exceeded by 2030.[29] The latest report from the International Panel on Climate Change, launched September 2013, predicts the warming trend will continue. It is already known that exceeding the existing target risks dangerous climate disruption. The most likely triggers of policy action were seen to be the impacts these events could have on food prices and water scarcity.

> "Addressing urban pollution, water stress, climate change: these are now going to happen in places like China and India simultaneously."

Accordingly to the IPCC, an increase in 2°C in global temperatures could cause a 20% fall in wheat yields. This would exceed any possible gains from warming in areas currently too cold to grow crops, as well as any benefits from rising CO_2 concentrations.[30] More recent research has suggested that rising temperatures could result in a 12-13% fall in yields for corn, rice and wheat between 2010 and 2050.[31] Water shortages are also increasingly becoming a problem, and this will impact significantly on agriculture, which accounts for 70% of fresh water use.[32] The OECD estimates that 44% of the world's population live in areas of severe water stress, a figure that could rise to 47%, or 3.9 billion people, by 2030.[33]

There are existing examples of how governments respond to sudden food price hikes. The 2007/8 food prices hikes moved hundreds of millions of people into poverty and the subsequent food riots shook governments in dozens of developing countries. Faced with the significant political risks associated with food prices, governments globally reacted to the 2007/8 crisis rapidly, and often in unpredictable and unprecedented ways. Food exports were suspended or restricted by 31 countries, while 46 importing countries reduced taxes on food grains or introduced economy-wide price controls or consumer subsidies.[34] Richer grain-importing nations bought up large tracts of land in poor agricultural ones, leading some to accuse them of 'land grabbing' at the expense of the poor.

Though events in 2007/8 were triggered by food price hikes caused by an increase in the price of primary energy, food prices will also be determined by supply. If this becomes repeatedly disrupted by extreme weather events, the question for investors is whether this will trigger governments to undertake more systematic attempts to reduce carbon in the atmosphere, and if so, over what time frame.

Section Five: **What Investors Want to Know**

Investors have long had to manage the many variables that determine how value may be created and destroyed in the complex energy system. The shale revolution does not change that. Nor does climate change. However, the potentially transformative extent of such changes suggests that prudent risk management involves – at a minimum – improving the cross-fertilisation of research findings between equities, between asset classes, and over longer time-frames. And they may even require a more active approach.

Recommendation 1:	For investors to **bridge internal silos** across geographic regions, asset classes and investment styles in order to improve understanding of energy risks in supposedly uncorrelated asset classes.
Recommendation 2:	For investors to **expand risk horizons** in acknowledgement of the fact that today's investable timeframes may prevent understanding of long-term risk.
Recommendation 3:	For analysts and investors to **build price and demand scenarios** to enhance understanding of systemic energy risk in their portfolios.
Recommendation 4:	For investors to **commission more climate-related research** in order to enhance their understanding of risk.
Recommendation 5:	For investors to require **greater transparency and disclosure** from investee companies.
Recommendation 6:	For investors to **improve understanding** of public policy and regulation, and their investment implications.

In order for investors better to anticipate and manage risks associated with the volatility of the system, including long-term climate-change-related risk, *EnergyFutures* participants identified a number of ways in which the information gap could be bridged: by improving in-house and broker research, by requiring greater disclosure and transparency of investee companies, and by enhancing their own understanding of how public policy is made. They also noted that other stakeholders in the energy system, most notably governments and companies, would also benefit from more systematic analysis, which cross-references findings from across the energy system.

Recommendation 1: To Bridge Internal Silos

Investors have an opportunity to address the limitations of a siloed approach to research and fund management. This includes placing a premium on analysis that tries to assess the energy impact embedded in supposedly uncorrelated asset classes and how energy shocks might reveal common exposures and vulnerabilities in asset classes that are traditionally considered relatively immune from one another. Investor participants in *EnergyFutures* warned that conventional sector/industry classifications are unable to capture the extent of the risks and opportunities of climate change, and argued in favour of greater cross-fertilisation of research findings from across geographic regions, asset classes and investment styles.

"Your archetypal Chief Investment Officer sees (energy) as superclusters: fuels (oil, gas, coal), with a different relationship to users of oil... So getting in a room people who look across those sectors is hard. The fund management and investment world is very poor at doing cross-sectoral work."

Recommendation 2: Expand Risk Horizons

The importance of expanding risk horizons over time was also emphasised, particularly to address some of the environmental risks in energy investing. Interviewees agreed that climate change will have a material impact on the energy sector, yet the vast majority of investors continue to invest as if it were immaterial. This is striking, given that some research suggests that climate change could contribute 10% to the portfolio risk for a representative mix of assets.[35] Yet, there are good reasons for this. Due to current investable timeframes, there is little conviction that climate change considerations will affect valuations in the short term, nor that it will affect how capital markets view risk at a macro level (for instance, through any changes to the equity risk premium).

Recommendation 3: Build Price and Demand Scenarios

Investors view the energy system through the prism of price. So the fact that the market still has no meaningful way of pricing carbon goes a long way to explaining why many mainstream investors remain phlegmatic about climate change. Investor understanding of the systemic energy risk in their portfolios could be enhanced by undertaking scenario exercises on demand, energy use and the energy mix, and price scenarios on gas, oil and coal and value at risk.

Recommendation 4: Commission More Climate-Related Research

Another way of bridging the gap between today's valuations and future climate risk is through the commissioning of more broker research specifically designed to understand the scientific findings and to evaluate climate risk and opportunities.[36] There is already a discernible trend in this direction. The commissioning of research designed to understand climate risk impacts on quoted stocks should be consolidated.

Recommendation 5: Require Greater Company Transparency and Disclosure

Requiring greater transparency and disclosure from investee companies could also enhance investor decision-making. This could include more on price sensitivity including: oil price assumptions on capital expenditure decisions; break-even information for operating costs; more data on resource access and resource value; fuel price assumptions and fuel hedging plans; and CO_2 price forecasts. In addition, companies should provide more information on baseline climate change scenarios they are using for capex decision-making; information about their disaster planning and calculations of climate risk from extreme weather events. Finally, investors are interested to know more about the lobbying activities of their investee companies.

Recommendation 6: Improve Public Policy Understanding

The third way to bridge the information gap is to better understand the policy and regulatory environment, and its investment implications. This is a key driver of how the energy system will evolve, nationally, regionally and globally, with significant market consequences. This is particularly true when it comes to climate-related policy. There are mixed views on the merits for investors in engaging directly with policy makers. Some believe they have little leverage. Others that it is important for asset owners to articulate a more coherent policy agenda: to seek to shape policy rather than merely understand where it is headed. There are difficulties for investors in communicating effectively with regulators and governments, who tend to be divorced from the world of the markets. But there are also concrete examples of where such an engagement has had a constructive outcome.

Section Six: **Conclusions**

"There is a reputational angel for investors around energy. It's no longer just a pragmatic issue. Increasingly people are recognising that the investor bit of the chain is important. We have to acknowledge our role in the chain. We investors are going to have to be more accountable around these issues."

The energy system has changed significantly over the past decade. Changes to supply – primarily the advent of US shale gas – have had important repercussions for other fuel stocks and important implications for the price of primary energy. At the same time, the demand story is also in flux, with assumptions about coal consumption in particular being questioned. The nature, speed and scale of these changes – resulting from a combination of new technologies, political will, environmental concerns and market forces – have taken many people by surprise, including some investors. They demonstrate that the apparently immutable energy system may be capable of more change, more quickly than had previously been thought possible. In doing so, they also raise the question as to whether other transformative changes to the energy system might be in the making and, if so, how investors should identify and prepare for them.

One clear conclusion was that investors – along with others who have a stake in the energy system: governments, investors, companies, consumers and citizens – need to engage in a much more systematic analysis of the energy system. For investors this is vital in order to understand different sources of risk embedded in their portfolios. Grappling with this is likely to require a shift from a traditional asset-driven paradigm to a mindset that looks across sources of risk. It will require greater transparency on the part of investee companies – about their price assumptions, their scenario findings and their long-term investment strategies. Investors will need this information to identify risks, measure them and monitor them. Once these risks are clearer, they can be incorporated into the construction of portfolios in a way that diversifies investors' risk exposure. And there will be opportunities, not just risks, as a result of energy changes. Regulatory change may lead to interesting new business models, representing a much bigger proportion of the market as demand for their services grows. This type of portfolio construction may well look very different in its weighting of different asset classes compared with more conventional models.

To achieve these aims, *EnergyFutures* made six recommendations on how to undertake more systematic risk analysis. They are outlined in Section 5.

A Paradigm Shift

In addition to these moves towards more systematic risk management, a small but growing group of investors is going further, to ask whether there is scope for investors to start moving from more analysis to action? Due to their concerns about the potential value destruction of failing to adequately manage climate risk, they argue for investors to actively seek to invest in such a way as to contribute to climate change mitigation. And they argue that fiduciary duty over the long term requires such a position. They pointed to the recent HSBC report Shifting Capital Markets by 2°C, which identifies five themes that could help shape the capital market's response to climate disruption, through 2020 and beyond, as characteristic of the sort of investor response needed.

Any such investor action would have to be managed to avoid any increase in the short term risk profile of portfolios. This is likely to be best achieved by introducing improved systemic analysis of the energy system. There is growing government and public interest in responsible capitalism and concern about future investment performance. Investors may well come to be judged on how well they manage such systematic risk.

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Selected References

1. World Economic Forum, *Energy for Economic Growth: Energy Vision Update 2012* (Geneva, 2012). Accessed at: http://www3.weforum.org/docs/WEF_EN_EnergyEconomicGrowth_IndustryAgenda_2012.pdf.

2. OECD, *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels* (Paris, 2012). Accessed at: http://www.oecd.org/site/tadffss/48805150.pdf.

3. McKinsey Global Institute, *Disruptive Technologies: Advances that will Transform Life, Business and the Global Economy* (Paris, May 2013). Accessed at: http://www.mckinsey.com/insights/business_technology/disruptive_technologies.

4. Deloitte, *Oil and Gas Reality Check 2013: A Look at the Top Issues Facing the Oil and Gas Sector* (New York, 2013). Accessed at: http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Energy_Resources/dtt_er_OG_Reality_Check_2013_05102013.pdf.

5. McKinsey Global Institute, *Disruptive Technologies*.

6. US Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* (Washington, DC: June 2013).

7. E. Krukowska, 'EU Urges Energy Market as US Shale Gas Widens Price Gap', *Bloomberg*, 22 May 2013.

8. K. Johnson, 'US Coal Finds Warm Embrace Overseas', *Wall Street Journal*, 6 Feb. 2013.

9. A. Riley, *The Geopolitical Implications of the Shale Gas Revolution* (London, 2012).

10. PwC, *Shale Oil: The Next Energy Revolution* (London, Feb. 2013). Accessed at: http://www.pwc.com/en_GX/gx/oil-gas-energy/publications/pdfs/pwc-shale-oil.pdf.

11. A. Makan, 'US Shale Output Erodes OPEC's Oil Market Share', *Financial Times* (11 July 2013).

12. Citi, *The Unimaginable: Peak Coal in China* (London, September 2013).

13. HSBC, *European Energy Utilities: Energy Demand to Lag GDP by a Widening Margin* (London, Apr. 2013).

14. Citi, *The Unimaginable: Peak Coal in China*

15. Michael W. Parker, Purdy Ho, *Asian Coal & Power, Less, Less, Less… The Beginning of the End of Coal, Bernstein Research* (2013)

16. Citi, *The Unimaginable: Peak Coal in China*

17. A. Riley, *The Geopolitical Implications of the Shale Gas Revolution*

18. Nicholas Stern, *Stern Review on the Economics of Climate Change* (London, Oct. 2006). Accessed at http:/www.hm-treasury.gov.uk/sternreview_index.htm.

19. Carbon Tracker and Grantham Research Institute, *Unburnable Carbon 2013: Wasted Capital and Stranded Assets* (London, Apr. 2013).

20. P. Spedding, N. Robbins and K. Mehta, 'Oil and Carbon Revisited: Value at Risk from Unburnable Reserves', *HSBC Global Research*, 25 Jan. 2013.

21. Mercer, *Climate Change Scenarios: Implications for Strategic Asset Allocation* (London, 2011).

22. 'Tepid, Timid: The World Will One Day Adopt a Carbon Tax But Only After Exhausting All the Alternatives', *The Economist*, 29 June 2013.

23. HSBC, *European Energy Utilities.*

24. International Energy Agency, *Redrawing the Energy-Climate Map: World Energy Outlook Special Report* (Paris, 10 June 2013).

25. 'NRG Doubles Down on Distributed Generation', Rocky Mountain Institute (blog), 11 Apr. 2013. Accessed at: http://blog.rmi.org/blog_2013_04_11_NRG_Doubles_Down_on_Distributed_Generation.

26. Bernstein, *Asian Coal & Power, Less, Less, Less… The Beginning of the End of Coal*

27. WHO, *Global Burden of Disease Report* (Geneva, 2012).

28. Bernstein, *Asian Coal & Power, Less, Less, Less… The Beginning of the End of Coal*

29. International Energy Agency, *Redrawing the Energy-Climate Map*.

30. The Economist, *The 9 Billion-People Question* (London, 2011).

31. HSBC, *Scoring Climate Change Risk – Which Countries are Most Vulnerable* (London, 9 Aug. 2011).

32. Chatham House, *The Feeding of the Nine Billion* (London, 2009). Accessed at: http://www.wfp.org/sites/default/files/alex_evans.pdf.

33. HSBC, *Scoring Climate Change Risk*.

34. US Department of State, *Food Prices Crisis of 2007–2008: Lessons Learned* (Washington, DC, 2011). Accessed at: http://www.state.gov/r/pa/prs/ps/2011/03/157629.htm.

35. Mercer, *Climate Change Scenarios*.

36. Mercer, *Climate Change Scenarios*.

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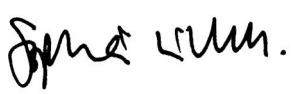

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