Financing the Future of Energy

The opportunity for the Gulf's financial services sector

A report for the National Bank of Abu Dhabi by the University of Cambridge and PwC

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What is the report's purpose?

The report presents the evidence behind the changing nature of the global energy system over the next decade, highlighting the growing demand for sustainable energy in the Gulf region; the technologies that are most likely to close the supply-demand gap; and the scale of the financing required. Arguments are prepared for why banks might choose to develop and support these opportunities, and how they can work with policy makers to positively enable this to occur.

What is its scope?

The report sets out the global evidence on the future of energy within a Gulf region context. The intention is to provide the evidence base from which the financial services sector can consider their approach to providing products and services which will support the growth of the low carbon economy. The opportunity now is for financial services organisations to understand the evidence, explore the new structures that might be required, engage the relevant Governments and, ultimately, convert the trends into bankable solutions.

What geographies does it cover?

The report covers the Gulf region, specifically, Kingdom of Bahrain, Kuwait, Sultanate of Oman, Qatar, Kingdom of Saudi Arabia and United Arab Emirates (UAE). We have tried to use this definition of 'the GCC region' throughout the report. However, there are cases where the data we use is relevant but do not divide a region in quite this way (such as data on the Middle East more broadly), and we have indicated this where it occurs.

Who is it for?

The report is intended principally for the finance community in the Gulf region, and NBAD in particular. It provides insights into how that community might engage with public and private sector stakeholders to create a more energy efficient economy, turning the aspirations of the region for sustainability – for example in Abu Dhabi's Vision 2030 – into a reality that will attract the attention of the rest of the world and unlock significant financial opportunities. The report will also be of interest to the energy sector and Government partners more widely in the region and in the West-East Corridor.

What methodology was used?

Three forms of evidence were used in this report. Firstly, the report draws on global analyses from energy expert bodies and academic studies to present the core trends and context of supply and demand behind the changing nature of global and regional energy systems. Secondly, the scenarios presented in the report draw on the Future Technology Transformation model developed by the University of Cambridge, derived from many previous academic studies and a solid regional and global database of energy investment trajectories. Thirdly, the report draws upon a wide range of interviews conducted in Abu Dhabi during the period October 2014 to January 2015, covering key policy, energy sector, project developer and banking industry stakeholders.

Who are the authors?

The underlying research and writing of the report was carried out by the University of Cambridge Institute for Sustainability Leadership and the Cambridge Centre for Climate Change Mitigation Research in the UK, and PwC's Sustainability and Renewables team based in Abu Dhabi, UAE with additional support from PwC's Global Sustainability and Energy networks.

Foreword
Financing the Future of Energy

Alex Thursby
Chief Executive, NBAD

Energy has been the cornerstone of the economies of this region. Even now, as we see an increasingly diverse range of economic activity, the future of the Middle East is inextricably bound up with the future of energy.

The world's thirst for energy continues to grow and meeting the demand will be a real challenge. The rapid development of the GCC countries means we are part of that global picture. Energy demand, expected to increase threefold in the next fifteen years, will far outstrip today's supply. To close the gap will require huge levels of investment in projects that provide additional generation capacity and improve the efficiency of our energy use.

We should not under estimate the scale of the task facing us all. But, for the region, it gives us the opportunity to create solutions for highly efficient energy systems that both supply our energy needs locally and connect to a growing world market in energy technology. Since this will require innovative approaches to financing energy, we believe it also presents real opportunities for the region's banking sector. That's why we commissioned this report: we want to understand better what the real drivers are so we can respond to them effectively.

Some of the report's findings may surprise you, as they did me. For example, renewable energy technologies are far further advanced than many may believe: solar photovoltaic (PV) and on-shore wind have a track record of successful deployment, and costs have fallen dramatically in the past few years. In many parts of the world, indeed, they are now competitive with hydrocarbon energy sources. Already, more than half of the investment in new electricity generation worldwide is in renewables. Potentially, the gains to be made from focusing on energy efficiency are as great as the benefits of increasing generation. Together, these help us to reframe how we think about the prospects for energy in the region.

At NBAD, our strategy is to expand our presence along the rapidly growing super-region that stretches from Africa through the Middle East to Asia, that we call the West-East Corridor. The vibrancy of these economies is driven by the rise of new megacities, rapid industrialisation and increasing middle class wealth and expectations. This report has also highlighted for me the reality that the transformation under way right across the West-East Corridor brings with it an almost insatiable demand for new energy. These countries are looking for different kinds of solutions, to break out of traditional centralised approaches to generation and use new technologies to help them leapfrog developed economies.

As this report shows, when we look to the future, it is very clear that renewables will be an established part of the global energy mix. Governments around the world, including the Gulf region, are setting out their ambitions for decarbonising their economies, and the global debate about energy has never been more intense.

We are delighted to have had the collaboration of Masdar, Abu Dhabi's renewable energy company, in producing this report. Their expertise does an enormous amount to put the UAE at the forefront of the renewable energy debate and their international profile is a national asset.

So for NBAD, this report is the start of a journey: we want to learn more, collaborate more and make a real contribution to helping this region to meet its own energy challenge. We think this region has the potential to become a global centre of excellence in new energy solutions and we hope to work with others to better understand the role that the banking sector can play in financing the future of energy.

Executive Summary

Financing the future of sustainable energy offers excellent opportunities for the banking sector in the Gulf region.

This report provides the evidence base needed to convince financiers that those opportunities are real, large and happening now. It aims to give them the context they need to guide their choices and shape the financial products which will support the development of the energy industry.

The opportunities encompass projects that generate energy, that transmit and distribute energy to consumers, and that improve the efficiency of energy use. All of these – especially when combined – will help to address a fundamental requirement for the region: ensuring that supply can continue to meet the growing demand for energy. At the same time, it can enable the region to move towards greater prominence as a global home of sustainable energy.

The need for a strategic approach to energy finance is driven by the pressures of growth in the region, pressures that are creating the greater demand for energy. As this report will show, there is a large and projected gap between supply and demand for energy in the Gulf, especially in the form of power (electricity). This is driven by growing populations and increasing per capita GDP with associated lifestyle benefits and challenges. More electricity generation is needed to serve a more energy intensive industrial base, greater use of air conditioning and an urgent scaling up of desalination capacity to meet future water demands. Energy demand in the region is expected to triple during the next 15 to 20 years. Rising to these challenges will require both substantial new generation capacity and wiser, more efficient, use of that energy.

While the economies of this region have been built on oil and gas production, and that will continue for the foreseeable future, the energy system of the past will not be the same as the energy system for the future. It is clear that renewables will be an established and significant part of the future energy mix, in the region and globally.

The argument of this report has four pillars, as follows:

$150bn

US$150 billion was invested in solar generation globally in 2014.

Pillar 1

The scale of the opportunity is large. The investment required for power generation, transmission and efficient use of energy is in the order of tens of billions of US dollars per year in the region – and hundreds of billions (possibly a trillion) US dollars per year worldwide. Continued rising demand will ensure a locked in energy demand, which underpins the attractiveness of this area as an investment proposition.

Of the increased generation capacity, a considerable percentage will come from renewables. In 2014 alone, US$150 billion was invested in solar generation globally, and US$100 billion in wind. For the last few years, more than half of the total investment in new electricity generation worldwide has been in renewable energy technologies. The trend has been enabled by continuing reductions in technology costs, rising demand for electricity in developing countries, and a significant drive by Governments to switch to less carbon intensive generation sources to respond to climate concerns.

Globally, the economic development of the Middle East, Africa and Asia – the fast emerging markets which have been termed the 'West-East Corridor' – have particular importance because this is where the largest amount of new demand will come from. This corridor will be characterised by the rise of new mega cities, rapid industrialisation, and growing middle class wealth and expectations.
The nature of the energy demand in these countries will be different from the pattern which is now set in the developed world, requiring much more new-build generation (rather that adaptation or upgrading of established grids), rapid deployment and innovations which can reach large populations, often living in off-grid situations. For the economies along this corridor, there is a huge opportunity to leapfrog traditional approaches to developing energy systems, moving immediately to cutting edge technologies, more cost-efficient and decentralised systems, and applying more innovative approaches to finance these developments.

Pillar 2

Renewable energy technologies that can realise these opportunities are proven, cost-effective and available today. They also have the benefit of balancing economic, energy supply, sustainability and social ambitions for consumers, policymakers and investors.

For solar PV and on-shore wind technologies, there is already a track record of successful deployment. Prices have fallen dramatically in the past few years: solar PV falling by 80 per cent in six years, and on-shore wind by 40 per cent. The speed of this shift towards grid parity with fossil fuels means that, in many instances, perceptions of the role of renewables in the energy mix have not caught up with reality. At the end of 2014, the 200 MW Dubai Electricity and Water Authority (DEWA) bid in Dubai set a new world benchmark for utility scale solar PV costs, showing that photovoltaic technologies are competitive today with oil at US$10/barrel and gas at US$5/MMBtu. As Government and utilities are driven to bring new generation capacity on stream, this new reality presents a significant opportunity to make savings, reduce fuel cost risks, achieve climate ambitions and, at the same time, keep more oil and gas available for export.

Other technologies capable of transforming the wider energy system also represent medium term investment opportunities, particularly storage technologies and concentrated solar power. They are currently running behind solar PV and on-shore wind in the maturity curve but are rapidly catching up. They can already be seen to be following a similar path towards proven deployment and operation, reliability and falling costs.

Efficiency and demand-side management is the other side of the equation in closing the energy gap of the future. There is particular emphasis on efficiency in developed economies, seen for example in more efficient industrial processes and even instances of innovative approaches by suppliers to incentivise reduced energy use in their customer base. Even in the Gulf region, where local energy prices have until recently provided comparatively little economic incentive for efficiency, there is now a growing awareness of the merits of reducing demand, particularly in construction and the built environment. Recent tariff rises in Abu Dhabi and Dubai, for instance, have looked to further support moves in this direction. Reducing local use also has the economic benefit of freeing up the oil and gas resources of these countries for future export.

Pillar 3

Investors and developers see a global stage for projects. While the particular characteristics of demand and supply are local, the opportunity for proven technologies and finance packages is global. For example, government ambitions and targets have put solar and wind power at the heart of future energy developments in the Middle East. Ambitious targets and well-developed programmes create the opportunity for the development of significant local markets and experience. Building renewable energy technology supply chains and capacity within the region will also open up the opportunity to export expertise and deliver solutions elsewhere, especially along the West- East Corridor where the requirement to meet new demand and to find non-traditional and innovative solutions is even more pressing.

Pillar 4

Realising the opportunity will require collaboration between policymakers and financial institutions.
Governments all over the world, including in the Gulf region, are setting ambitions and shaping strategies to respond to climate change and decarbonise their economies. Because of the sheer level of investment needed to deliver on those strategies, there is a major role for the private sector, especially the finance sector, to play in enabling Governments to make those policy ambitions a reality.

The traditional models of financing used for large infrastructure projects can be enhanced to support more frequent and fast deployment of renewable technologies. The banking sector has a major part to play, but so too do other financial services actors: insurance companies or global institutions such as the Clean Development Fund. Recent experience in delivering solar PV and on-shore wind projects on the global stage has forged new approaches to financing renewable energy – such as securitisation, aggregation and green bonds - which can usefully be adapted for the Gulf region. Alongside the financial sector, though, Governments have a continued contribution to make, from establishing Power Purchase Agreements or procurement frameworks that enable new technologies to be deployed at scale and drive down costs. Plus the key contribution of Governments is to provide the longer term certainty that is a prerequisite for new project development.

This situation provides the cue for the financial sector to engage and work closely with Governments to establish mutually beneficial solutions: ensuring that the right policy frameworks are in place to facilitate the financing which will be needed and then helping to deliver the capital required.

Dubai set a new global benchmark in December 2014: at 5.84 US cents per kW hour, the bid for Dubai Electricity and Water Authority's 200 MW solar PV plant was cheaper than oil at US$10/barrel and gas at US$5/MMBtu.

Renewables in the context of a low oil price

The sharp fall in the oil price in 2014 has raised the question of whether the trend towards a more integrated energy mix and the growth of renewables will continue, or be stalled by more affordable oil and gas. There are strong reasons to believe it will continue.

- First, the huge rise in energy demand is for the most part electricity, yet only 5 per cent of global electricity comes from oil so, in that regard, oil is not a direct competitor with renewable electricity sources but rather a complement to it. Also solar is on track to achieve grid parity in 80 per cent of countries within the next two years, so cost is no longer a reason not to proceed with renewables.

- Second, there has been an historic concern that renewables are an unreliable option, because the wind blows only intermittently and the sun does not shine all the time, but that is proving to be less of an issue. For the Gulf region, the peak in electricity demand tends to occur during the middle of the day, and modern grids can now easily cope with at least 40 per cent of renewable input before requiring modifications. Even if there is intermittency, the increasing role of gas in the electricity market provides an ideal complement to the generation profile of renewable energy technologies. Furthermore, developments in storage technologies are progressing rapidly, and in the next few years utility scale solutions will be deployed that further minimise concern around what was until recently seen as a major inhibitor to the uptake of renewable generation.

- Finally, the underlying drivers towards renewable energy sources are long term: the looming gap in demand and supply that needs to be filled by significantly increased electricity generation; the challenge of managing finite or hard-to-reach resources; the desire of Governments to secure local supplies and where possible to disconnect from the volatility of the oil price; plus policy frameworks worldwide that seek to decarbonise their economy in response to climate change and pollution concerns. All of these are set to continue.

The opportunity for the Gulf region

The landscape of energy production and use is changing both regionally and globally. The government of Abu Dhabi's twin reports, the Economic Vision 2030 and Environment Vision 2030, stand out in the region as plans for a future that will enhance economic performance, while also meeting the goals of a more sustainable economy that improves quality of life for citizens. Achieving this vision, however, will require innovations in energy supply and demand, including sustainable energy sources and high efficiency energy use. Recognising that there is significant existing infrastructure in place, the transition to this new energy future will be gradual – probably requiring several decades. But making the transition smoothly requires strategic decisions in the short term – over the next five to ten years – to avoid locking the energy system into further investments that will need to be rethought as unavailability of competitively priced conventional fuel sources mounts and environmental sustainability becomes an increasingly important performance criterion.

The introduction of more sustainable energy generation and improvements in the efficiency of energy use will reduce the energy intensity and carbon intensity of the Gulf region. The region currently has the highest energy intensity (energy use per unit of GDP) and carbon intensity (carbon dioxide emissions per unit of GDP) of any global region. It also has one of the world's highest per capita energy consumption and carbon emission rates, and lowest rates of deployment of renewables. If the region is to take a world-leading role in these areas, opening itself to a global marketplace and participating in the financing of energy projects in other nations that have set ambitious sustainability targets, it will be necessary to demonstrate the ambitions and the delivery capability at home. The central role of Government in the economies of many of the countries in the region can help to support a rapid transition if a decision is made to do so.

This transition to a more sustainable energy future will also involve the development of innovations that tie in well to the centres of scientific and technological expertise in the region, such as Masdar. By linking energy projects to innovation and the high tech economy that comes with it, the region has the potential to develop a workforce and the solutions for highly efficient energy systems that both supply the energy needs of the region and connect to a growing world market in energy technology and finance.

The opportunity for the finance sector

The opportunity for the region is also an opportunity for the finance sector. What at first appear to be challenges as the region makes the transition to a new energy future can become the source of the opportunity, when it is recognised that the situation will demand innovative responses in technology, industry and infrastructure – all of which need to be financed. The intention of this report is therefore to lay out a vision for the opportunity that exists for the financial community by not only supporting these areas of growth but by also innovating itself.

If the transition is to be successful, however, careful thought – founded in a strong base of evidence – is needed to ensure that financial resources are directed towards the most fruitful projects that will lead the region to global leadership in the most effective manner while maintaining profitability and of course, meeting demand. Hence, the following chapters develop the evidence base, describing the current state of the energy system in the nations of the region, the state that must be reached if supply is to keep pace with demand, the potential drivers of change – such as economic growth, population growth, availability and prices of oil and gas, regional climate and sustainable energy policy, and the restructuring of local economies so they have a broader base in high value economic activities.

The intention of this report is to enable the finance sector to understand more fully the opportunities which exist and to provide the context for developing appropriate financial products and structures to enable the energy industry to deliver these opportunities. With greater amounts of capital available for these transformational projects, and through close working with key stakeholders in the policymaking arena, the banking sector can become one of the driving forces, accelerating the transition to a much needed new world of energy.

The region currently has the highest energy intensity and carbon intensity of any global region.

Future Energy Trends

Rising demand

US$48 trillion of investment in energy infrastructure is needed in the next 20 years: the bulk of it in non-OECD countries.

MENA energy demand is expected to grow by 8.3 per cent per year between 2013-2019: more than x3 the global average.

Over 170 GW of additional capacity will be required in the GCC region alone by 2020.

Rising investment levels

More than 50 per cent of investment in new generation capacity worldwide is in renewables.

US$260 billion a year has been invested in renewable energy technologies worldwide for the past five years.

Green bond issues to pay for low carbon energy projects reached US$36.6 billion in 2014, more than triple the previous year.

The falling cost of solar PV

Prices for solar PV modules have fallen over 80 per cent since 2008.

Solar PV will be at grid parity in 80 per cent of countries in the next 2 years.

Solar PV is already cheaper than grid electricity in 42 of the 50 largest US cities.

Technologies with proven track record

Industrial applications of energy efficiency can deliver 100 per cent payback in five years.

Modern wind turbines produce x15 more electricity than the typical wind turbine in 1990.

The cost of energy storage is expected to drop to US$100 per kWh in the next five years, against US$250 now.

Chapter 1

Filling the energy gap

The scale of the financing opportunity in sustainable energy is large and growing, driven by the looming gap between energy supply and demand: it will require both new generation capacity and energy efficiency to fill that gap.

1.1
Introduction

In this chapter we look at the first of the four pillars of the argument: the scale of opportunity for financing projects is large, driven by a looming gap between energy supply and demand that is projected to rise dramatically over the next 10-15 years.

Closing that gap will necessitate projects in both energy generation and energy efficiency. The investment required is in the order of tens of billions of US dollars per year in the region, and hundreds of billions of US dollars per year – potentially, even a trillion US dollars – globally.

1.2
The gap between energy supply and demand

There is a gap looming between the increasing demand for energy and the ability to meet that demand through an adequate and reliable supply. We turn first to demand, where there has been a rapid rise in the Gulf region. The evidence shows that energy use is already large and increasing, and this creates a locked-in demand for that energy, helping to de-risk the financing of energy generation projects. We then turn to energy efficiency, noting that closing the gap will require significant investments in both supply and efficiency.

Figure 1 shows two metrics of energy demand (electricity and total primary energy use), a metric of environmental sustainability (carbon dioxide emissions) and two drivers related to GDP and population growth. The increases in all of these metrics have been stable (and hence reliable) over the past decade. In fact, the rate of growth has been increasing in the past five years. **All indications are that this same rate of growth in energy demand will continue for at least the next 20 years, with market demand tripling by 2030 compared to 2014. This is unsustainable: in practical terms, it is simply not possible to build enough new generation capacity, traditional or renewable, in time to meet this growth in demand which explains why energy efficiency measures will also have to play such a key role alongside generation.**

An additional measure of energy use is the energy intensity of the economy. This is an important metric of economic performance, as high energy intensity drives up the cost of production for goods and service, affecting both domestic populations and the competitiveness of the region in the global market. As can be seen in Figure 2, the GCC nations have significantly higher energy intensity than the economies with which they will increasingly compete in that global market.

The potential solution of financing projects to improve the energy efficiency of the economy, which will also reduce the gap between supply and demand, are limited in the Gulf by current tariff structures which often remove any incentive to curb use or introduce demand side measures.

Krane[2] has produced a detailed analysis of the projected gap between demand and supply out to 2020. The rate of growth in energy consumption (see Figure 3) demonstrates that the region remains a market with a locked-in demand for energy production, which is a crucial part of the business case for investments in new energy generation.

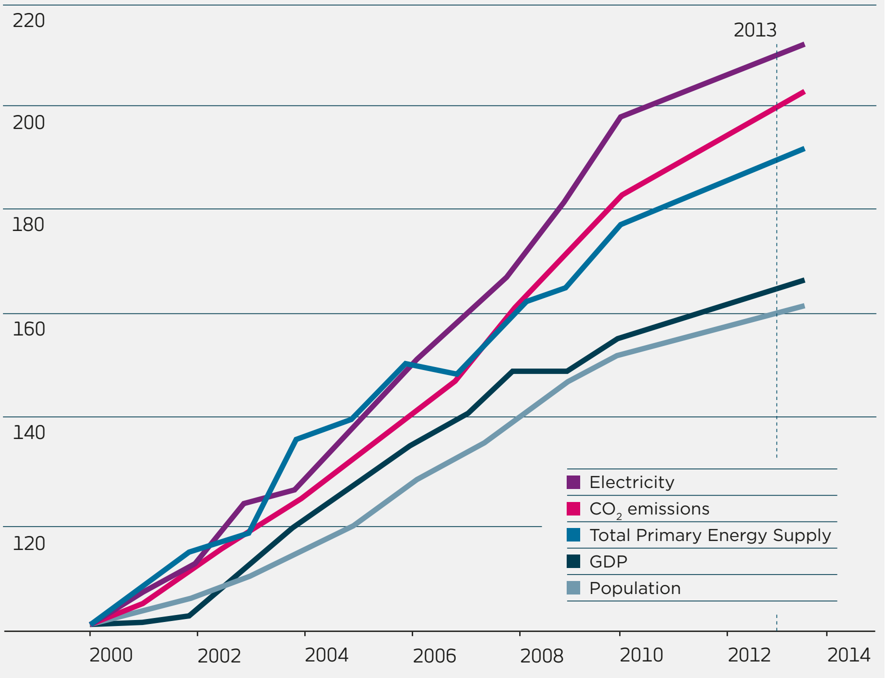
Further reinforcing the images of a growing gap between supply and demand, a recent study by the Gulf Research Centre[5] estimates that power demand in the Middle East will rise by approximately a factor of 3 or more by 2050 (by 50 per cent by 2030), second only to the rate of growth in India.

Forward projections for transport and industrial energy demand are similarly large. A recent Chatham House Report[6] demonstrates that transport is approximately 10 per cent of the energy demand across the region and growing, and is already slightly above 20 per cent for Saudi Arabia. Industrial energy use (non-power generation) is approximately six per cent for the region, although again there is variation between the nations and the energy use by industry as regional economies make the transition to a more diverse mix of economic sectors. Again, closing the energy gap in transport and industry requires a balance of projects between new energy generation and improved efficiency.

x3

Energy demand in the Gulf is expected to triple by 2030.

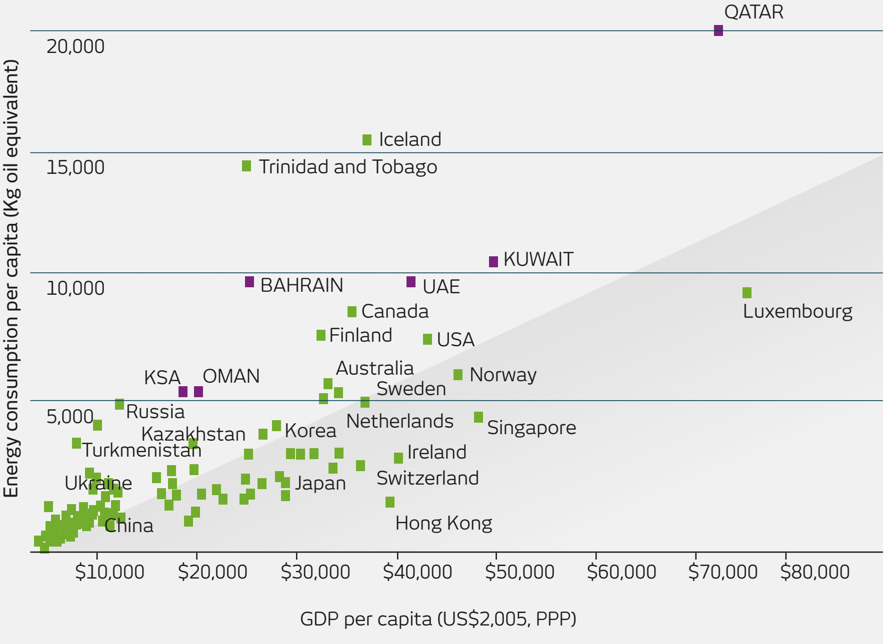
Figure 1. Basic energy trends in the GCC countries



Source: Based on International Energy Agency data

Energy, carbon, GDP and population data on the GCC region for the period through 2013.

Figure 2. National energy intensities



Source: World Bank, 2011

Energy intensity of the economy for the nations of the world. GCC regional economies are shown as purple squares. To make comparisons, the reader should draw a vertical line through the economy of a region, and compare per capita energy consumption for the same GDP per capita values for nations along that line. Data are from the World Bank[1].

1.3
New generation capacity

Meeting the expected increase in energy demand across the Middle East will require significant scaling up of both traditional and renewables generation capacity.

Oil and gas infrastructure will remain core to the region's energy system for the foreseeable future. Saudi Arabia is one of a handful of countries that still burn crude oil directly for power generation, using an average of 0.7 million bbl/d of crude oil during the summers from 2009 to 2013. During that same period, Iraq and Kuwait, the next two largest users of crude oil for power generation in the Middle East, each averaged roughly 0.08 million bbl/d of crude burn[7]. In all cases this represents significant foregone revenue that could have been achieved had alternatives been in place to meet domestic power generation requirements and the oil had been sold on international markets. Meanwhile, increasing pollution and impacts on human health are now also influencing the Governments to consider alternative sources to oil for new planned generation.

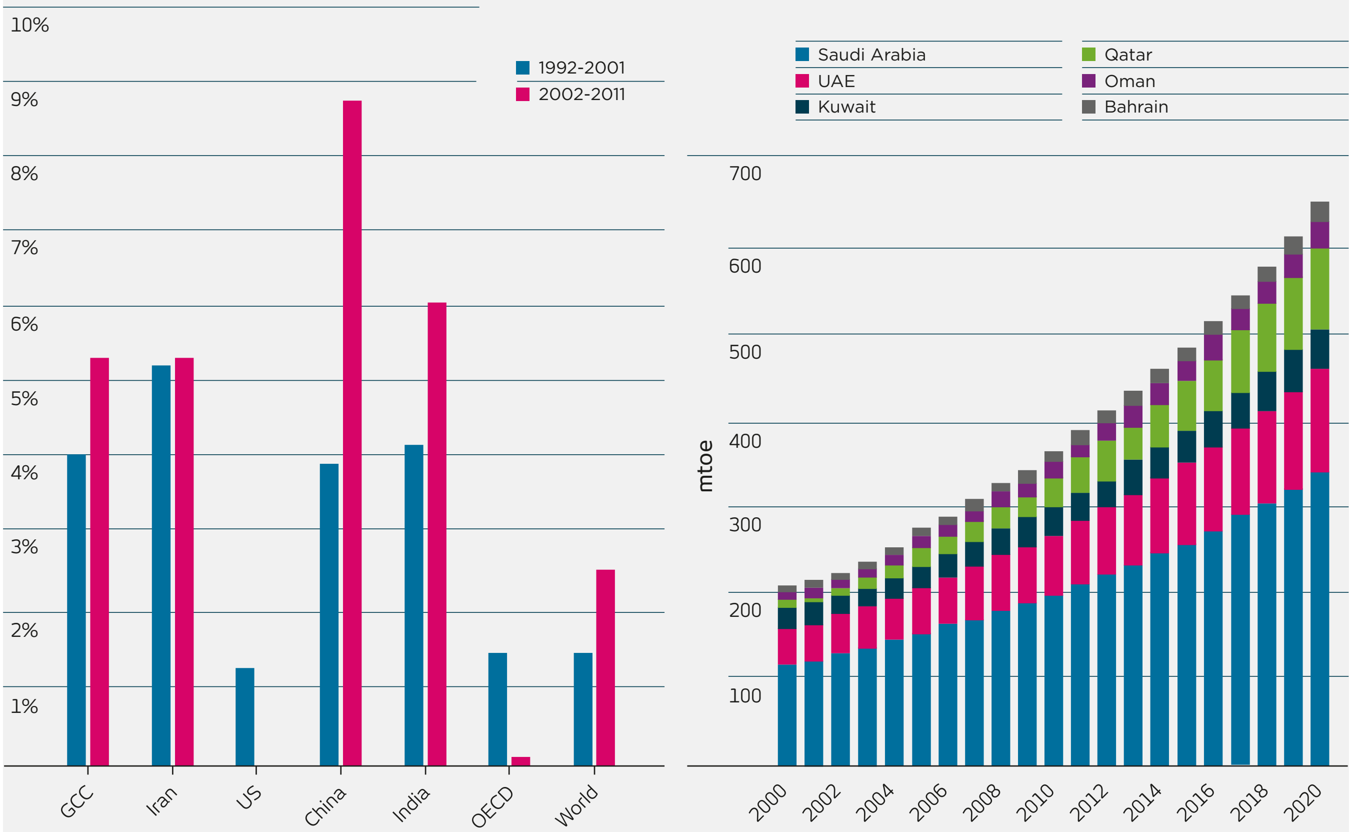
For other countries in the region, notably Kuwait, Qatar, Oman and the UAE, gas represents a large part of the current energy infrastructure. Most of these, with the notable exception of Qatar, are becoming net and growing importers of gas from other countries as their economies develop and domestic supplies become scarcer and/or more expensive to harvest. The resulting potential impact on Government budgets has increased the focus on ways to reduce gas demand through energy efficiency measures, the use of substitutes for natural gas – such as, enhanced oil recovery and other industrial processes, and of course the use of alternatives. For the UAE, new domestic production is estimated to require prices of US$6-8/MMBtu, while LNG imports cost US$12/MMBtu and imported US 'unconventional' of shale gas would cost US$6-8/MMBtu under the best scenarios. By comparison, new cost data suggests that solar PV would be the UAE's most attractive option to save fuel when incremental gas is above US$8/MMBtu and solar CSP when it is above US$9.5/MMBtu.

Historically, natural gas and renewable energy sources have been seen as competitors. However, increasingly, the view globally is that natural gas is also the perfect conventional energy candidate as a support to the growing development

Figure 3. Projected Energy consumption

Average yearly growth primary energy consumption (BP)

GCC primary energy consumption; projections to 2020 (EIU)



Past and projected energy consumption in the GCC region, including a comparison of past and current rates of growth against other world regions (left figure). Data for the left figure are from a study by BP[3], and for the right figure are from the Economist Intelligence Unit[4].

of renewable energy generation[8]. In recent years in Europe and the US, gas has successfully demonstrated its potential to play a major role as a 'transitional' fuel until lower emission renewable energy technologies become fully cost effective.

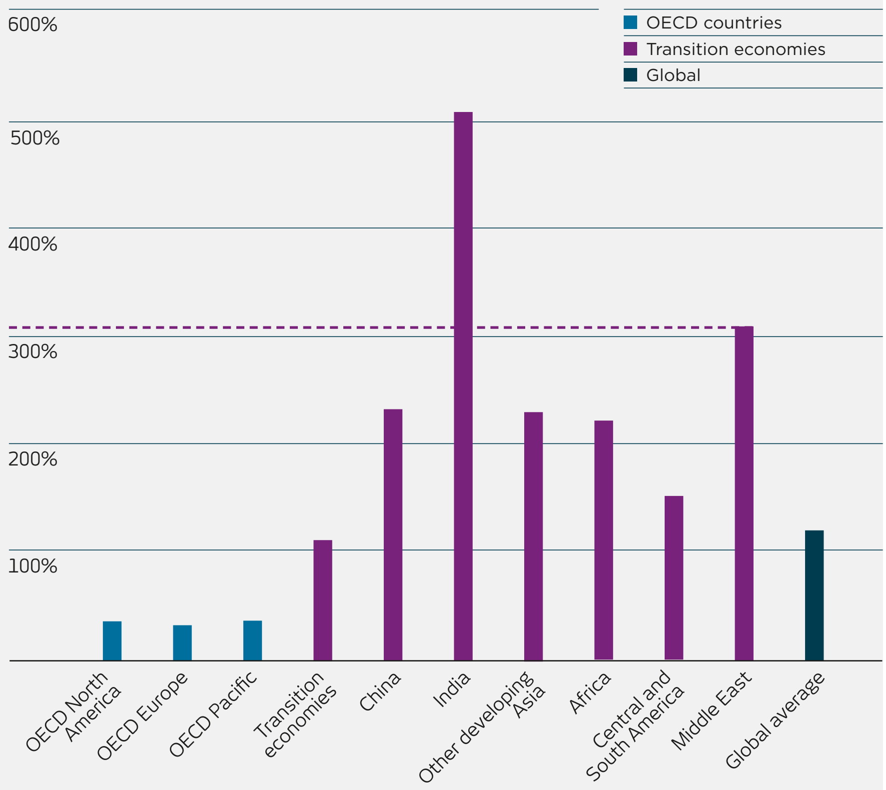
This has played a part in driving one of the most notable trends in power generation globally over the past few years, namely that over 50 per cent of investment in new generation has gone – and continues to go – into renewables. This has amounted to an average of US$260 billion a year worldwide over the past five years. The trend is for this percentage to continue to increase and, indeed, MENA's renewable energy capacity is expected to increase sixtyfold by 2030 compared to 2013 levels.

This will have two key impacts for the region. First, as these projects come online and start to deliver, they will increase the confidence of Governments and investors in renewables as a credible value proposition and encourage further investment. Second, the transition to renewables as a more substantial part of the future energy mix will begin to happen in the Gulf, as has happened elsewhere in the world.

70k MW

China has a target to generate 70,000 MW of solar power by 2017.

Figure 4. Projected increase in demand to 2050



Source: IEA, 2010.

Note the large increase for the Middle East, taken here to be representative of the GCC region. The y-axis is the percentage growth compared to today.

China leads the world in solar energy deployment

New renewable capacity installation outside the OECD exceeded growth within the OECD for the first time in 2013 – with China now leading the way in solar PV, as it does in wind generation. Between 2010 and 2012, China's capacity for solar PV generation grew almost nine fold to 7,000 MW. In 2013, it added more than that again: a further 11,300 MW – the largest additional solar PV capacity of any country in any one year. That included the completion of the world's largest solar PV project of 320 MW, adjacent to Longyangxia hydropower dam in Qinghai.

Apart from adding to the world's capacity of installed solar generation, the scale of investment is accelerating the learning effect of deployment, production and process improvement, and further cost reduction for a technology which is then available for deployment worldwide. In future, as well as continued large project development, China intends to move into smaller systems that do not need long-distance energy transmission, aiming to deploy more than 8,000 MW of rooftop solar PV in 2014.

China's solar PV industry has become a significant economic contributor, generating national income of US$52 billion in 2013, and employing 1.6 million people. In May 2014, the Government raised its sights further still, announcing a target of 70,000 MW from solar power by 2017.

1.4

Renewable generation in a world of low oil prices

The business case for any energy project depends at least in part on the relative costs of one energy supply against another. This raises the question of whether the high level of investments in renewables seen over the past several years will be affected by a period of low oil prices, such as the sharp drop experienced in 2014. We address this question by noting five features of the world energy market:

- Oil is a small percentage of the fuel used in power generation, which is where most of the investment will take place; approximately 5 per cent. Therefore the price of oil is not very relevant to a discussion on investment in power generation for most parts of the world. In the Middle East approximately 35 per cent of electricity generation comes from oil, with much of this focused in Saudi Arabia, so the comparison has greater resonance within the region.
- The decline in costs of renewables has been so rapid that, in many cases, the finance sector is using outdated perceptions on the relative prices of fossil fuel and renewable energy supplies. In many circumstances and countries, solar PV now has grid parity with fossil fuels, and nowhere is that more evident than in the recent record set for costs of 5.84 US cents per kWh for the Dubai Energy and Water Authority (DEWA) DEWA's solar PV plant in Dubai.
- While the price of oil fell dramatically in 2014, that price has always fallen and risen. By contrast, the costs of renewable – especially solar PV and on-shore wind – have been declining steadily and rapidly. This decline will continue, especially at the module and systems level for solar PV, due to 'learning-by-doing' enabling continued process improvements in the sector and the entry of large-scale technology providers such as China and US into the global market.
- One of the greatest areas of concern for the feasibility of mainstream solar power is receding. Historically, the incapacity of grids to cope with the intermittent nature of sun or wind generation made solar, and renewables generally, riskier than oil or gas sources. However, modern grids can manage up to 40 per cent of renewables easily, reducing the need for back-up fossil-fuel generation.
- Renewable generation capacity, once built, has no variable fuel cost to account for. That makes renewables an attractive option for developers. In addition, especially where it involves solar PV or on-shore wind, renewable production can be brought into operation quickly, in 12-18 months, and provides a flexible option for places where there are currently no grids.

40%

Modern grids can manage up to 40 per cent of renewables easily.

Renewables for new build versus existing power generation

The reductions in the oil price experienced in 2014 have raised some doubts about the economics of substituting oil with renewables in Middle East oil and gas producing countries, even as the costs of on-shore wind and solar PV grow ever more cost-competitive against fossil fuels in many parts of the world.

Updated regional data on fossil fuel break-even prices published by EI New Energy in February 2015 indicate that for new build generation on-shore wind and solar PV remain cheaper than a new oil project in the Middle East. The calculations, based on their model of the regional levelised cost of energy, suggest it would be cheaper to develop on-shore wind or utility-scale solar PV capacity than to build a conventional oil-fired plant in the Middle East at any oil price above US$20-30/bbl over the 25-30 year lifetime of a new project.

The picture becomes less favourable for renewables when considered against the many existing oil-fired plants in the Middle East, which currently account for some 35 per cent of the generation mix in the region. Because running costs are lower, solar PV needs oil prices of more than US$45/bbl to compete with a half-depreciated oil-fired power plant, and more than US$60/bbl to displace a fully depreciated one.

For renewables, a significantly greater proportion of the investment is front loaded. This is an important drawback at times of lower oil revenue, which in turn limits the amount of investments that countries are able to front, even when calculations show that alternative technologies are cheaper than oil and gas over the long lifetime of a project.

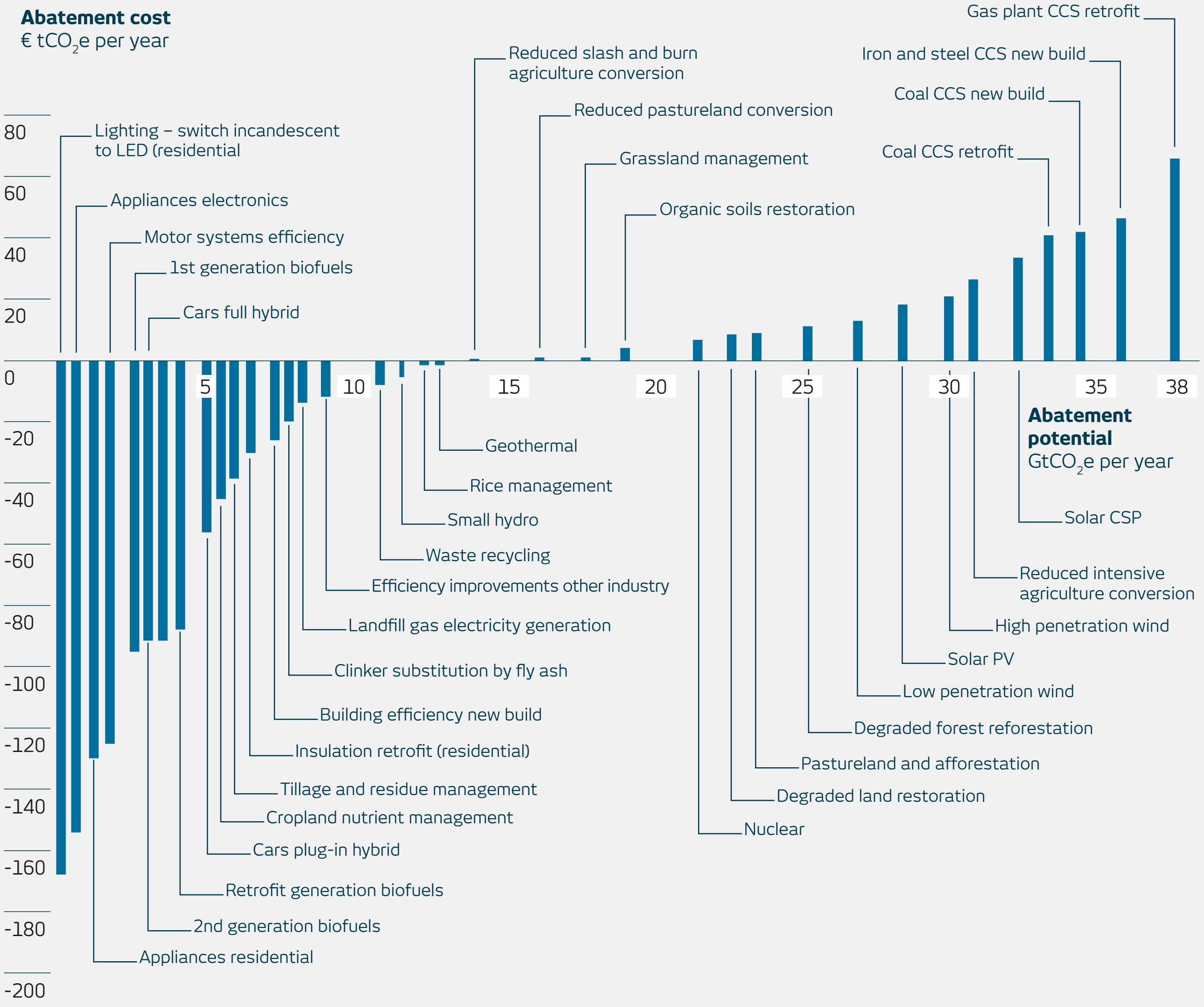
1.5 Energy efficiency

While increased energy generation is the traditional approach to bringing supply up to meet growth of demand, the same aim of balancing supply and demand (and retaining a reserve margin) can be met by demand reduction, which reduces the rate of growth in demand.

An important feature of energy efficiency projects is that they are capable of closing the gap between supply and demand in a more cost-efficient manner than reliance on new generation capacity alone.

Figure 5 shows the Marginal Abatement Cost Curves for energy system improvements, considering both supply and demand (energy efficiency). For each option, the costs are total expenditure (TOTEX) through to 2030. In other words, they include both initial capital expenditure (CAPEX) and operating expenditure (OPEX). When the reduction in OPEX is higher than CAPEX over the lifetime of a project, the MAC value is negative. Note that most of these negative values are associated with projects that improve the energy efficiency of buildings, transport and industry, further reinforcing the argument that investments must balance new energy generation and improved energy efficiency.

Figure 5. Projected marginal abatement costs (MACs) to 2030



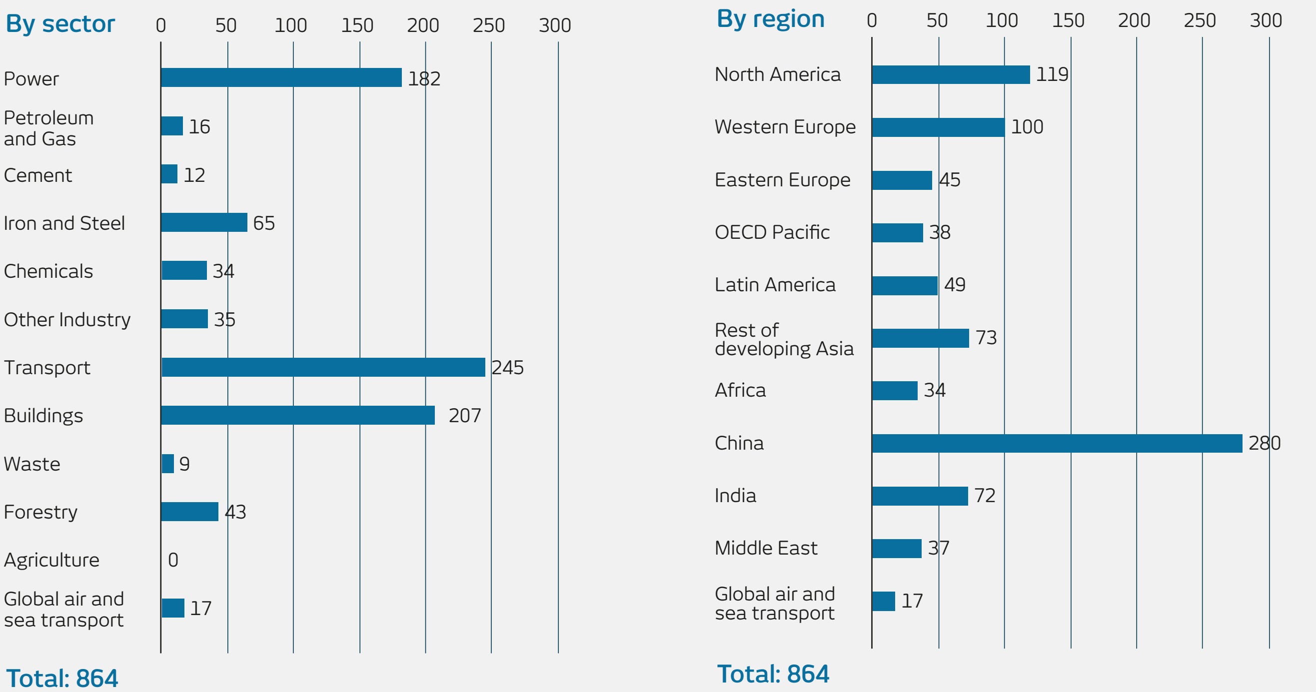
Marginal Abatement Costs (MACs) through to 2030 for a variety of energy improvements[9]. The energy efficiency options all show negative MAC values when averaged over the lifetime of a project, meaning they more than pay back their CAPEX finance.

1.5 continued

The same MAC study[12] also provides estimates of energy and other infrastructure investments needed in the region. Note the estimate for the Middle East (the study does not consider the GCC as a separate region) in Figure 6 of a required US$37 billion/year in expenditures out to 2030.

The payback periods for improvements in industrial efficiency have also been studied by the Global Economy and Development program[10] using a database of 119 projects carried out primarily in developing nations (such as the nations along the West-East Corridor). As shown in Figure 7 opposite, for industrial applications the payback is significant and the payback periods are short, strengthening the business cases for such improvements: 100 per cent payback after five years in some instances, for example. RBS, acting with its NatWest partnership in the UK, is one bank which has introduced these mechanisms to their client base with considerable success.

Figure 6. Annual investment requirements for full carbon abatement



Annual investment requirements to achieve the full carbon abatement potential of the regional energy system.

More efficient lighting can reduce global energy consumption

With approximately 20 per cent of the world's electricity being used for lighting, more efficient bulbs represent a significant opportunity to reduce global energy consumption. The 2014 Nobel Prize in Physics went to three Japanese scientists who were able to build the world's first blue light emitting diode (LED). Their invention paved the way for the white LED bulbs that are now available universally. They are 19 times more efficient than conventional incandescent light bulbs and can last 50 to 100 times longer.

With LED lights also using so little energy, they can now be run off local solar PV panels, which means that there is finally a cost effective way to provide light to the 1.5 billion people currently not connected to the power grid. The potential applications for solar-powered LED electricity will be particularly relevant in the emerging economies along the West- East Corridor.

1.5
continued

Figure 7. Internal rate of returns for energy efficiency improvements

Sector	Payback Years	IRR 3 years (%)	IRR 4 years (%)	IRR 5 years (%)	IRR 10 years (%)
Automotive/autoparts	1.93	26	37	43	51
Cement/ceramics	2.19	18	29	36	45
Chemicals	2.90	2	14	21	32
Equipment manufacturing	2.10	20	32	38	47
Food and beverages	1.10	74	83	87	91
Metal	1.50	45	55	60	66
Paper	0.90	96	105	108	111

Estimated internal rate of returns for a variety of energy efficiency improvement (demand reduction) investments, assuming the current rate of annual increase in unit energy costs[3].

The region has a significant potential for energy efficiency improvements due to the role of the Governments in holding large property estates. Energy efficiency projects require aggregation of properties to keep the costs of programmes such as retrofits low. Government estates are therefore ideal opportunities to begin the process of efficiency improvement, as they also represent properties where the owner and the occupant are the same, which avoids the problem one often finds where the owner must pay for the energy efficiency improvement but the occupant benefits from the decreased energy costs. There is also an incentive for the public sector to lead the way because declining energy demand makes renewables more feasible (supporting national ambitions for low carbon energy) and decreases domestic demand for fuels that might otherwise improve the economic base through the world market.

The private housing sector also presents a substantial opportunity for energy efficiency. The majority of residential properties occupied by foreigners are rented. Currently there is no incentive for builders and landlords in many of the GCC countries to install energy saving technology and materials in new build accommodation, but this could change should Government policies be introduced requiring them to do so. Developments such as the rising electricity and water tariffs in Abu Dhabi and Dubai may spur the take up of energy efficiency projects.

By leading the way, Governments can begin to tie the discussions of energy efficiency to the role of subsidies to the private sector, as discussed in Chapter 4. This is already emerging as an opportunity. For example, Etihad Energy Services Co. was established in 2013 as an initiative by DEWA to create a viable market in Dubai for energy efficiency services (ESCOs) in the built environment. Its initial focus is on Government buildings and on opportunities with an ROI of 3 years or less.

Some industrial applications of energy efficiency can deliver 100 per cent payback in five years.

1.6
Meeting the demand

Four broad features of the likely development of the energy system in the region have been laid out by the Economist Intelligence Unit[11]:

- The region will "invest in adding value to exported fossil fuels", with oil and gas processed into refined fuels, petrochemicals and plastics. In addition, "more gas will be channelled for use in energy-intensive local industries". To this comment we would add that if more gas is needed for industry, this could increase the use of solar PV for electricity in buildings and in desalination. The recent 5.84 US cents per kWh bid in Dubai has completely changed the global reference point for levelised costs for solar PV power, providing evidence for the grid parity mentioned previously. The other solar technology, Concentrated Solar Power (CSP), although currently more expensive than solar PV, may also be able to support local industrial energy requirements.

- The region will "invest in power production to meet soaring demand. Electricity demand will rise by seven to eight per cent per year on average. In the face of seasonal electricity shortages, the region will invest heavily in gas-fired generating capacity, and will try to rein in demand for electricity. Tighter energy-efficiency regulations are more likely to be enforced…".

- "To diversify their economies and benefit from increased global demand for renewable fuels, GCC states will invest in alternatives such as solar and nuclear power. These sources will help them to meet the shortfall in electricity supplies…". To this we can add the benefit to these economies of creating new, high-value jobs in the renewables sector. We are already seeing some progress on the nuclear front with an advanced program underway in the UAE with the first reactor due to come online in 2017, and significant targets set in Saudi Arabia.

- The region will "devote more resources to developing 'cleaner' energy technologies…To maintain their markets in countries that have set carbon dioxide emission limits, GCC states will invest in technologies such as carbon capture and sequestration". Carbon capture and storage, currently remains very expensive to develop, although that may reduce in coming years if sufficient projects are undertaken around the world. In the meantime, renewable technology energy sources already meet the same low carbon ambitions at significantly lower costs.

How this energy system develops will depend on the policies and sustainability ambitions of the region. Outlined below are three different possible scenarios of the transition of the energy system over the next several decades. In all three cases, the example used is that of power (electricity), as this remains the largest component of the energy gap.

The evidence for these three scenarios was developed using the Future Technology Transformation model of the Cambridge Centre for Climate Change Mitigation Research[12]. All three cases meet the energy demand of the region out to 2030, although they differ with respect to the resulting mix of improvements in energy and energy efficiency. As will be seen in the figures, many of the technologies are projected to have complex patterns of deployment over time due to the competing influences of other technologies, market saturation, resource availability, changing levelised costs through learning by doing and economies of scale, and the assumed introduction of the most significant environmental regulations in 2030. Since all of these issues could change dramatically in the future, the following three scenarios should be taken as indicative only, as the economic region of the Future Technology Transformation model includes some nations not in the GCC, and the outputs are summarised in Figure 8 below.

Figure 8. Summary of potential outcomes for scenarios on the following pages

Scenario	Total investment in new power production – annual average, US$	Total investment in new power generation – 2015-30, US$	Energy intensity of economy – per cent of current value	Carbon intensity of economy – per cent of current value	Ranking in OECD aspirant nations league table
1. Business as usual	**13 billion**	**195 billion**	**77 per cent**	**71 per cent**	**Bottom third**
2. Cautious	**15 billion**	**225 billion**	**68 per cent**	**50 per cent**	**Middle**
3. Innovative	**17 billion**	**225 billion**	**64 per cent**	**45 per cent**	**Top third**

Business as usual

SCENARIO ONE

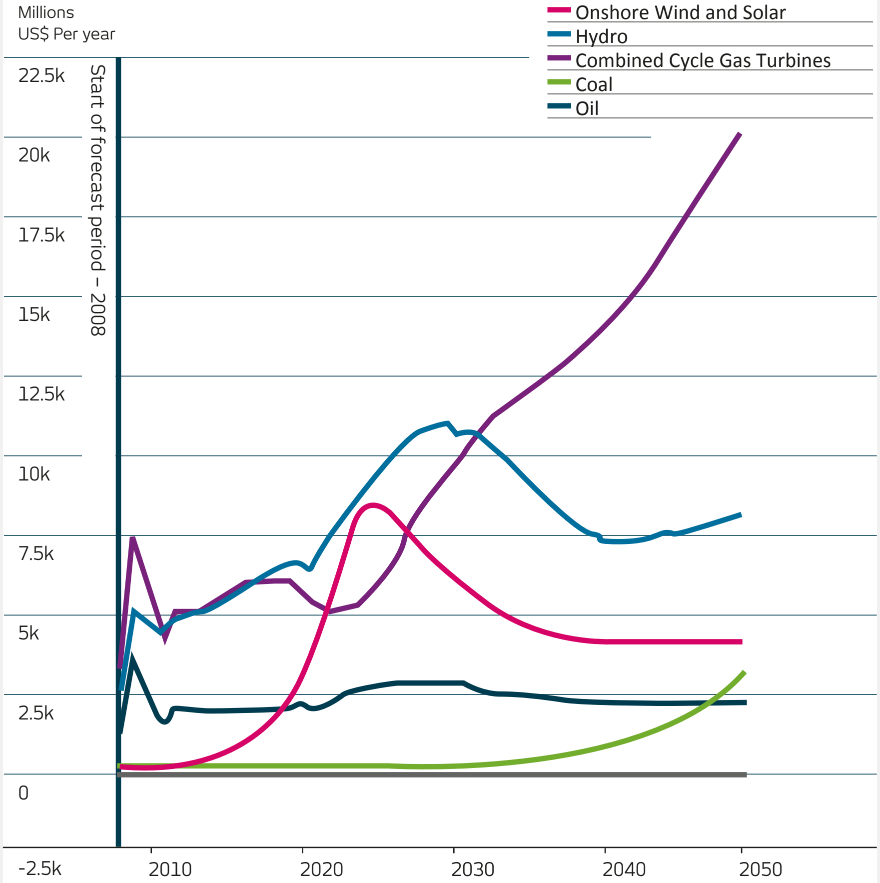
The 'business-as-usual' scenario assumes a continuation of current policies of energy supply in the GCC region. It is assumed that there will be no stringent requirements for carbon emissions reductions, no price signal from a carbon tax, no renewable portfolio requirements, no programmes of energy efficiency improvement (other than as technologies reach the end of their life and are replaced with whatever is available on the market at that time) and a complete reliance on levelised cost of energy (LCOE) as the criterion for selecting suitable projects.

Under this scenario, the total investment in new power production capacity is an average of US$13 billion/year, for a total (2015-2030) of US$195 billion.

Energy intensity of the economy declines to 77 per cent of the current value, and the carbon intensity declines to 71 per cent of the current value due to on-going improvements in the efficiencies of traditional power generation and use delivered by the market.

Following this scenario would place the region into the bottom third of the aspirant nation league tables (taken here to be the OECD nations) with regard to energy and carbon intensity of the economy. The results of the model, showing projected level of new generation investment, are given in Figure 9a.

Figure 9a. Business as usual scenario: projected annual investment in new electricity generation



Projected annual investment in new electricity generation capacity out to 2050 in the business-as-usual scenario. In the scenario, 'coal' is not 'clean coal'. The horizontal grey line at zero per cent is for reference only.

Cautious

SCENARIO TWO

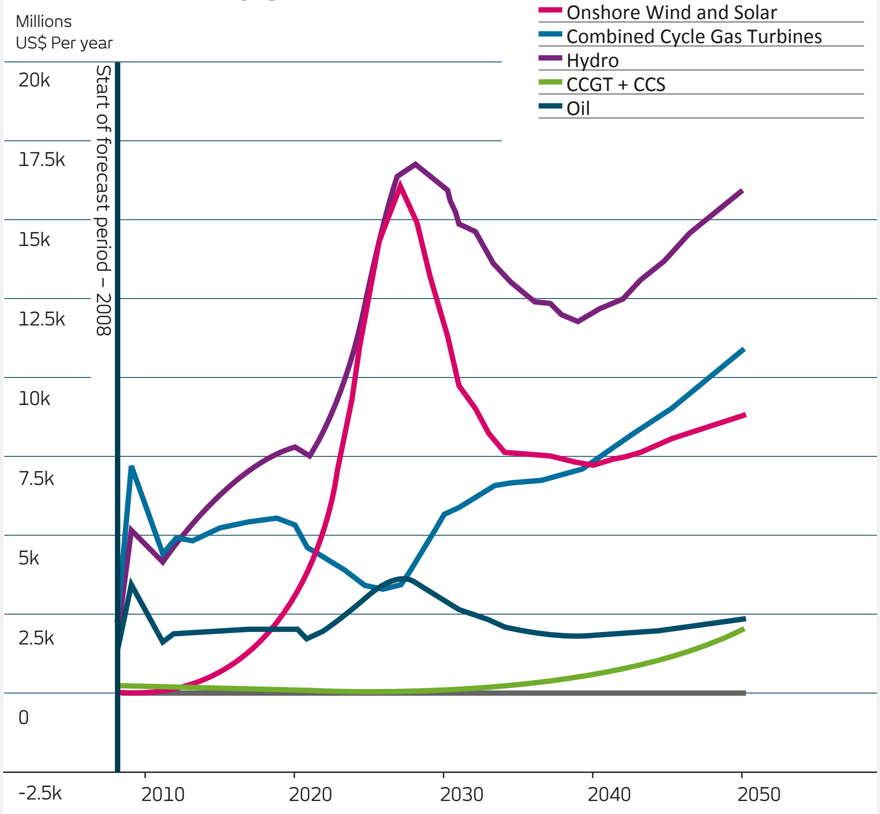
The 'cautious' scenario assumes the adoption of sustainable energy technologies to fill gaps between supply and demand as those technologies mature and become cost competitive with traditional energy projects. It retains many of the assumptions of the business as usual scenario, but adds low carbon feed-in tariffs (to stimulate delivery of renewables) and a low carbon price for the region (which then results in energy efficiency improvements).

Under this scenario, the total investment in new power production capacity is an average of US$15 billion/year, for a total (2015-2030) of US$225 billion.

Energy intensity of the economy declines to 68 per cent of the current value, and the carbon intensity declines to 50 per cent of the current value.

Following this scenario would place the region into the middle of the aspirant nation league tables with regard to energy and carbon intensity of the economy. The results of the model, showing projected level of new generation investment, are given in Figure 9b.

Figure 9b. Cautious scenario: projected annual investment in new electricity generation



Projected annual investment in new electricity generation capacity out to 2050 in the 'cautious' scenario.

Innovative

SCENARIO THREE

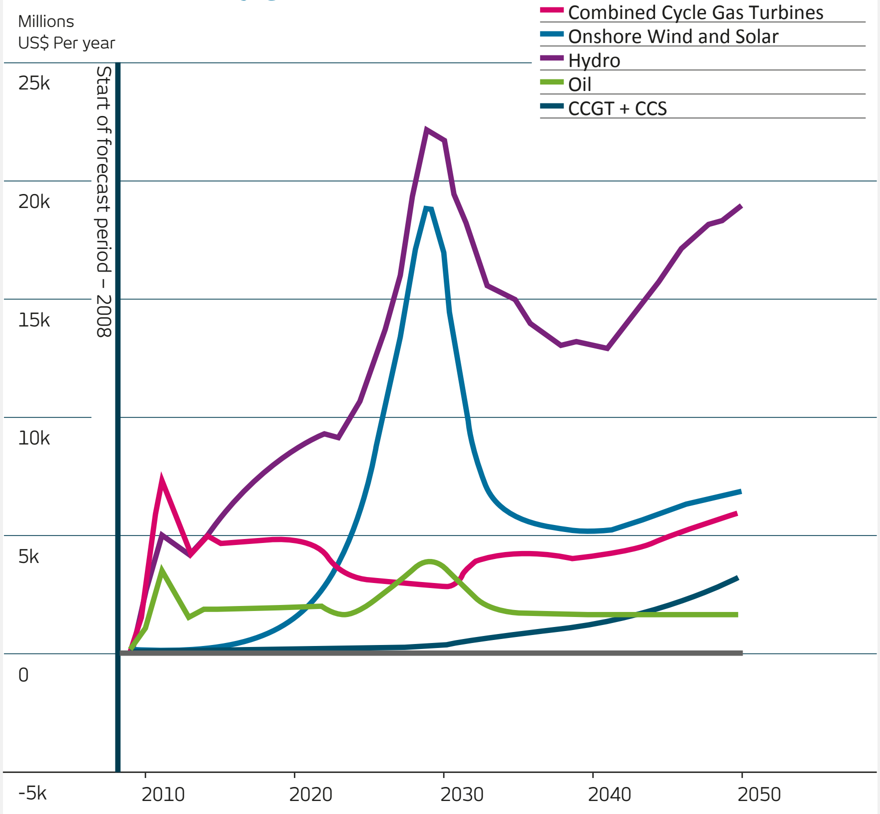
The innovative scenario assumes a design to place the region on the cutting edge of sustainable, reliable energy systems out to 2050. It involves significant investment in renewables as a form of low carbon energy. It includes in addition to the 'cautious' scenario assumptions, high CO_2 prices (rising to US$100 per ton of CO_2 by 2050) driving energy investment and demand reduction, Feed-in Tariffs (FiTs) for renewables, regulations banning the construction of new coal power stations and significant investment in energy innovation that turns the region into a global centre for innovation in energy systems.

Under this scenario, the total investment in new power production capacity is an average of US$17 billion/year, for a total (2015-2030) of US$255 billion.

Energy intensity of the economy declines to 64 per cent of the current value, and the carbon intensity declines to 45 per cent of the current value.

Following this scenario would place the region into the top third of the aspirant nation league tables with regard to energy and carbon intensity of the economy. The results of the model, showing projected level of new generation investment, are given in Figure 9c.

Figure 9c. Ambitious scenario: projected annual investment in new electricity generation



Projected annual investment in new electricity generation capacity out to 2050 in the 'innovative' scenario.

1.7 The role of finance in responding to the energy challenge

A study by FEMIP[13] in 2012 identified the three key barriers to uptake and deployment of sustainable energy in the Mediterranean region to be financial, regulatory and limitations in grid capacity. (They do not examine energy efficiency improvements.) Their study includes more than the GCC nations, and does not include all of those nations, but the results are representative. They conclude with a simple but relevant message that for the countries considered:

"The main obstacle seems to be financial."

In particular they identified that there was a dearth of finance ready renewable energy projects for financiers to support and more should be done to address this situation. This is also true for the GCC region, although here liquidity is not an issue and is available for the right projects.

A more complete review of the important role of finance in energy projects of the GCC region has been conducted by the European Central Bank[14]. While the report was originally produced in 2008, conversations with the report authors in 2014 suggest that the conclusions they draw remain sound. A summary of the key points from their analysis and ours include the following points:

- Within the finance sector, the source of financing and debt needed for renewable energy projects in the GCC is still primarily bank-based. Whilst international banks have historically had a significant presence, it is now increasingly dominated by domestic banks who have the opportunity to play a much larger role as this sector develops. For other countries in the region, including Egypt and Jordan, development banks remain an important source of concessional finance for certain projects. There is now also increasing participation and partnerships directly with international banks for major infrastructure projects. One of the main reasons for this is that international banks often follow international contractors. For example, the 200 MW solar PV plant awarded recently in Dubai had US, Chinese, Saudi, Spanish and French companies responding, as well as those from the UAE. Alongside improvement in the local regulatory and policy framework of the region, procurement policies in the GCC that support and encourage bidding by international players will also help to attract additional international finance to the region. Local banks remain a key source of debt finance for energy projects, but given the scale of investment required, they may not be able to meet all of the required demand on their own. International players remain interested in regional opportunities; however they will consider these against other investment opportunities on the world stage.
- The focus to date for financiers has been on short-term maturity, while energy system improvements will require movement towards longer-term maturity. Project developers are looking for longer tenors – often 20-25 years that banks currently are not comfortable with. This is despite the returns on profitability being reasonable and backed by long term Power Purchase Agreements that offer utility style bond returns. Banks and their shareholders that are looking to play a more significant role in the growth of renewable energy projects will need to be more open to accepting longer tenors. This will in turn require coordination with Governmental policy, as discussed in Chapter 4.
- Banks are well capitalised and profitable; the limitations to the stream of energy finance are typically ones of availability of 'shovel-ready' energy projects. If this area of investment is to become accepted as a core part of future business, the finance sector would be well advised to engage more meaningfully at an earlier stage with developers of energy projects to help shape and move such projects forward.

x60

MENA's renewable energy capacity is expected to increase sixtyfold by 2030 compared to 2013.

- Traditional finance instruments globally are undergoing rapid change in response to the opportunity provided by renewable energy; ranging from securitisation to aggregation to green bonds (discussed further in Chapter 4). Some new approaches are being developed in the GCC as early projects take hold. Meanwhile, even though the local capital markets are currently underdeveloped regionally compared to other similarly wealthy regions of the world, some international experience could be relevant to the GCC. To develop a greater understanding of renewable energy project development, banks in the region could look to invest in energy projects in more mature markets. That would put them in a good position to bring into the GCC knowledge of world class financing approaches that can be adapted to support the development of regionally appropriate and innovative financing instruments.

- Foreign participation in bank-financed projects in the region is lower than that in other developed regions of the world because of the perceived higher risk and the lack of local sector understanding and participation. By increasing their involvement internationally and regionally in renewable energy projects, local banks can step into this gap and develop a track record for delivering innovative, world-class energy projects. With this as a basis, the region can then look to become a global leader and innovator.

- Organisations such as Masdar, have invested in a range of overseas renewable energy projects, for example in Spain and the UK, and through practical experience developed a good understanding of how these are financed. This technical and financial knowledge can now be leveraged back into the region to support local project development.

1.8 Subsidies

A review of energy supply and demand in the GCC region would not be complete without also considering the backdrop to, and recent trends in, electricity pricing in the Middle East with a particular focus on the direct and indirect subsidies provided in a number of its member states. This is a complex area. Whilst not the focus of this report, there are a number of other studies that have looked in detail at the arguments for and against the subsidy of conventional energy and electricity by regional Governments. What is clear is that whilst pricing policies that reduce the domestic cost of input fuels or electricity can provide a short-term solution to the need to provide low cost energy solutions, they may also prevent a shift towards a more sustainable energy system in the longer term.

Reducing and removing these policies, in a targeted, de-politicised and clearly communicated manner, will create space in public budgets for other much needed interventions in for example healthcare, schooling, housing. In Egypt the national budget for energy subsidies was US$17 billion in 2011-12, more than 20 per cent of budgetary expenditure and around 7 per cent of GDP, so it is unlikely to be a sustainable policy for the long run. On the other hand, in Jordan there have been no formal subsidies on oil products since 2012 which means the country has moved in line with market prices. As of 2015, there are signs that more Governments in the region are beginning to take steps to address the unsustainable levels of subsidies for both electricity and water. This trend has been driven by the absolute and growing amount of US$ costs, by the changing energy landscape described above, and perhaps also by the realisation that providing support instead for renewable energy can have significant positive domestic economic, social and environmental benefits.

More governments in the region are taking steps to address the unsustainable level of subsidies for both electricity and water.

50%

Over 50 per cent of investment in new generation worldwide goes into renewables.

1.9. Conclusions

To summarise the case for an ambitious programme of finance of improved energy systems for the region:

- There is a looming, large and growing gap between energy supply and demand in the region. Demand is expected to triple by 2030. This gap must be met, and so there is locked-in demand for the energy generated by projects.
- Filling this gap requires investment in significant levels of new generation capacity, as well as improved energy efficiency to mitigate demand.
- The new energy generation capacity should include a significant share of renewable sources, as these are both financially competitive with traditional fuels and will move the region towards its stated sustainability ambitions.
- There is also a large global market for renewables and low carbon energy systems, especially along the West-East Corridor. This is the region where the energy gap is most evident due to rapid urbanisation and energy intensive industries. It is also a region where renewables will not be 'disruptive', since much of the demand needs to be met by building new generation capability rather than replacing or adapting old capacity. This provides the West-East Corridor economies a real opportunity to leapfrog traditional energy systems.
- The scale of investment needed is immense: tens of billions of US$ per year in the Gulf region, and hundreds of billions of US$ per year globally.

Chapter 2 goes on to explore the drivers to the increased investment in renewable energy generation, particularly solar PV which has such potential for the Gulf region.

The West-East Corridor economies have a real opportunity to leapfrog traditional energy systems.

Chapter 2

Deploying proven and cost-effective technologies

In the past few years, solar PV and on-shore wind power have rapidly become price competitive with higher carbon options in many parts of the world – and other low carbon technologies are advancing rapidly.

2.1 Introduction

We turn now to the technologies that can fill the gap in supply and demand discussed in Chapter 1. The argument of Chapter 2 is that there are already technologies, especially those of solar PV and on-shore wind, that are market ready, well tested in the field, and price competitive with traditional and much higher carbon options.

They have a track record of deployment at scale under a variety of local resource conditions and many parts of the Gulf region have the land space and resource intensity to capitalise on this. When combined with investments in energy efficiency improvements, the region can move quickly towards closing the gap between supply and demand in a way that balances economic, energy and sustainability (low carbon) ambitions.

The technologies discussed in this chapter are mature, both technologically and economically. Most importantly, their prices, and their competitiveness with traditional energy systems, have been improving rapidly, some already achieving grid parity.

Chapter 2 considers both individual technologies of energy production and efficiency of end use, and auxiliary investments that that link energy production and use into more efficient systems for the future.

The focus here is largely on new generation capacity and energy efficiency of end use. Sitting between generation and use is the transmission and distribution system, where the role of Government investment is much larger than is the role of the private finance community, which is why it is not considered here – although even distribution could become a private sector opportunity if Governments choose to promote localised energy generation such as rooftop solar PV.

What has happened recently to solar PV energy, and the speed with which it has happened, has been remarkable.

2.2
Renewables achieving grid parity

For many years, it seemed as though solar energy might never achieve a breakthrough. But developments in the past couple of years have changed that. What has happened recently to solar PV energy, and the speed at which it has happened, has been remarkable. Without question, it is now one of the most promising emerging renewable energy technologies with a wide variety of applications internationally.

This is largely due to the significant reductions in costs of solar PV modules, which have dropped by approximately 80 per cent in the last six years. It is perhaps not widely understood that, as a result, solar PV systems are now at or approaching retail electricity prices in many markets, across both residential and commercial user segments.

The key drivers behind this reduction in costs have been developments in both manufacturing and deployment. There have been considerable increases in worldwide manufacturing capacities enabling production to happen at scale, and a move of module manufacturing from European countries and the United States to Asia, notably China, where scale has made greater efficiencies in the manufacturing process possible.

Simultaneously, supported in many countries by Government policies, new capacity around the world has also increased significantly year on year. A total of 7 GW was installed in 2009, 2014 was six to seven times higher than this. In the last ten years, cumulative installed capacity has grown at an average rate of 49 per cent per year. There is currently 135 GW of installed solar PV capacity globally.

80%

Solar PV is expected to reach grid parity in 80 per cent of countries in the next two years.

Kenya is to be home to Africa's largest wind farm

December 2014 saw the financial close of the Lake Turkana Wind Power Project (LTWP) in Kenya. At US$709m (70 billion Kenyan shillings), it is the largest single wind power project to be constructed in Africa and the largest private investment in the history of Kenya to date.

The project encompasses 365 wind turbines, plus the overhead grid collection system, high voltage sub-station and upgrades to the roads locally. When fully up and running in 2017, it will generate approximately 20 percent of Kenya's installed capacity. It will provide 300 megawatts of reliable low cost energy to the Kenyan national grid, on a 20 year fixed price purchase agreement. It will also help to reduce the country's dependence on unreliable hydropower and imported fuel with volatile pricing. That makes the project a key plank of the government's commitment to scale up electricity generation to 5,000 megawatts and a flagship project in the country's Vision 2030.

The African Development Bank was the lead arranger, with Nedbank and Standard Bank of South Africa.

The consortium of equity investors includes KP&P Africa B.V. and Aldwych International as co-developers, plus the Finnish Fund for Industrial Cooperations (Finn Fund), Industrial Fund for Developing Countries (IFU), KLP Norfund Investments, Vestas Eastern Africa and Sandpiper.
In addition, Kenyan and Spanish government funds are backing the construction of a transmission line to deliver LTWP electricity – along with power from any future plants locally - to the grid.

2.2
Continued

The geographical pattern of deployment is also changing rapidly. A few European countries, led by Germany and Italy, initiated large-scale solar PV development, but solar PV systems are now expanding in other parts of the world. For the first time since 2004, more new capacity was installed in Asia in 2013 than in Europe. China alone installed more than all of Europe, with over 11 GW in 2013 representing 37 per cent of global growth. China is expected to continue leading the global market, accounting for about 37 per cent of global capacity by 2050.

Solar PV's share of global electricity is expected to reach 16 per cent by 2050 and 20 per cent of all renewable electricity. Expectations across the board are that these cost reductions in both solar PV modules and systems are set to continue in the coming years making solar PV even more competitive. The IEA estimates that solar will become the cheapest form of electricity generation worldwide between 2025-2030.

Much of the global growth to date has been in the form of grid-connected utility scale systems, with crystalline silicon (c-Si) module currently dominating the solar PV market with around 90 per cent share. Centralised, utility-scale systems represent close to 40 per cent, but decentralised currently represent approximately 60 per cent of the global installed capacity, e.g. household systems. Off-grid systems account for only 1 per cent at most today, but hold significant potential. An important part of the potential of solar PV technology is its flexibility and adaptability: it is uniquely suited to decentralized and off grid situations which broaden the global applications of the technology for the future – from solar powered LED lighting to roof top generation.

The most exciting developments in solar PV have happened recently in the Gulf region. The Dubai Electricity and Water Authority (DEWA) recently accepted a bid from ACWA Power at US$0.0584 / KWh for a 200 MW solar PV plant. Apart from setting a new benchmark for solar PV costs globally, At this price point it demonstrated that solar PV is already competitive with oil at US$10/barrel and gas at US$5/MMBtu – and set a new benchmark globally. With much of the region suitable for vast arrays of solar PV to deliver electricity at scale, this could herald an era of increased focus on solar PV as the future generation technology of choice to tackle the challenge of how best to meet current daytime peaks in demand. Once this has been done, there is the potential for exporting this expertise to neighbouring countries and along the West-East Corridor more broadly.

Looking ahead, it is anticipated that solar PV will approach grid parity in 80 per cent of countries around the world in the next two years. This will be driven in part by further cost reductions in the price of the modules themselves, and also in the costs of the full solar systems and their installation.

Wind power is on its way to similar levels of competitiveness. On-shore wind electricity generation is now cheaper than oil and gas in most OECD nations. As with solar PV, the price competitiveness is driven in great part by improvements in the efficiency of the technologies: modern wind turbines produce 15 times more electricity than the typical wind turbine did in 1990. Today, a single wind turbine can power 500 homes. Wind too, is becoming a more established part of the energy mix in more countries. For example, 30 per cent of Denmark's and 20 per cent of Spain's energy supply came from wind in 2013. And in Brazil, wind power was excluded from one of the country's national auctions on the basis that it would price out all other technologies, renewable and conventional.

x15

Modern wind turbines produce 15 times more electricity than the typical wind turbine did in 1990.

2.3

A wide array of technologies for the future energy system

The technologies of supply and demand in which the finance community will increasingly participate are divided into the five categories below. However, the largest opportunities are in supplying power, and so that set of technologies receives the greatest attention in this chapter. The five categories are:

- Power (electricity)
- Cooling and Heating
- Water
- Waste
- Transport

Before exploring the emerging technologies, it is worth noting the possible role of gas as a transition fuel. A number of studies have noted that natural gas could overtake coal as the predominant source of power and indeed oil as the world's leading source of energy within the next 20-30 years. It has gained in popularity both because it is a clean-burning source of energy and because it is less carbon-intensive than either coal or oil. It emits scarcely half as much carbon as coal does for each unit of energy produced. In contrast to both coal and oil, which often emit sulphur dioxide and nitrous oxides when burned, gas burns cleanly. It is this clean-burning quality that has appealed to Governments (especially China and India) as a way of reducing air pollution. Natural gas's potential to play a central role as a backup source and thus support the transition from the fossil fuel era to the solar/ renewables era, has also meant a greater focus on gas fired plants in countries with high proportions of renewables in their energy mix.

Part of the potential of solar PV technology is its flexibility and adaptability: suited to decentralised and off grid situations.

Also, whilst not covered in detail, recent developments in the unconventional or "shale" oil and gas area have also caused disruption to traditional energy markets. As outlined in a recent Chatham House report[15] in terms of gas markets, the shale gas revolution is already having an impact both regionally and globally. It has created an oversupply of LNG and a general downward pressure on gas prices that may result in coal substitution e.g. in China and South Africa. However, the current uncertainties regarding the future viability, levels of production etc. remain unresolved. How far technically recoverable resources of shale gas will translate into actual production continues to create serious investor uncertainty. This report has therefore not looked to examine and identify the opportunities for the financial community in the shale oil and gas area for the region or the West-East Corridor.

Set out below then, is a brief description of the technology and its relationship to high efficiency and high investment return, and a consideration of the potential contribution of each technology to improving the energy and/or carbon efficiency of the national/ regional economies.

2.3.1

Power (electricity)

The candidate technologies for power (electricity) production and storage are described below. Upfront capital spending per installed kW in the GCC region is taken from the recent Energy Intelligence report[16]. As already mentioned however, the costs of the renewables options below have been declining significantly.

- **Traditional coal, oil, gas or diesel fuelled turbines.** Investment costs are in the range of US$1,829/kW and US$900/kW for combined cycle gas turbines.

- **Solar Photovoltaic.** The region has one of the highest solar insolation values (amount of solar radiation reaching the surface of the earth) of anywhere in the world. Investment costs are in the range of US$2000/kW for large solar arrays (10 to 100 MW), although significantly lower values have recently been obtained for specific projects such as in Dubai (lower by a factor of three. This has created a new reference point for solar PV and clearly highlighted that this technology can now be a game changer for the region's energy systems in future.

This rapid change in the price of – and market competitiveness of – solar PV, partly as a result of significant investments in the technology by Germany, China and other countries to date, is now a major driver of change to renewable energy systems globally. As discussed in Chapter 1, this competitiveness remains robust even against the decline in the oil price in 2014, and indeed in the face of possible further declines. With further decreases in the price of solar PV forecast, this situation will continue into the future.

One of the most important inhibitors to the take up of renewable sources is the development of energy storage. Since wind and solar power are inherently intermittent, the challenge has been the lack of storage technologies and, therefore, the requirement to back up capability from fossil fuel sources. However recent investment in these technologies hold out the promise of utility scale solutions.

US$5 bn

Investment in energy storage capacity is expected to be $US 5 billion a year by 2020.

Energy storage is attracting new investment

The next major challenge in securing renewables as an established part of the future energy mix is reliable, affordable storage. Storage is key to tackling the challenge of intermittent generation and the economics of renewables will be improved by it: the cost of installing capacity remains the same but the cost per kW hour is significantly reduced.

Storage technology is advancing all the time. Abu Dhabi's Masdar Institute is currently working with the Massachusetts Institute of Technology (MIT) on a prototype of a new concentrated solar power system, called CSP on Demand, intended to capture the sun's heat for electricity generation later when sunlight is no longer available.

Total Energy Ventures (TEV), the venture capital arm of the French energy major Total, announced that it is investing in California-based Stem at the start of 2015. It's TEV's fifth investment in storage and smart grids. Senior Vice President, Bernard Clement said, 'We believe that the combination of information technologies and energy storage solutions can significantly reshape the way power is distributed and enable greater, more flexible use of renewable energies'.

Energy storage technologies have been in need of large-scale purchase and deployment opportunities to drive down the price of batteries. Recent commitments by US energy players may have provided that long-awaited impetus. Southern California Edison (SCE) awarded a huge 250 MW worth of energy storage contracts in November 2014 – providing a significant chance to test a number of different energy storage technologies at scale. There is a new requirement by California State for utilities to invest US$50m, but the SCE position is five times the level required by the state. Storage projects amounting to 363 MW were announced in 2014 alone, according to the consultancy Navigant. BNEF estimates that by 2020 there will be 11.3 GW of storage installed globally, 80 per cent of it in the US (primarily in California), Germany, Japan and South Korea – and by then, investment in storage will be running at US$5 billion a year.

- **Concentrated solar with turbines for power (no storage).** Such facilities are already being tested – and are in operation – in countries such as the US, Spain, the UAE (SHAMS 1), Egypt, Morocco, Algeria and South Africa. The carbon intensity is approximately five per cent that of a coal-fired power plant (without CCS). Investment costs are in the range of US$5500/kW but are also dropping rapidly – for example, with a recent bid in South Africa priced at US$1200/kW. There is also the option of combining such plants with forms of storage to extend operations beyond daylight hours e.g. with molten salt tanks. This puts the technology into a different category of renewables – one that is dispatchable and no longer intermittent.

- **Wind turbines (on shore or off shore).** The carbon intensity is approximately that of concentrated solar, or five per cent that of a coal-fired power plant (without CCS). Investment costs are in the range of US$1500/kW and also showing further decreases.

- **Integrated Gasification Combined Cycle (IGCC).** IGCC technologies are now well developed in the market. The carbon intensity is approximately 40 per cent that of a coal-fired power plant (without CCS). IGCC is not considered in the Energy Intelligence report, although IGCC tends to be twice the cost of Combined Cycle Gas Turbines (CCGT), so a value of US$1800/kW is suggested here.

- **'Clean coal' with carbon capture and storage.** This category also includes oil, diesel and gas power plants. They reduce the carbon emissions by 70-90 per cent (depending on the technology used). They are currently in the early stages of testing, with limited field-testing with investment costs in the range of US$3800/kW. In the GCC region, DEWA has initiated the Hassyan Clean Coal Power Project as a key step in the implementation of the energy diversification strategy formulated by the Dubai Supreme Council of Energy.

- **Nuclear power.** Whether nuclear is a truly sustainable power source depends on estimates of the world reserves of uranium or (in the case of the more advanced reactors) thorium. Within the GCC, the UAE has identified nuclear as a core part of its future energy generation mix. It is looking to generate up to 25 per cent of its electricity needs – or 5.6 GW – through nuclear means by 2020. Currently the only other Gulf country that is actively pursuing a nuclear programme is Saudi Arabia. It hopes to become the Middle East's largest nuclear power producer over the next 20 years at an estimated cost of roughly US$100 billion, with plans to build 16 nuclear power plants that will generate 17.6 GW of power progressively to 2032. The carbon intensity is five per cent that of a coal-fired power plant (without CCS). Investment costs are in the range of US$4000/kW when decommissioning and waste storage costs are included.

- **Geothermal.** This technology can be used for either heat or power. The carbon intensity is only a few percent of that for a coal-fired power plant (without CCS). Investment costs are in the range of US$3800/kW, although this technology is most applicable in only a few nations in the region such as Saudi Arabia, but more widely applicable in the West-East corridor.

Recent investments in storage technologies hold out the promise of utility scale solutions.

2.3.2
Cooling and heating

For the region as a whole, air conditioning is a major contributor towards power demand in buildings, and on national grids as a whole. Managing the demand for cooling effectively represents an opportunity for the Gulf region. Current daytime demands, especially during summer months, distort the demand curve and requires vast amounts of excess generation to be on hand to meet peak needs – and this creates huge challenges for utilities. This area warrants immediate attention because, if correctly addressed, the resulting savings can be significant.

Despite the significant power requirements involved, a major portion of AC units in most countries are probably not maintained properly and thus suffer losses in efficiency over their lifetimes, of up to 40 per cent. Proper routine maintenance of AC equipment could restore efficiencies in the first year, and prevent such losses from occurring for the following years over the lifetime of the equipment.

Heat, on the other hand, is not a prime candidate for financing in the GCC region since it is needed only for specialist applications in industry and for provision of hot water in buildings and cleaning. However, heat can be converted to cooling through technologies such as absorption chillers. Also heat is an important end use of energy in the colder nations such as the northern US or EU, and hence is relevant as the financial institutions of the region consider a global market.

The relevant technology for cooling or heat is not related to how the heat is produced, but rather to large-scale distribution to individual buildings and operations. This improves the efficiency of the system (slightly) and costs (significantly). If the fuel is biomass, the carbon intensity is reduced to 10-20 per cent of a traditional boiler using diesel or gas.

The candidate technologies globally for cooling/heat production are as shown below:

- **District heat/cooling provision.** District cooling is becoming more prevalent in the region and studies in the UAE have shown that centralising the cooling supply of nearby buildings into one facility, which supplies cooling through chilled water, brings better efficiency than grid powered ACs.
- **Thermal storage in phase change materials.** These materials change from a solid to a liquid to store heat when demand is lower than supply, and release that heat back when the change is reversed (when demand exceeds supply). Where it is relevant (which is primarily in colder nations), it reduces heating carbon intensity by 20 per cent.
- **Concentrated solar.** This is the same as concentrated solar in Section 2.3.1, except the energy is retained as heat rather than being converted to power. The carbon intensity is 20 per cent that of a traditional gas-fired boiler when life cycle analysis is used.
- **Geothermal.** This is the same as geothermal in Section 2.3.1, except the energy is retained as heat and transferred to a distribution system rather than being converted to power. The carbon intensity is 10 per cent that of a traditional gas-fired boiler when life cycle analysis is used.

The demand for cooling and the underlying demand for electricity could be further managed without the need for any additional technology or service by taking steps to change consumer behaviour, encouraging them to set standard A/C temperatures to reasonable room temperatures. In situations where it may not be possible to achieve the necessary level of behaviour change, it will be worth focusing on Green Retrofits to existing villas and apartments which are electricity and water intensive. These would include improving building insulation, infrastructure improvements to reduce energy demand for cooling (replacement of existing stock with newer, more modern air conditioning units, the use of absorption chillers, and so on) and the introduction of building energy management systems that also control cooling. The introduction of any of these measures would both deliver performance improvements and remove excessive levels of demand for cooling for both residential and commercial users.

2.3.3
Water

Water production – including desalination – represents between 25 per cent and 50 per cent of both energy demand and carbon emissions in many of the nations of the region. In Abu Dhabi for example, the water and electricity sector is estimated to accounts for 46 per cent of GHG emissions[17]. Due to climate and structural factors in the regional economies, the baseline of per capita consumption is comparatively high – resulting in high national energy, water and carbon intensities. Estimates of future water demand for commercial and residential use show a steep growth across the region and - with local water tables falling rapidly - much of that supply is currently expected to come from desalination. This link and dependency on energy equates to a significant proportion of current energy demand and will result in further pressure on Governments. At worst, it may be impossible to fully meet future water demand whilst also reducing the carbon intensities of their economies.

Analysis carried out by PwC for the UAE, that is representative for the region, shows that while there is no single 'silver bullet' today, there are many very promising existing options that could be deployed now or in the near future. From a water production point of view, one promising area is Reverse Osmosis (RO) technology. This is economically viable today based on the fact that RO has a far lower energy demand than the current alternative (Multi Stage Flash, MSF). Also, if countries in the region look to expand their electricity grid in future with non-thermal and non-water producing technologies, such as nuclear and solar PV, there will be a greater need for alternative 'water only' generation technologies to complement current co-generation and future 'electricity-only' plants.

Looking beyond water production, the demand side is also an area worth exploring further. In the buildings sector for example there are a number of technologies that are already self-funding. Saving energy and water consumed in a country's building stock pays for the incremental infrastructure cost of greener buildings – new building design as well as retrofitting existing buildings.

Results of the analysis in land use and agriculture also identified two key areas that merit further investigation across the region: hydroponic farming and solar powered atmospheric condensers. Hydroponics is a branch of agriculture where plants are grown without the use of soil. The nutrients that the plants normally derive from the soil are simply dissolved into water instead, and depending on the type of hydroponic system used, the plant's roots are suspended in, flooded with or misted with the nutrient solution so that the plant can derive the elements it needs for growth. An atmospheric water generator (AWG) is a device that extracts water from humid ambient air. Water vapour in the air is condensed by cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air. Unlike a dehumidifier, an AWG is designed to render the water potable. With much of the Gulf region experiencing conditions of high humidity, especially during the summer when water is particularly needed, subject to pricing, this represents a particularly appropriate technology for deployment.

Water production represents between 25 per cent and 50 percent of both energy demand and carbon emissions in many GCC nations.

Other areas worthy of further examination include:

- **Loss reduction.** This is a high priority for the region, as levels of water loss in piping are high. Reducing loss will decrease demand for desalinisation and/ or allow greater use of water by industry.

- **Concentrated solar.** This technology has developed rapidly as a source of both power and desalinated water. The heat is used in a distillation process that removes the salt.

- **Sustainable urban drainage systems.** This is a technology of demand reduction, capturing and re-cycling run-off from the limited rainfall in the region, as well as from irrigation of vegetation. These systems can reduce water demand by 20-30 per cent, which then reduces the energy demand for water by a similar amount.

- **Low flow water technologies.** These are also a form of demand management, limiting the water required to meet uses for showering, toilets, sinks, etc. Fitting of buildings with such technologies typically reduces water demand by 20 per cent, again decreasing the energy demand for water production and piping.

- **Drip agriculture.** Again, this is a form of demand reduction. The result is a 50 per cent or higher reduction in water use for the same crop yield. The technology is already being rolled out in countries such as the UAE as water becomes priced to consumers.

Decisions on whether to adopt such water-saving technologies may, in the first instance, be driven by the need to preserve dwindling aquifer water supplies. Given the direct link with domestic agriculture and resulting implications for national food security priorities, the value placed on availability will increase, especially for Governments.

2.3.4
Waste

While there are many technologies for waste reduction and processing, the only technology relevant to the current discussion is waste-to-energy facilities. These facilities can use essentially any waste with carbon content, and so are suited to most municipal, industrial and agricultural waste. They convert the waste to a synthetic gas through either gasification or pyrolysis. The gas can then be used as a fuel for a gas-fired power plant or boiler, or can be converted to a variety of materials for industrial use. Early projects are being considered in the region, for example a 3275 tonne per day waste to energy project in Kuwait.

2.3.5
Transport

Here we consider only technologies related to energy use in transport.

- **Roll on-Roll off transport of goods.** Heavy goods vehicles (HGVs) consume significant amounts of energy per ton-km of transport. Both the energy and carbon intensity of individual heavy goods vehicles is reduced by a factor of three or four if they are placed onto the beds of trains for long distance travel[18] (such as in the West-East Corridor). An emerging possibility for the region is the intention to link a number of domestic rail systems to form the GCC heavy rail network.

- **High fuel efficiency vehicle fleet.** The fleet average fuel efficiency in the GCC region is approximately 30 miles to the gallon (the same as in the US). By contrast, low weight vehicles with high efficiency engines are available with fuel efficiencies twice this value.

- **Alternative energy vehicles.** Market-ready options are biogas, hydrogen and electric vehicles. Carbon intensity of such vehicles is 10 per cent that of petrol or diesel vehicles for the same fuel efficiency.

2.3.6
Costs of energy technologies

Figure 10 shows both the CAPEX (Capital Expenditure) and OPEX (Operating Expenditure) for the energy generation technologies discussed here. They are the result of stakeholder workshops conducted by the EU[19], but values should be approximately the same in the GCC region due to the increasingly global market for these technologies.

Figure 10 raises an interesting challenge for the finance community. Over the lifetime of a technology, the TOTEX (Total Expenditure) is the difference between (i) the sum of CAPEX and OPEX, and (ii) the fuel costs. Use of TOTEX as the financial metric raises the attractiveness of both energy efficiency projects and renewables. However, finance (and investment more broadly) is typically controlled by CAPEX because initial expenditures are of primary concern to developers.

-50%

To reduce energy demand costs utilities less than half the cost of producing the same amount of electricity at a power plant.

2.4
Auxiliary investments

Section 2.2 and 2.3 looked at technologies of energy generation that might be deployed individually in the region. Their efficiency of meeting demand, their costs and their ability to also contribute to sustainability ambitions are enhanced by several auxiliary projects that could also be targets of finance. A good summary of these has been provided by the EU[20]. They are in all cases examples of the technologies used in what are increasingly called 'smart cities'.

2.4.1
Smart grids

The infrastructure for delivery of power in most of the nations of the GCC region is currently inadequate to support significant growth in power generation capacity. This infrastructure will require two improvements to meet growth in demand:

- Larger transmission and distribution capacity to bring this power to the point of use.
- A smart grid to ensure the greatest efficiency of use of the generation capacity, including load-levelling.

A smart grid is one in which the elements of the energy system along the value chain 'speak' to each other, re-routing energy to where it is needed at the moment, turning appliances on and off so

Figure 10. CAPEX and OPEX for energy generation technologies

Type of generation		Generation technologies	Capex 2010 €/KW	Opex fix €/KW	Opex variable €/MWh	Fuel 2010 €/KW
Fossil		Coal Conventional[1]	1,400–1,600	18-22	~1	20–25
Fossil		Gas Conventional	700–800	13–17	~1	45–50
Fossil		Coal CCS[2]	2,700–2,900[3]	60–80	~3	26–31
Fossil		Gas CCS[2]	1,500–1,600[3]	35–45	~2	55–60
Fossil		Coal CCS Retrofit[3]	1,250–1,450[3]	60–80	~3	26-31
Fossil		Coal CCS Retrofit[3]	750–950[3]	35–45	~2	55–60
Fossil		Oil	750–850	15–20	~1	100–150
Nuclear		Nuclear[4]	2,700–3,300	90–110	~0	7–9
RES	Intermittent	Wind Onshore	1,000–1,300	20–25	~0	~0
RES	Intermittent	Wind Offshore	3,000–3,600	80–100	~0	~0
RES	Intermittent	Solar PV	2,400–2,700	20–25	~0	~0
RES	Non-Intermittent	Solar CSP[5]	4,000–6,000	180–220	~0	~0
RES	Non-Intermittent	Biomass dedicated	2,300–2,600	13–15	8–10	45–55
RES	Non-Intermittent	Geothermal	2,700–3,300	90–110	~0	~0
RES	Non-Intermittent	Hydro	1,800–2,200	5–10	~0	~0

CAPEX and OPEX costs associated with the power technologies. TOTEX is the sum of CAPEX and OPEX expenditures. These values are the global averages; many of the most recent solar projects have come in at significantly lower costs, in part due to innovative finance structures. Note: The values expressed here do not include the time value of money, as that requires application of an assumed discount rate. The value of that discount rate (1 per cent, 5 per cent, etc.) is subject to significant disagreement in the economics community, and the final calculation of the NPV is a sensitive function of the assumed discount rate. However, if the same discount rate is applied to both the incoming and outgoing streams of a project, the effect on payback period will be minimal.

demand is balanced by supply, using environmental information to select the optimal mix of energy generation, etc. A smart grid also allows for greater penetration of renewables into the market, whose intermittent generation would otherwise make load-levelling more difficult. 'Load levelling' here refers to a relatively constant demand rather than the peaks and troughs that usually are found in energy demand. By smoothing or levelling this demand, an energy system operates more efficiently; for example, the carbon intensity of the energy system can be significantly reduced through load levelling. Full development of a 'smart grid' will require:

- Significant investment, probably by Government (see Chapter 4)
- Deploying monitoring systems for energy demand, with a capability to manage this demand remotely at either the generation or transmission sites
- Development of ICT capabilities to collect, analyse and respond to shifts in demand in real time
- Connection points for renewable energy generation
- Adding energy control systems at the point of use to both increase the efficiency of use and to determine how available energy will be allocated to the end uses of energy
- Charging stations for electric vehicles into the grid.

These innovations often are called 'Virtual Power', meaning they do not provide new power generation but rather re-allocate existing power to achieve the most efficient and sustainable use.

Cost of energy efficiency is less than half the cost of increasing energy production

For many utilities the top priority is to make sure there is exactly enough power in the grid to meet demand. They do this by adjusting the supply, taking power plants on or off-line and they influence demand with efficiency programmes aimed at their commercial and residential customers. New research in 2014 by scientists at Lawrence Berkeley National Laboratory reported that it costs utilities just US$ cents 2.1 in total to reduce energy demand by 1kWh. This is less than half the cost of producing the same amount of electricity at a power plant.

As utilities retire their oldest, more polluting power plants, many are expected to adopt energy efficiency programs as the cheapest option available. Early evidence from programs in the US shows that every US$1 spent on efficiency programs delivers US$4 of benefits.

Potential savings delivered from energy efficiency in the UAE

A recent Masdar Insitute – General Electric (MI-GE) project looked at identifying how the adoption of higher efficiency products throughout the UAE electricity value chain could generate national wealth savings for the UAE Government by decreasing natural gas consumption - and hence the carbon intensity of the electricity value chain. Their findings are startling.

Electricity end-use showed the highest potential annual savings by far, especially from interventions in cooling and lighting. The technical 'market size' of savings from energy efficiency at end-use was estimated at around 20 billion AED annually. Interventions to reduce waste in the oil and gas area providing the second largest savings of around 3 billion AED per year, and with energy efficiency savings from operating power plants being the lowest at between 200 million to 600 million AED annually, depending on the efficiency enhancement scenario.

2.4.2
Microgeneration and district schemes

A highly efficient, sustainable energy supply will inevitably involve greater emphasis on distributed and even 'off-grid' generation capacity (this is especially true in the developing nations along the West-East Corridor where industrial parks figure prominently in development plans), with co-generation of power and heat to avoid heat being wasted from power production, and with district energy distribution systems. Capture and use of the waste heat involves co-location of traditional (thermal) energy generation and industrial operations.

2.4.3
Sensors, efficiency and ICT

Highly efficient energy systems require large scale deployment of energy performance sensors at the points of transmission, distribution and end use. The sensors provide information on specific locations where energy demand is rising or falling; how components of the system are performing (for example whether the efficiency of an air conditioner is beginning to decline due to a problem that might be developing); where individual properties (such as homes) might be temporarily disconnected because they are unoccupied and system efficiency could be improved by reducing the demand from that building; etc. Infrastructure improvements such as these in turn require investment in the ICT infrastructure of the region, and the linking of the ICT system to all parts of the energy system. The sensors are an opportunity for finance institutions to help their clients connect to the smart grid, which often is accompanied by tariff reductions from the energy suppliers.

2.4.4
Low carbon transport infrastructure

Reducing transport emissions is also tied to load-levelling due to the potential for electric or fuel-cell vehicles to serve as energy storage to compensate for the intermittency of renewables. Two categories of projects will be required to fully realise this potential:

- Two-way energy charging and storage in vehicles, an example being the required network of power charging stations for electric vehicles. A two-way system allows a vehicle (battery or fuel cell) to receive power from the grid or from more localised generation systems, to store that power, and then to be available for re-connection to the grid when the grid requires return of the stored power.

- Cooperative, intelligent transport systems. The efficiency of a transport system is improved through logistics. In such systems, vehicles speak to each other, to signalling stations and to potential users to identify the most energy efficient solution to meeting mobility needs.

20bn AED

Savings from energy efficiency at end-use in the UAE is estimated at around 20 billion AED annually.

x3

MENA energy demand is expected to grow by 8.3 per cent per annum between 2013-2019: more than x3 the global average.

2.5 Conclusions

It is clear for a number of reasons that there are solutions ready today that are cost competitive and market-ready to meet the energy supply-demand gap in ways that can help countries achieve their low carbon and sustainability ambitions:

- Costs of solar PV have declined appreciably over the past three to five years. This decrease has caught much of the energy community by surprise, and so investment decisions today are in many cases not reflecting this new reality of market competitiveness of solar. Solar PV is now reaching, and in some cases (such as Dubai) exceeding, grid parity with traditional power plants. That means that cost savings can be made today by investing in solar PV in the region instead of conventional power plants.

- On-shore wind is on the same trajectory, just behind solar PV in market competitiveness. There are other renewables on a 'conveyor belt' of innovation, scale and market competitiveness, although not yet competitive with solar PV or on-shore wind. Energy storage presents a potential game changer for renewables and from a cost perspective is also not far from being market ready.

- As discussed in Chapter 1, the market competitiveness of solar PV (and increasingly of on-shore wind) is robust even against the 2014 decline in the oil price. That competitiveness is unlikely to be reversed, especially considering that future fuel costs for renewable energy technologies are effectively zero.

- Water desalination is a very large part of the energy consumption in several of the nations of the region, and will grow as the population and demand increases. Improvements in water use are critical in reducing energy demand. Renewable energy technologies can play an increasing role in helping to produce water especially as local water tables become more depleted.

- There are identifiable finance structures for large-scale energy projects that distribute the risk equitably across the partners that can easily be adapted to renewable energy projects. Equally importantly, this risk is now reduced further due to the rising demand for energy and the market-tested nature of solar PV and on-shore wind technologies.

The competitiveness of solar PV is robust even against the 2014 decline in the oil price.

Chapter 3

The global energy opportunities

For GCC countries to compete successfully in the changing energy market globally, they will need to demonstrate success in delivering low carbon energy systems in the region.

3.1
Introduction

In Chapter 3 we argue that the ability of the GCC countries to compete in the emerging energy market globally will depend on demonstrating success in delivering energy systems – including low carbon systems – in the region itself.

In the GCC itself, the market for energy projects – both generation (supply) and efficiency (demand) - clearly is large and growing. As seen in Chapter 1, that market is on the scale of tens of billions of US dollars per year through at least 2030. This scale of investment does not change dramatically as one moves between the different scenarios considered in Chapter 1: 'business as usual', 'cautious' and 'innovative', although the mix of projects required does change. The business case for investing in ambitious, low carbon, sustainable energy systems is therefore robust across a range of plausible scenarios.

As new projects are delivered in the coming years – particularly under the 'cautious' and 'innovative' scenarios – the region has the opportunity to develop a global reputation for vision, technological innovation and delivery of high-value, sustainable energy projects. The opportunity will be to leverage that reputation to increase the region's presence on the international stage – especially within the West-East Corridor - in three ways:

1. The Gulf region can provide finance for the delivery of energy projects in other regions, exporting this expertise and replicating the success of its home markets.

2. The region can attract energy suppliers and financiers into the region, with a track record as a home for safe investments, drawing on the success of – and continuing need for – these projects.

3. The emerging energy innovation of the region will attract high tech, high value energy projects and companies that will 'move the goalposts' of global energy supply and demand whilst also creating jobs and knowhow.

Chapter 3 examines these issues, identifying the nature and scale of the opportunities they present. The point is not simply that the scale of finance required is large, but that the finance institutions in the region can play a significant and active role in supporting the industry by developing a range of appropriately structured financial products. The opportunity is nowhere more evident than in the West-East Corridor. This will be the greatest market for the energy system innovations discussed in Chapter 2 mainly due to the fact that urgent demand for energy generation is likely to run significantly ahead of new grid capacity. This will create enormous demand for the type of 'off-grid' and distributed solutions which renewable energy generation is particularly suited to.

This increased opportunity globally is enhanced by the fact that the Governments of the developed economies have set ambitious sustainability targets both for themselves and for the projects they finance in the developing world. To lead the financing on such projects, the Gulf region will need to demonstrate its ability to deliver similar projects locally, and then an ability to bring similar success to projects globally. **If that can be done, the financial institutions of the region will be participating fully in the global energy opportunity of hundreds of billions US dollars per year.**

The finance institutions in the region can play a significant and active role in supporting the industry.

21%

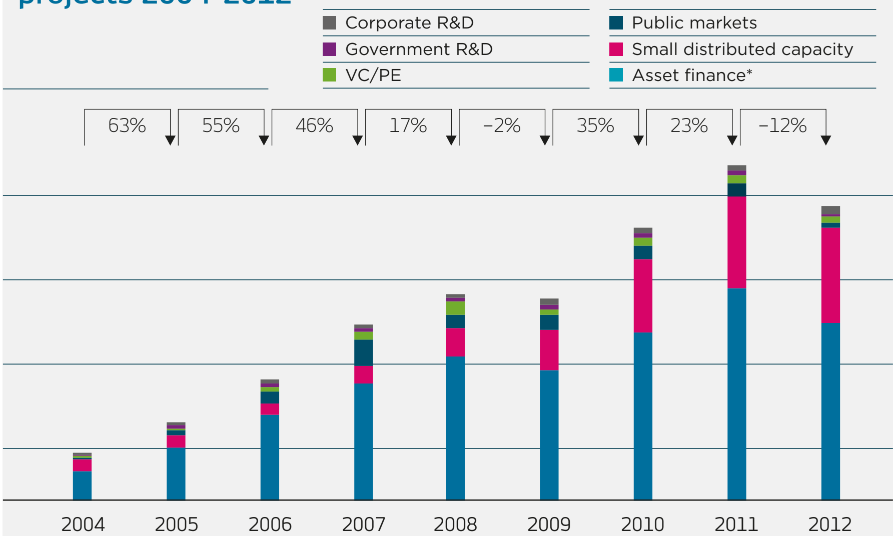
Renewable technologies as a whole produce 11 per cent of world energy and 21 per cent of global electricity.

3.2
Global finance and delivery

Global project development for energy generation has been running at more than US$400 billion per year for the past several years. As discussed in Chapter 1, an important feature of the current energy landscape is that more than half of that investment is in renewable, low carbon supplies, with the rest being in traditional fossil-fuel plants[21]. There have been fluctuations in this number of around 10 per cent, but the trend has been upwards for the past 4 years. Looking back, renewables accounted for 57 per cent of global power investment in new generation in the period 2000-2013.

What is equally impressive is that renewable energy technologies as a whole (biofuels, biomass, geothermal, hydropower, solar and wind) currently produce 11 per cent of world energy and 21 per cent of world electricity production[22]. When one considers solar and wind, only 3 per cent of global electricity is currently supplied by these renewables, indicating that there remains significant 'head room' for further investment as nations shift away from fossil fuels.

Figure 11. Year on year growth in renewable energy projects 2004-2012



*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: UNEP, Bloomberg New Energy Finance

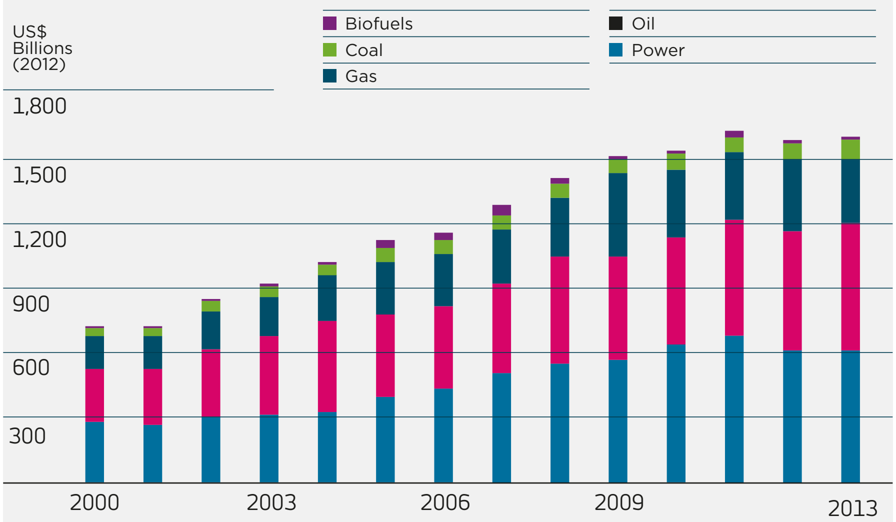
The year-on-year growth in new renewable energy projects between 2004 and 2012.

Figure 11 above describes only projects that generate energy (for example, creation of new power plants). In addition, there are investments in extracting and refining fuels, principally oil, coal and gas. These also count as energy investments. Those are larger still, amounting to more than a trillion US dollars per year in 2012[3]. At the moment, therefore, investments in new supplies of fossil fuel for energy production are a factor of 2-3 higher than those for energy generation. This is testament to the world's continuing reliance on fossil fuels. With growing emphasis on a lower carbon energy supply and a growing pressure to fill the energy gap, however, this gap will shrink and a larger percentage of total investment will be in projects involving generation rather than exploration, extraction and refining of fossil fuels.

3.2
continued

How large is the global opportunity into the future? The International Energy Agency (IEA) has compared growing demand and the current energy supplies. They estimate a need for US$48 trillion in energy generation investment between today and 2035 (an average of US$2.4 trillion per year), rising to 53 trillion (US$2.7 trillion per year) if energy efficiency projects are included. Their estimate of the breakdown of these investment opportunities is shown in Figure 12.

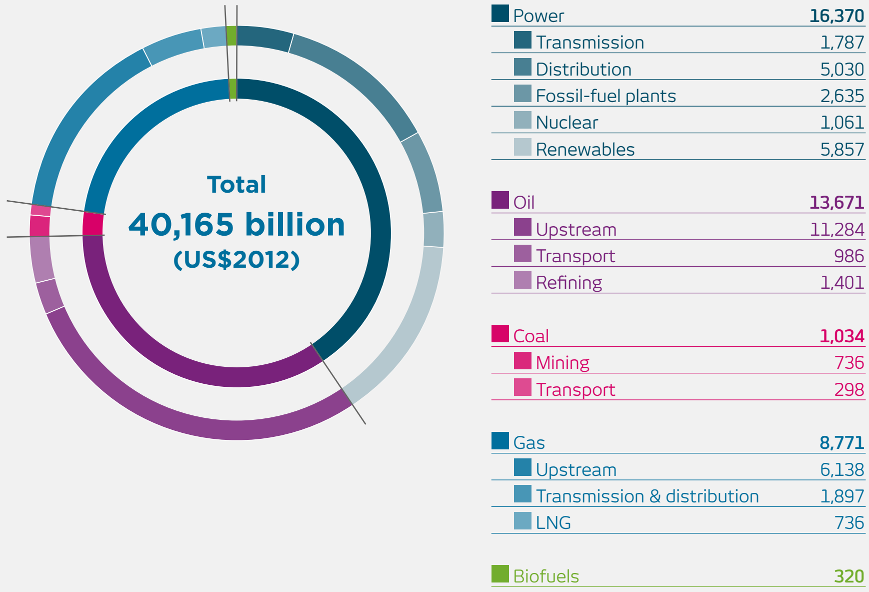
Figure 12. Investment year on year in total energy supply



Note the continuing dominance, at least at the present, of investments in fossil fuel supplies to meet demand through traditional power plants. Reproduced from the IEA report[2].

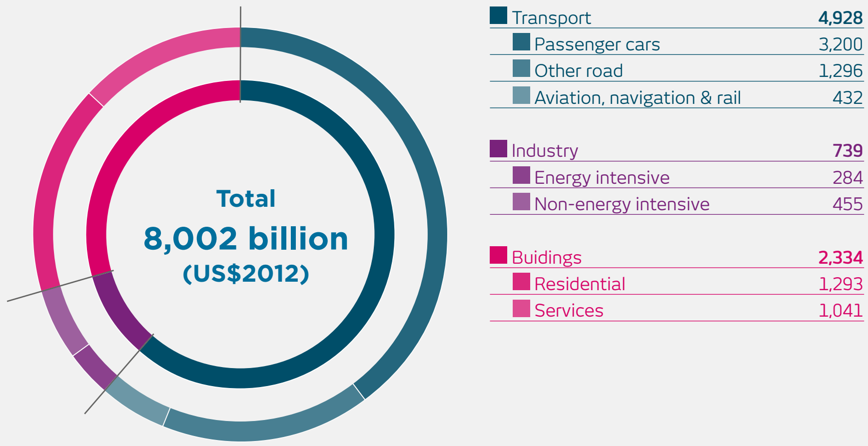
Renewables accounted for 57 per cent of global power investment in new generation in the period 2000-2013.

Figure 13a. Projections of global investment required for energy production 2014-2035



IEA projections[22] of global investment/finance required for energy production, divided into the categories of projects. Values are cumulative investments (2012 US dollars) between 2014 and 2035.

Figure 13b. Projections of global investment required for energy efficiency improvements 2014-2035



IEA projections[22] of global investment/finance required for energy efficiency improvements, divided into the categories of projects. Values are cumulative investments (2012 US dollars) between 2014 and 2035.

3.2
continued

A comparison across the different kinds and locations of energy projects financed can be seen in the finance stream of the World Bank Group[24] in Figure 14 below. Note that while the largest share of finance went to projects in Europe and Central Asia, projects in Sub-Saharan Africa and South Asia were close behind in scale. The figure for South Asia is especially significant given the potential role of the West-East Corridor to provide a large market for energy finance for the GCC.

Some of the countries of South East Asia qualify for finance through the Clean Development Mechanism[25] if their growth in energy supply is through lower carbon alternatives to traditional fossil fuels. This will reduce the investment risk of projects, with the cost of the energy project paid for through the transfer of funds from the developed to the developing nations as the former strive to meet their carbon reduction targets. International finance of low carbon, renewable energy projects can therefore act as an adjunct to or backstop for traditional bank finance, helping de-risk such finance.

Tying into the source of global finance will require demonstrated strengths in three areas:

- Forming partnerships with Governments and corporations to deliver on innovative energy projects along economic growth corridors.
- Developing expertise and a reputation for finance and delivery of renewable energy, especially solar PV and on-shore wind.
- Working with international finance mechanisms such as the Clean Development Mechanism and the international Green Climate Fund[26] to create innovative finance instruments that can deliver on lower carbon energy supplies and improved energy efficiency.

Figure 14. Location and nature of energy projects financed by the World Bank 2007 – 2012

Table 1: World Bank Group Energy Portfolio by Region, FY2007–FY2012 (US$ Millions)

Region	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012
Sub-Saharan Africa	1,224	1,261	1,754	5,281	1,156	1,813
East Asia and the Pacific	251	1,505	1,229	990	2,116	968
Europe and Central Asia	518	1,194	2,295	1,182	2,384	2,331
Latin America and the Caribbean	489	1,157	801	1,948	1,331	551
Middle East and North Africa	368	360	806	1,050	67	748
South Asia	947	2,158	1,446	2,495	1,062	1,710
Multi-Region Projects[1]	65	35	–	–	64	55
Total Energy Financing	3,862	7,670	8,332	12,947	8,181	8,177

Notes:
[1] Multi region projects are those with components in more than one region

Table 2: World Bank Group Energy Portfolio by Sector, FY2007–FY2012 (US$ Millions)

Region	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012
Energy Efficiency	753	1,521	1,685	1,802	1,551	1,353
Renewable Energy[2]	840	1,471	1,678	1,905	2,977	3,615
New Thermal Generation[3]	364	1,087	987	4,287	290	690
Other Energy[4]	717	1,015	1,702	2,019	1,783	1,369
Transmission and Distribution	458	1,650	1,204	2,208	1,397	270
Upstream, Oil, Gas, Coal	729	972	1,076	725	182	880
Total Energy Financing	3,862	7,670	8,332	12,947	8,181	8,177
Total Low Carbon[5]	**1,761**	**3,338**	**3,363**	**5,584**	**5,937**	**5,480**
Total Access[6]	**905**	**1,784**	**2,201**	**1,020**	**1,031**	**1,499**

Notes:
[2] Includes hydropower.
[3] New Thermal Generation includes all new fossil-fuel power plants, including new high efficiency fossil-fuel power plants (super- and ultra-critical plants).
[4] Other Energy includes energy policy support and technical assistance projects.
[5] Low Carbon projects include renewable energy projects, energy efficiency projects, and projects that support increased use of cleaner fuels to displace more carbon intensive ones.
[6] Access includes projects aimed at increasing access to electricity services.
[5,6] These categories are not mutually exclusive, as some projects are classified as blended Low Carbon and Access.

3.3

Making the GCC region attractive to project partners

How can the large, global finance institutions be attracted to the region, with the potential this brings for local finance institutions to form partnerships with the global institutions? The IEA World Energy Investment Outlook report[2] contains a useful description of the risks that are faced in developing energy projects, including in the GCC region. They are summarised in Figure 15, divided between political, economic and project-specific risks. While the IEA has listed these as risks to finance, the entries can all be reversed to ask what the region must do to be seen as a safe haven.

Figure 15. Categories of risk to project finance

Category	Description
Political	Risks related to:
Country	■ Quality and resilience of political institutions and the legal system. ■ Conflict or civil unrest affecting the safety and security of assets or personnel. ■ Possibility or expropriation or nationalisation. ■ Cross-border issues, especially where ultimate marketing or the output involves transit through a third country.
Policy and regulatory	■ Credibility and durability of energy policy frameworks or support schemes. ■ Misalignment with eventual climate or environmental policies, e.g. carbon pricing or new emissions standards. ■ Consistency and stability of the legal or tax basis for investment. ■ Complexity of the business environment (e.g. for permitting, licensing, local content) and transparency of business dealings. ■ Restrictions on currency convertibility or transfer of funds.
Economic	Risks related to:
Market	■ End-user prices held below costs of production (subsidies). ■ Shifts in absolute or relative prices that undermine revenues. ■ Declines in demand for the fuel or technology in question. ■ Competition from alternative providers or technologies.
Macro-economic	■ Unstable or inflationary economic environment. ■ Abrupt fluctuations in exchange rates, especially where costs/repayment and revenues are in different currencies.
Financial	■ Rise in interest rates, where debt is based on floating rates or needs to be re-financed.
Project-Specific	Risks related to:
Construction and costs	■ Project completion delays, low build quality, cost inflation or overruns.
Partners	■ Reliability and performance or consortia members or suppliers. ■ Ability of off-takers to meet their obligation to pay for the produced energy. ■ Mismatch of incentives and time horizons, e.g. between tenants and property owners for a building efficiency investment.
Human resources	■ Availability of necessary expertise and qualified labour.
Environmental and social	■ Possible climate impacts, e.g. water scarcity. ■ Local population or other environmental degradation. ■ Public opposition and relations with local communities.
Operation	■ Geological risk, e.g. smaller or more challenging resources than anticipated (for upstream projects). ■ Uncertain future decommissioning or abandonment costs.
Technological	■ Lower-than-expected performance (e.g. in terms of efficiency, reliability) of chosen technologies.
Measurement (for efficiency purposes)	■ Identification and quantification of the savings attributed to the efficiency investment.

Note: The categories of risks to project finance as identified by the IEA[22].

Multinationals invest in renewable energy

Energy is a significant operational cost for big business. In the past few years, several non-energy global corporates outside the energy sector have invested in their renewable power generation to minimize their energy costs long-term, to meet their commitments to emissions reduction and as a hedge against volatility in the fossil fuel markets. Two sectors which are particularly active are retail and telecommunications:

Walmart, the world's largest retailer, is working towards 100 per cent renewable power by 2020. By the end of 2013, it had 335 active renewable energy projects underway across its global operations, generating energy at its stores and facilities to provide 2.2 billion kW hours of energy annually. The business has committed to producing or purchasing 7 billion kW hours of renewable energy globally by the end of 2020. In addition, they intend to improve efficiency, reducing the energy intensity of all their sites by 20 per cent by 2012, from a 2010 baseline.

IKEA also aims to operate on 100 per cent renewable energy by 2020. In 2013, the business invested in 206 wind turbines and 550,000 solar panels in eight countries, as well as introducing energy efficiency measures. They produced 1, 425 GW hours of electricity in the year, more than third of their total energy needs.

Google has invested US$1.4 billion in 15 wind and solar generation projects with the capacity to generate 2GW of power because, it states, it 'generates attractive financial returns'. In addition, the company also purchases renewable energy which currently fuels a third of its operations.

Apple, the world's largest company, is building the largest non-utility solar array in the US. All Apple data centres now run on renewable energy sources and the plan is to reach 100 per cent renewables for all sites.

Commitments to invest in solar as part of their business plans by 300 leading private sector companies in the US amount to nearly 1GW of new capacity, and represent a major increase in the commercial use of solar generation.

100%

Walmart, the world's largest retailer, is committed to 100 per cent renewable power by 2020.

3.4
Masdar as a global centre of excellence

For the Gulf region to succeed in the global marketplace it must position itself to compete with countries such as the US, China, Japan and the EU for innovations in energy provision and efficiency improvements. This includes building a capacity for world-leading education in high tech energy, research and development around sustainable energy solutions, and providing a testing ground for deployment of these innovations so the credentials of these innovations can be established.

Here, the primary example is Masdar[27], building on Abu Dhabi's Economic Vision 2030 and Environment Vision 2030. It is an example that can be replicated throughout the region. The particular features of Masdar which are attracting world-wide attention are the integration of:

- **An advanced education programme** aimed at improving the local knowledge-based economy, through the Masdar Institute of Science and Technology. The Institute is beginning to attract a global stream of students and researchers, some of whom will return to their home countries to spread the reputation of Masdar. Meanwhile a significant number are also remaining in the region to support the development and delivery of projects locally.

- **A hub for cleantech innovation.** Masdar is attracting large firms such as Siemens that are developing the next generation of solutions to energy supply and demand. The hub also provides services to help smaller cleantech firms grow from idea to full development, and provides a testing ground for their innovations. Masdar provides an innovative 'plug and play' energy infrastructure that allows firms to quickly test their innovations at scale.

- **A ‘living laboratory’ for sustainability.** Masdar does not only study sustainable energy solutions. It embodies these solutions in the construction and operation of the low carbon city currently under development. This has two benefits: it provides proof of innovative concepts taken through to implementation. And it provides a ‘demonstrator’ so other nations can visit, see how the solutions work in practice, and learn how to take those solutions back to their homes.

- **International policy leadership.** Masdar is now the home of IRENA (the International Renewable Energy Agency), which is highly influential in global discussions of how to provide policies that reduce the environmental impacts of energy production and use. The result? Masdar will increasingly become the centre of global policy drivers for sustainable energy.

Of particular interest in the context of the discussion about the global opportunity is that Masdar is already engaged in energy projects globally, such as in Spain and the UK. Also, the Tafila Wind Farm is the first utility scale renewable energy project in the Hashemite Kingdom of Jordan.

In 2013 Masdar acquired a 31 per cent shareholding of Jordan Wind Project Company (JWPC), a special purpose vehicle incorporated under the laws of Jordan. The project secured financing through a group of international financial institutions and banks, including the International Finance Corporation (IFC), the European Investment Bank (EIB), Eksport Kredit Fonden (EKF), OPEC Fund for International Development (OFID), the Dutch Development Bank (FMO), Europe Arab Bank (EAB) and the Capital Bank of Jordan (CBJ). It was the first wind project to reach financial close in the MENA region outside Morocco.

They are increasingly seen as reliable and effective partners in such projects, in part because of their energy expertise and in part because they marry that with a commitment to moving the world onto a lower carbon trajectory of energy generation and efficiency improvements. For example, the buildings at the Masdar site are world-leading with respect to energy efficiency and have attracted prominent energy-aware firms such as Siemens to locate facilities on the site. Meanwhile, the growing portfolio of international development projects which Masdar participates in is building expertise in the global marketplace for renewable energy - which can now be applied within the region.

Projects such as Masdar are raising the international profile of the GCC region for energy innovation. However, the degree to which this profile enhances the reputation for delivery depends on the success of such projects, such as their high efficiency buildings and their solar PV arrays. The local finance community will be crucial in ensuring the success of these projects, and through those projects, of Masdar.

International project development at Masdar

Internationally, Masdar Clean Energy has invested in the development of some of world’s most high-profile utility-scale renewable energy projects.

The London Array is the world’s largest off-shore wind farm. A joint venture with DONG Energy and E.ON, located in the Thames Estuary in the UK, it was inaugurated in 2013. With 175 turbines and 630 MW of capacity, it can power over half a million homes. And it saves over 900,000 tonnes of carbon dioxide emissions a year.

Dudgeon Offshore Wind Farm is Masdar’s most recent investment in the UK. Partnering with Norwegian multinational oil and gas company Statoil and Norway’s state owned electricity company Statkraft, it will generate electricity equivalent to powering more than 400,000 UK homes. When completed, it will bring Masdar’s gross installed cumulative capacity in the UK’s renewable energy sector to over 1000 MW.

Gemasolar is a 20 MW Concentrated Solar Power (CSP) project for Torresol Energy, in Seville in Spain. It is a Masdar-SENER joint venture and the first commercial plant to apply this type of technology in the world. Using an innovative molten salt heat storage system, the plant is able to provide solar energy 24 hours a day. And it saves 30,000 tons of CO2 emissions a year.

In total, Masdar’s Concentrated Solar Power (CSP) portfolio accounts for nearly 10 per cent of global CSP capacity

US$48tr

US$48 trillion of investment in energy infrastructure is needed in the next 20 years: the bulk of it in non-OECD countries.

3.5 Conclusions

Several conclusions can be drawn from the evidence on the global position of the GCC region in the energy markets of the future:

- The global market for financing energy infrastructure systems will be on the scale of trillions of US$ per year over 20 years – the bulk of it in non-OECD regions, amongst which GCC nations are numbered and the West-East Corridor economies are a growing force.
- Increasingly stringent carbon reduction targets by the developed nations (Annex I nations under the UN Framework Convention on Climate Change) will increasingly require delivery of sustainable energy systems, in addition to traditional energy fuels and generation within joint partnership projects located in developing nations (such as along the West-East Corridor)
- Becoming globally competitive in this market will require regional demonstration projects that show the capacity of the Gulf financial institutions to stimulate and support movement towards ambitious sustainability visions and goals.
- In addition to specific energy projects, the GCC region must take a position at the forefront of technology innovation. Centres such as Masdar are leading the way in creating that international reputation that can attract innovative corporates to locate in the region.

Much has been accomplished over the past several years in investing in new energy solutions of all kinds: remember the current percentage of investment going into renewables. Many international financial institutions, such as Citigroup and HSBC, have built up significant expertise in these areas. Their experience and approaches to financing could be adapted to be relevant in the Gulf – and they may also provide the opportunities to partner in energy projects along the West-East Corridor.

Chapter 4 discusses options for how the finance sector might do to support the more rapid development of renewable energy projects in the region.

Masdar is a joint venture partner in the London Array, the world's largest off-shore wind farm - 175 turbines capable of powering more than half a million homes in the UK.

Chapter 4

Aligning policy and finance

To deliver a sustainable energy system for the long term, the financial community and policymakers need to work collaboratively: stimulating and de-risking investment, and developing innovative structures which can support the financing of future energy.

4.1
Introduction

Chapter 4 outlines the need for the policy and financial communities to work in collaboration.

It needs to be a mutually reinforcing relationship: policymakers need the financial system to participate fully in order to deliver on their declared strategies; the financial system requires confidence in the clarity and stabliity in the policy frameworks.

In recent years, many countries around the world have developed policy frameworks which set out their aspirations to increase low carbon energy supplies, to increase the long term security of energy supplies generally and ensure more affordable energy for end users. In due course, these policies will have a profound impact on the future energy mix of those countries and on the shape of the energy market. These policy frameworks can provide insights into how the performance metrics against which energy projects will be judged are likely to change over time.

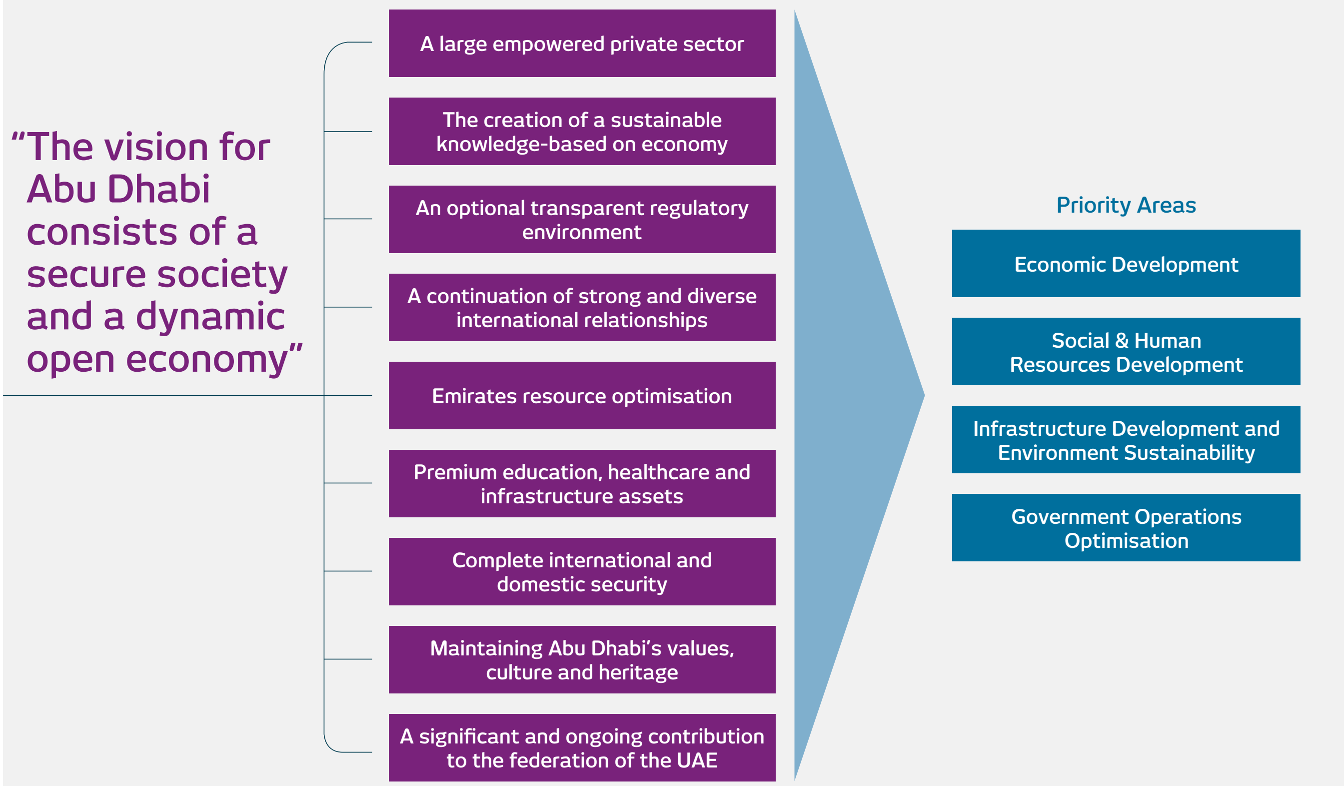
In the GCC, the Economic Vision 2030[28] and Environment Vision 2030 of Abu Dhabi is the most comprehensive of such policy documents. Those two Visions, and the processes that produced them, make it clear that success will be achieved only if the Government and private sector activities can be coordinated and harmonised. This coordination recognises that the private sector and Sovereign Wealth Funds will provide most of the finance as a business proposition, with the Government supporting that flow of capital with stable, reasonable policies and development/planning procedures.

The Abu Dhabi vision contains nine Pillars of Policy that will be required to deliver the desired outcomes (see Figure 16 below).

The transition to an energy system where supply meets demand supports the Priority Area of Economic Development. The transition to a lower carbon energy system is the primary driver to delivering the Priority Area of Infrastructure Development and Environmental Sustainability. They also support the following Pillars of Policy:

- **Creation of a sustainable knowledge based economy.** This is supported by a focus on high tech innovations in energy technologies.
- **Emirate resource optimisation.** This is supported by a focus on energy efficiency improvements and on increased reliance on renewables that do not have a finite fuel stock.

Figure 16. Pillars and priorities of the Abu Dhabi Policy Agenda Vision



Source: The Emirate of Abu Dhabi Policy Agenda 2007-08

The Pillars of Policy, and their four Priority Areas of application, in Abu Dhabi.

- **Premium education, healthcare and infrastructure assets.** This is supported through development of a world-class energy infrastructure that delivers low energy and carbon intensity for the economy..

The Vision is summarised in the following statement:

"Abu Dhabi is not just seeking to develop its economy. The aim is for the Emirate to take its place among the most successful economies of the world by 2030. The Abu Dhabi Government will judge the success of its economic performance against the performance of the most successful economies globally. In particular, it will look to benchmark against the experiences of flourishing 'transformation economies', such as Norway, Ireland, New Zealand and Singapore."

We would add to this statement a metric of economic performance highlighted in this report in Chapter 1: that of energy and carbon intensity of the economy. This is emphasised in the analysis undertaken for the 2030 Vision report that shows Abu Dhabi's own assessment of its sustainability ranking it at number 110 of 146 countries. This is due to many factors discussed in that report, but a strong contributor is low resource optimisation and the high carbon intensity of the energy system. A sound energy policy linked to economic growth is critical in raising this ranking.

The Economic Vision 2030 has a companion in the Environment 2030 Vision for Abu Dhabi. The Environment Vision uses the same process of defining aspirant nations, assessing the current performance of Abu Dhabi across a variety of environmental metrics, compares that performance against those of other nations in the league table, and identifies strategies to move Abu Dhabi up that league table while maintaining the economic ambitions laid out in the Economic Vision 2030.

The key conclusion of the Environment Vision 2030 is that the infrastructure of Abu Dhabi must improve with respect to climate change (minimising the impact of climate change); clean air and noise pollution (contributing to safe and healthy living conditions); water resources (efficient management and conservation of water resources); biodiversity, habitats and cultural heritage (conserving these for current and future generations); and waste management (enhanced value creation through optimised material flows and waste management).

Through careful selection of projects in Abu Dhabi (and the region), these two strands of ambitions – Economic and Environment – can be harmonized and made mutually supportive.

On the global stage, there are examples of Governments providing the framework for low carbon energy generation that can lead to effective scaling up of renewables deployment and a change in the long term energy mix. China's commitments to both solar PV and on-shore wind are now well recognised, and have changed the trajectory of their energy future and, because of their scale, have had significant influence on the world market for these technologies.

Governments around the world have been seeking to decouple economic growth and demand in energy demand. Developed economies, such as the US, Denmark and Germany in particular, have made great strides on energy efficiency measures and the percentage of electricity that comes from renewable energy sources. At the end of 2014, Germany achieved a decoupling for the first time, with renewables also edging ahead of lignite, representing 27 per cent of the electricity generation mix.

Less well understood yet is the potential for developing Governments to set the pace on efficiency. India's announcements in 2014 to introduce energy efficiency measures that will save 100 billion kWh of electricity give a sense of the growing will to make a real impact on constraining demand through enforcing efficiency.

Countries around the world have started to make commitments to decarbonise. Whilst the reality is that in most countries ambition and policy has lagged reality for some years, advances in technology and sharply falling prices of renewables make it more likely that more countries will see the delivery of these commitments within their grasp. At the same time, other concerns are taking their place alongside climate change for policymakers. The fast growing economies which have seen steeply rising use of coal and gas fired electricity in recent years are experiencing health challenges from air pollution. China has recently taken decisive action through policy frameworks set up to reduce air and water pollution that are likely to lead to further deployment of low carbon energy solutions.

Part of the appeal of shifting towards low carbon energy solutions is economic. For fossil fuel importing economies, renewables offer the opportunity to disconnect from volatile oil prices, while providing more secure local supplies. Plus in the longer run, there is the benefit of a more favourable balance of trade due to less imported fuel. For the fossil fuel producing economies, a greater proportion of renewable sources in the domestic energy mix offers the opportunity to retain more of the fossil fuel resource for the export market (as discussed below in 4.2).

Indian Government sets ambitious energy efficiency goals

India has set a target to save 100 billion KWh of electricity in 2015 through the introduction of energy efficiency equipment.

India is the world's fourth-largest energy consumer, yet around 400 million people, or a quarter of the country's population, currently have no access to power at all, and rely on biomass sources, such as wood, to generate heat and light – polluting the environment and subjecting themselves to health risks. When Prime Minister Modi came to power in May 2014 he promised to revive economic growth and provide electricity to the entire population by 2019.

The Minister for Power, Coal and Renewable Energy, Piyush Goyal, has said that India's commitment to reduce inefficient use of power will save around 500 billion rupees (US$7.9 billion) which will be directed towards providing access to electricity to 50 million people, helping the Government to achieve its targets to extend energy access to all.

Healthcare threat leads Chinese Government to declare 'war on pollution'

In March 2014, in recognition of the increasing concern about the impact of smog on air quality, water and soil, Chinese Premier Li Keqiang declared a 'war on pollution'. In August, Beijing announced a ban on coal use beyond 2020 to cut air pollution. Beijing's mayor promised 15 billion Yuan (US$2.4 billion) to improve air quality, while the Chinese National Centre for Climate Change Strategy and International Co-operation called for the country to decisively cut its reliance on coal.

Smoggy conditions in China's big cities have 'now become a problem which has severely affected the mental and physical health of the Chinese people', according to the Vice Chairman of the National Development and Reform Commission, the country's top economic planning body. China's 'obsolete development model' is its 'unreasonable industrial and energy structure', he says, identifying 'use of fossil fuels' as the root cause.

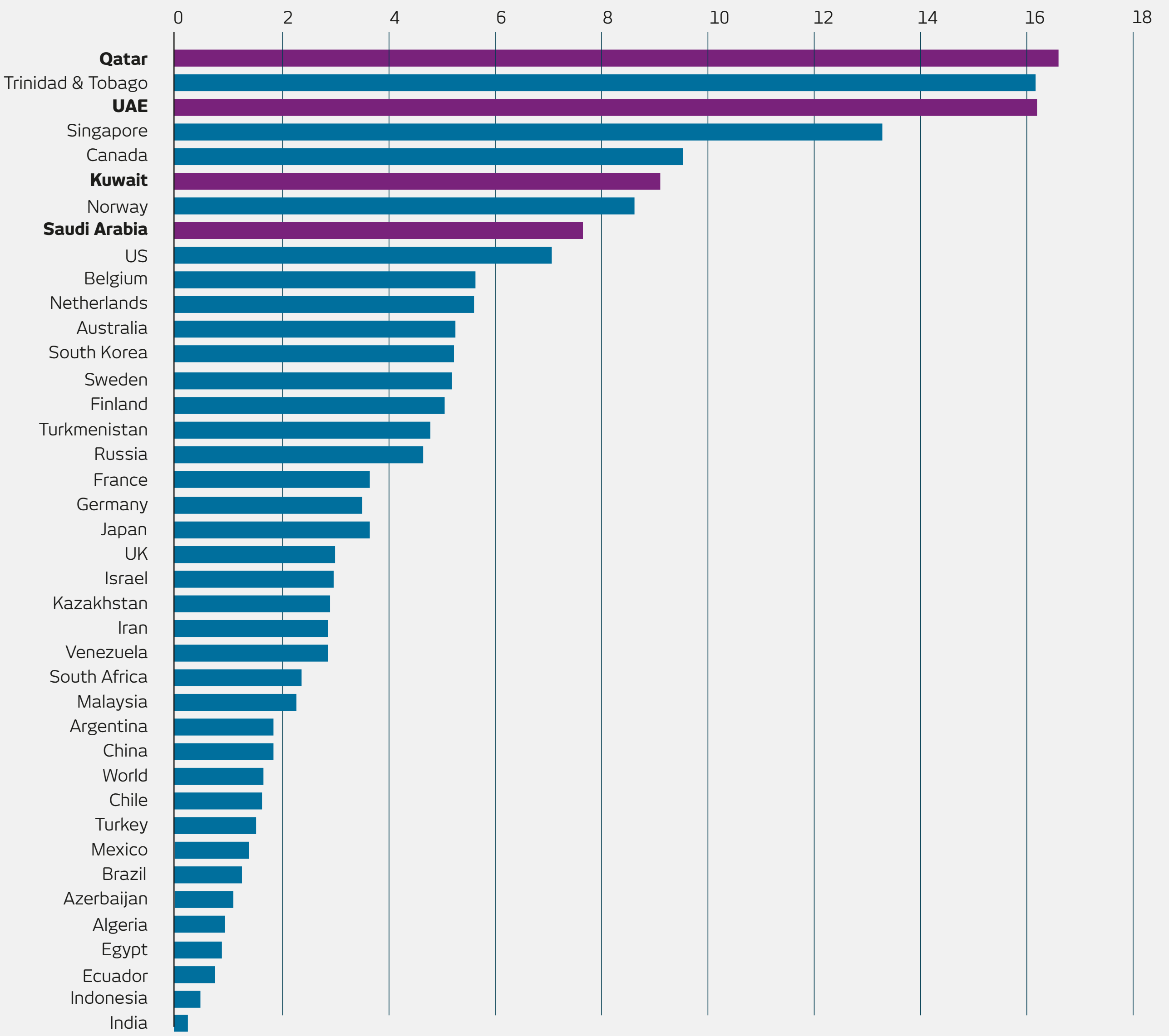
The healthcare impact of air pollution on citizens has become a priority issue for policymakers globally. Asthma and other respiratory ailments now affect over 40 percent of Delhi residents, with air quality recognised to be amongst the worst in the world. While the economic cost is difficult to quantify, a 2013 study by the United States Environmental Protection Agency found that the national economic healthcare cost caused by fossil fuels was between US$361.7 billion and US$886.5 billion annually. In 2014, the World Health Organisation reported that seven million premature deaths annually are linked to air pollution – by comparison with the 2.3 million killed globally in 2005 by the AIDs at the height of the pandemic.

4.2
The aspirations of the GCC in the global league tables

The necessary harmonisation of public and private sector actions requires understanding not only how the finance sector takes its decisions, but also the economic and sustainability ambitions of the Government. Those ambitions are laid out in, for example, the Abu Dhabi visions already mentioned. But are those ambitions being met and, if not, what else should be done by the Government to realise those ambitions, including support of action by the private sector? To begin, we ask: How does the GCC region compare to other nations with respect to energy intensity of its economy?

As shown in Figure 17, per capita total energy use in the region is high compared to that in potential 'aspirant nations' such as Germany and Brazil, where per capita oil consumption is a factor of 3 to 4 below that of Saudi Arabia[29]. This high per capita energy consumption in the region has two potentially conflicting implications. On the one hand, it means energy demand will remain high, offering opportunities for finance of new generation capacity of any kind, with a guaranteed uptake of the energy. On the other hand, it reduces the efficiency of the economy and places the region at the lower end of energy performance in global 'league tables' of sustainable performance.

Figure 17. Primary energy consumption per capita



Primary energy consumption per capita in different nations/regions, in tonnes of oil equivalent per person per year. Data are from BP[2].

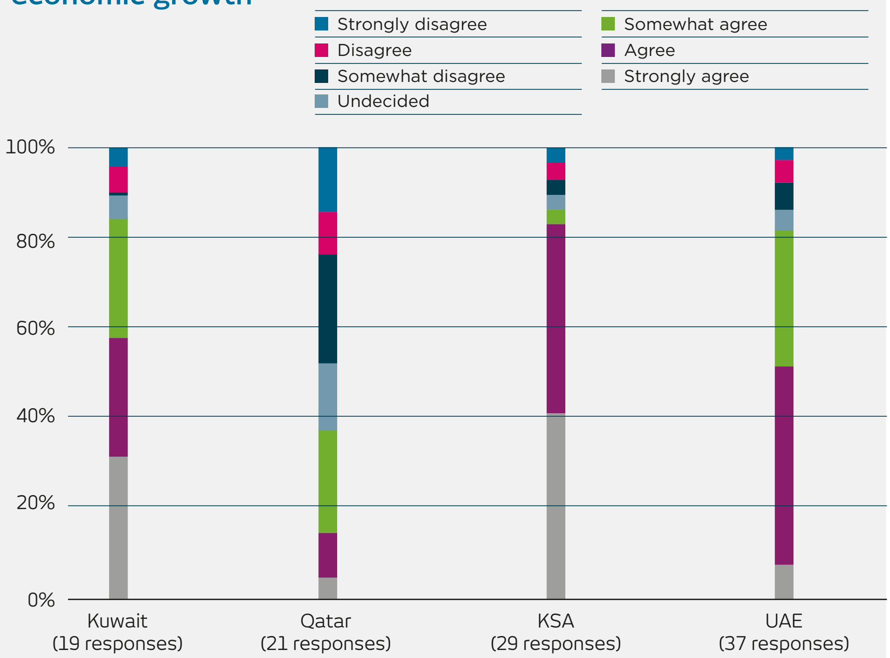
4.2 continued

Does this pattern of energy demand and production threaten the standing of the region by a measure of economic efficiency? To address this, Krane[3] interviewed 90 energy experts, economists, financiers and policymakers in the region, asking how strongly they agree that growth in energy consumption is threatening the future of the regional economy. Results are provided in Figure 18. Note that with the exception of interviewees in Qatar, between 40 and 80 per cent of respondents agreed with the statement that economic growth will be constrained by energy provision.

We now consider how the GCC region compares to other nations on a variety of metrics of energy, economic and sustainability performance. Here, we use the results of the Environment 2030 Vision exercise for the UAE[31]. The results were developed through a series of stakeholder events in Abu Dhabi, with the aim of identifying Government policies and planning procedures that could translate the ambitions of the 2030 Vision into on-the-ground projects (including energy supply and demand projects).

Per capital total energy use in the region is high compared to that in potential 'aspirant nations'.

Figure 18. Per capita energy consumption as threat to economic growth

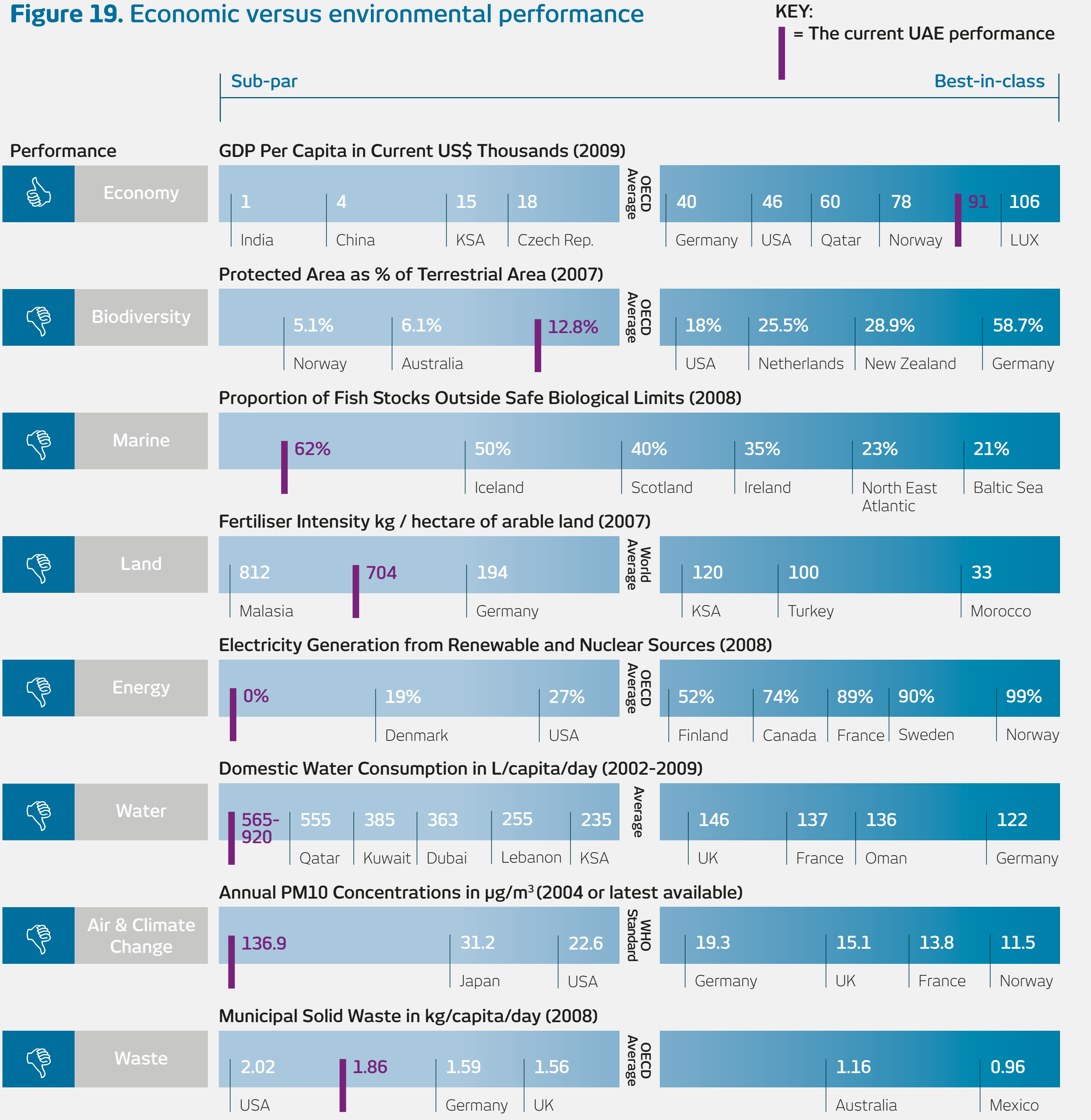


Interview results from the study by Krane[30], showing degree of agreement with the statement that continuing trends in per capita energy consumption were threatening continuing economic growth.

For Abu Dhabi, the attributes of the energy system, economy and sustainability considered as central by the stakeholders are shown in the first column of Figure 19.

Scores were assigned between 0 and 10 for each attribute, with the aim of Abu Dhabi stakeholders to be in the top quartile of the aspirant class after the economy and energy system were improved. This improvement was then linked to policies and planning procedures that would bring about the needed changes in the energy infrastructure.

Figure 19. Economic versus environmental performance



The attributes considered in the Environment 2030 assessment. Not to scale. Indicative.

4.2
continued

The current condition of Abu Dhabi was assessed with respect to each of the attributes, and then a series of 'future-looking' development and policy scenarios were applied. These included a 'business-as-usual' case where the current energy system of the region is simply scaled up to meet projected demand with no improvements in energy efficiency, and 'cautious' and 'innovative' scenarios where low carbon, renewable supplies are progressively developed after energy demand reduction has been achieved. Note in Figure 19 that Abu Dhabi scored in the lower half of the aspirant class for the measure of carbon intensity of the economy. Similar results would be found for the other nations of the GCC region.

Moving Abu Dhabi and other Gulf countries upwards within the aspirant class would therefore require policies and planning procedures that provide incentives for financing projects that improve the energy efficiency of the economy and increase the percentage of energy supplied by low carbon, renewable sources. At the moment, Government aspirations are not being translated in this way, hindering the ability of nations such as the UAE to proceed up the global league table. There is a crucial role here for finance institutions to bring together the relevant public and private sector actors so ambitions can be successfully translated into projects and policies that support these projects.

Recognising both the ranking of the GCC region in world league tables on energy efficiency and carbon intensity, the nations of the region have begun to put in place a variety of relevant policy measures that will drive a transition to lower energy/carbon intensity of the economy. Lahn and Preston[32] summarise these in a table reproduced here as Figure 20. They conclude that moving up the league table will require:

- **GCC countries to adopt fossil fuel and/or CO_2 intensity targets:**
  - For Qatar and Kuwait, per capita goals (of energy and carbon intensity) might work best.
  - For Saudi Arabia and the United Arab Emirates a GDP based goal is preferred due to these nations' significant roles in global primary fuel production.
- **Sectoral energy intensity targets to be set regionally:** "particularly in power generation, space cooling, vehicles and industrial production, for which there is ample potential to set regional benchmarks".

The region is expected to be importing 40 billion cubic meters of gas annually by 2025 – and double that amount by 2035.

Figure 20. Energy use targets and standards in GCC region

National Targets & Standards	GCC	Saudi	UAE	Abu Dhabi	Dubai	Oman	Kuwait	Qatar	Bahrain
Nationwide									
Low emissions development strategy									
GHG or CO_2 emissions reduction target									
Energy efficiency/Conservation target		○							
Power and water									
Electricity sector conservation target		○		◆	●	◆			
Electricity sector peak demand reduction target		○		●		○			
Renewables deployment target		●		●	●		●	○	●
Nuclear introduction target		●	●	●	◇				
Water intensity/Conservation target			○						
Transport									
Transport sector energy conservation target									
Vehicles efficiency standards									
Appliance and infrastructure									
Energy efficient labelling		◆	○	◆	◆				
Appliance standards		◆	◆	◆	◆		◆	◆	◆
Mandatory efficiency codes for new builds	○	●		●	○		●	●	
National retrofitting targets									
Industry intensity/Efficiency targets									
Oil and gas sector									
Efficiency/Conservation target		◆							
Flaring reduction target				◆		◆	◆	◆	
Other sectoral efficiency/Conservation targets									

● Target or mandatory standard announced at official national level
○ Target or standard aspirational or under proposal
◆ Partial/Sector specific (in the case of Oil & Gas Sector = national oil company target)
◇ Imported from Abu Dhabi

Current energy use targets and standards in the nations of the GCC region. Note the region-leading example set by Abu Dhabi, followed closely by Saudi Arabia and Dubai.

4.2 continued

Traditional energy sources such as oil and gas, and traditional sources of finance will certainly continue to play a major role in meeting the energy demands of the future for some time to come. However, almost all of the major economies of the world are changing their energy mix to rely less heavily on fossil-fuels. They aim as well to improve both the energy and carbon intensities of their economies (the amount of energy or carbon associated with producing one unit of GDP), and to reduce the negative environmental and health impacts associated with traditional energy generation.

This change is mirrored in the publically stated sustainability (including environmental) ambitions of the nations of the GCC region, such as the Environment 2030 vision of Abu Dhabi[33]. Reducing the intensity will help their economies produce more out of the energy they consume. This process is known as 'decoupling' the energy, environmental and economic performance of a country. Many of the nations with which the GCC region will compete on the global stage of energy finance, already use decoupling as a performance criterion in selecting projects for investment[34].

All of this speaks to a transition in the energy system – regionally and globally – to one that includes greater energy efficiency and an established role for renewables.

The opportunities for energy finance in the region have been reviewed in a recent study by El-Katiri and Husain[35]. They use Kuwait as a case study, but then expand this to the other nations in the region. Their analysis, and ours, has identified five issues that will cause changes to the energy systems of the GCC nations:

These five points suggest that a transition to a sustainable energy system is on the horizon for both the region and world; that the transition will be part of a broader 'green economy' vision; and that challenges exist but can be resolved (as will be described later in this report).

1. Regional energy demand has been growing at one of the most rapid paces in the world due to population growth, increased living standards and a move towards an economy with energy-intensive industries.

2. Fossil-fuels have been the cheapest source of energy, both regionally and globally. However, the levelised costs of energy (LCOE) – whether for power, heat, industrial processes or transport – of renewable sources such as solar PV or on-shore wind are reducing quickly and are approaching grid parity with fossil fuels. For the region, solar PV is already competitive with oil at US$10/barrel so there are immediate savings to be made now.

3. The rate of change in technologies of energy production – and energy efficiency – is strongly influenced by subsidies for energy from oil and gas. This artificially reduces the price signal that would usually drive energy system improvements. These same subsidies reduce system efficiency and drive increased consumption patterns. But these subsidies have a limited shelf life.

4. The transition to sustainable energy should be part of a larger movement to a 'green economy' that would provide high value jobs for nationals and create an international industry that the region could export to other nations such as along the West-East Corridor. The last two years have seen projects to develop Green Growth plans being undertaken by the UAE, Jordan, Indonesia and a number of Eurasian countries – once finalised these will provide the detailed framework that is necessary to advance these agendas in a practical manner and an example for other countries to follow.

5. The global energy system is moving away from reliance on oil and towards natural gas. Global demand for the GCC region's gas will also increase. The region will need to consider how to reduce the rising opportunity cost of growing domestic consumption.

4.3
Shaping Government policy

Policies have begun to develop for essentially all end use sectors except transport, as can be seen in figure 20. Each of these policies will influence the development of the energy system over the next several decades, creating opportunities for the finance sector to support those projects that are in line with these policy ambitions, and moving the region forward in the global 'league table' for energy and carbon efficient economies.

A more complete picture of the policies that will influence the choice of energy technologies in the region has been developed in the 2013 MENA Renewables Status Report[36]. These are summarised in Figures 21 and 22, reproduced from that report. Figure 21 includes regulatory policies, fiscal incentives and public finance. Figure 22 shows the targets established for renewable energy provision in each nation, divided into three categories of technologies. While the targets are modest, amounting to somewhere between 5 and 15 per cent of total power production by 2020, the figures do indicate growing momentum for investment in renewable energy projects.

Figure 21. Renewable energy support policies and targets in MENA nations

■ National Level

□ State Level

		Renewable Energy Targets	Renewable Energy Strategy or Plan	Regulatory Policies: FIT (incl. premium payment)	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/mandate	Heat obligation/mandate	Tradable REC	Fiscal Incentives: Capital subsidy, grant, or rebate	Investment/production tax credits	Reduction in sales, energy CO_2, VAT, or other taxes	Energy production payment	Public Financing: Public investment, loans, or grants (incl. R&D)	Public competitive bidding
NOEC	Algeria	✔	✔	■											■
	Bahrain	✔													
	Egypt	✔	✔	D		■				■		■		■	■
	Iran	✔	✔	■	■						■		■	■	
	Iraq	✔	✔												
	Kuwait	✔												■	■
	Libya	✔										■			
	Oman	✔								■	■		■	■	■
										□	□		□	□	□
	Qatar	✔												■	
	Saudi Arabia	✔		D										■	■
	Syria	✔		■		■					■			■	■
	UAE	✔	✔	D	□			□		□			□	□	□
	Yemen	✔	✔												■
	TOTAL NOEC	13	6	3 3D	2	2	0	1	0	3	2	2	3	8	8
NOIC	Djibouti	✔	✔												
	Israel	✔	✔	■				■						■	■
	Jordan	✔	✔	■		■	■					■		■	■
	Lebanon	✔	✔			■						■			
	Malta	✔	✔	■		■				■		■			
	Morocco	✔	✔											■	■
	Palestinian Territories	✔	✔	■		■						■	■		■
	Tunisia	✔	✔			■				■		■		■	
	TOTAL NOEC	8	8	4	0	5	1	1	0	2	0	5	1	4	4
TOTAL MENA		21	14	7 3D	2	7	1	2	0	5	2	7	4	12	12

Current renewable energy support policies and targets for the MENA nations. 'D' indicates 'under discussion'.

Figure 22. Renewable energy capacity targets in MENA nations

		Solar		Wind	Biomass, Geothermal, and Hydro	TOTAL
		PV	CSP			
NOEC	Algeria					
	by 2013	6 MW	25 MW	10 MW	–	41 MW
	by 2015	182 MW	325 MW	50 MW	–	557 MW
	by 2020	831 MW	1,500 MW	270 MW	–	2,601 MW
	by 2030	2,800 MW	7,200 MW	2,000 MW	–	12,000 MW
	Bahrain	–	–	–	–	–
	Egypt					
	by 2020	220 MW	1,100 MW	7,200 MW	–	8,520 MW
	by 2027	700 MW	2,800 MW	–	–	10,700 MW
	Iran					
	by 2013	–	–	1,500 MW	–	1,500 MW
	Iraq					
	by 2016	240 MW	80 MW	80 MW	–	7,700 MW
	Libya					
	by 2015	129 MW	–	260 MW	–	389 MW
	by 2020	344 MW	125 MW	600 MW	–	1,069 MW
	by 2025	844 MW	375 MW	1,000 MW	–	2,219 MW
	Kuwait					
	by 2030	3,500 MW	1,100 MW	3,100 MW	–	7,700 MW
	Oman	–	–	–	–	–
	Qatar					
	by 2020	640 MW		–	–	640 MW
	Saudi Arabia					
	by 2022	17,300 MW		6,500 MW	wind/waste-to-energy/ geothermal	23,850 MW
	by 2032	16,000 MW	25,000 MW	9,000 MW	3,000 MW waste-to-energy 1,000 MW geothermal	54,000 MW
	Syria					
	by 2015	45 MW	–	150 MW	–	195 MW
	by 2020	380 MW	–	1,000 MW	140 MW biomass	1,520 MW
	by 2025	1,100 MW	50 MW	1,500 MW	260 MW biomass	2,910 MW
	by 2030	1,750 MW	–	2,000 MW	400 MW biomass	4,200 MW
	UAE	–	–	–	–	–
	by 2020 (Abu Dhabi)	1,500 MW		–	–	–
	by 2030 (Dubai)	3,000 MW		–	–	–
	Yemen					
	by 2025	4 MW	100 MW	400 MW	6 MW solid biomass; 200 MW geothermal	710 MW
NOIC	Dijibouti	–	–	–	–	–
	Israel					
	by 2020	1,750 MW		800 MW	210 MW biogas and biomass	2,760 MW
	Jordan					
	by 2020	300 MW	300 MW	1,200 MW	–	1,800 MW
	Lebanon					
	by 2015	–	–	60-100 MW	15-25 MW biogas; 40 MW hydro	115-165 MW
	by 2020	–	–	400-500 MW	–	455-565 MW
	Malta					
	by 2020	28 MW	–	110 MW	7 MW biogas; 15 MW solid biomass	160 MW
	Morocco					
	by 2020	2,000 MW		2,000 MW	2,000 solid biomass	6,000 MW
	Palestinian Territories					
	by 2020	45 MW	20 MW	44 MW	21 MW solid biomass	130 MW
	Tunisia					
	by 2016	140 MW	–	430 MW	40 MW solid biomass	610 MW
	by 2030	1,500 MW	500 MW	1,700 MW	300 MW solid biomass	4,000 MW

Renewable energy capacity targets across the MENA nations, by technology.

4.3.1
Twin challenges: subsidies and cannibalisation

Government policies in the GCC region raise two issues mentioned repeatedly by stakeholders as influencing energy decisions: subsidies for energy (particularly electricity) consumption, and the increasing use of oil and gas within the region that not only siphons those fuels away from the world market, but is also such a critical part of the current economies of some of the nations of the region.

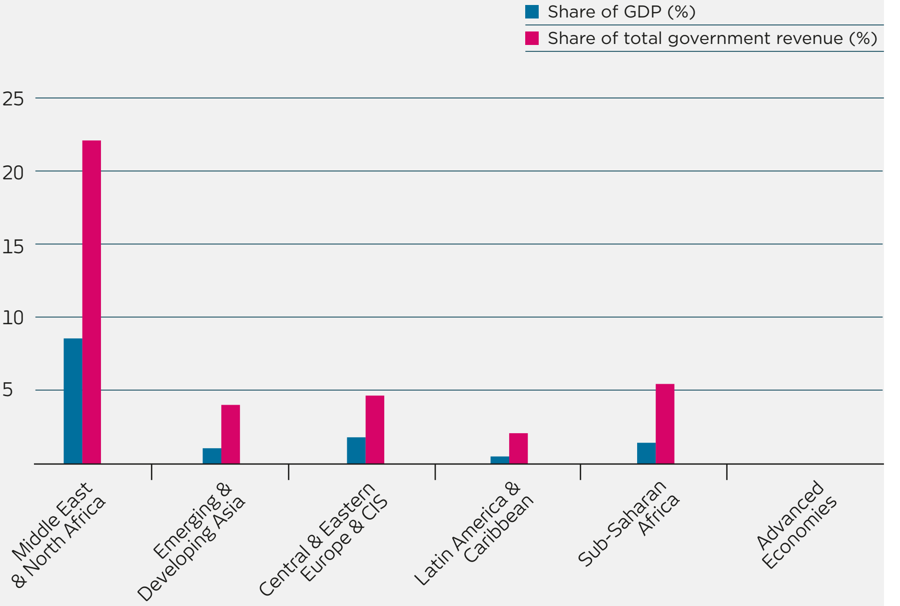
Many of the Gulf nations subsidise energy consumption, especially in homes. This is not unusual globally, but it is especially pronounced in the GCC region. The IMF[37] published a comparison of the rate of subsidy in the GCC region against other world regions. Figure 23 shows these data. Note that the GCC region is a factor of 5-20 above the subsidy rates of other regions with whom they might compete in any global market for renewable energy generation.

There are of course sound reasons for the subsidies in the region. They are a major way in which the sovereign wealth created by oil and gas production is passed through to citizens (and hence is seen as a sovereign right), and they are a potential source of attraction for business growth. However, those subsidies make it difficult to build a business case for investment in energy efficiency improvements. This is recognised, and when oil prices fell in the latter half of in 2014, Governments across the region started to either increase consumer tariffs or reduce subsidies, aiming to move electricity and water prices closer to market costs. Success is mixed – in Kuwait a recent increase in electricity prices introduced on the 1st January 2015 was removed on the 1st February 2015 to respond to dissent that arose following the first announcement. On the other hand, the rise in electricity and water prices for consumers in Abu Dhabi and Dubai have remained in place.

The second issue is one of cannibalisation of oil and gas for local consumption, removing these fuels from the world market. The growth in demand for natural gas is particularly acute in the UAE and Kuwait, where consumption was already at, above or close to production in 2012. The current rate of growth in gas demand could therefore see at least these two nations switch from being net exporters to net importers of natural gas, affecting the balance of trade and driving up the local cost of energy.

Taking a broader perspective, the region is currently a net exporter of gas (slightly), but that margin has eroded and will be erased over the next several years. It is projected that by 2025, the region will be importing 40 billion cubic meters, with double that amount by 2035. This will lead either to a switch back to oil-based energy production (and concurrent increases in carbon dioxide emissions), or to introduction of low carbon, renewable energy generation, deployment of nuclear, and/or to significant energy efficiency improvements to drive down the energy and carbon intensity of the economy.

Figure 23. Energy consumer subsidies as percentage of GDP and total Government revenue.



Percentage (y axis) of energy consumer subsidies as share of GDP and total Government revenue. Note that the GCC region has a much higher subsidy structure than the advanced economies with which it eventually will compete for leadership in energy innovation and finance.

Policy commitments decouple economic growth from growth in electricity demand

In 2014, renewable energy became the number one source of power production for the first time ever in Germany, Europe's largest power market. Coal used to dominate the market. But since 1990 renewables have grown eightfold, to be 27.3 per cent of domestic production, edging ahead of lignite as the top source of power in the energy mix.

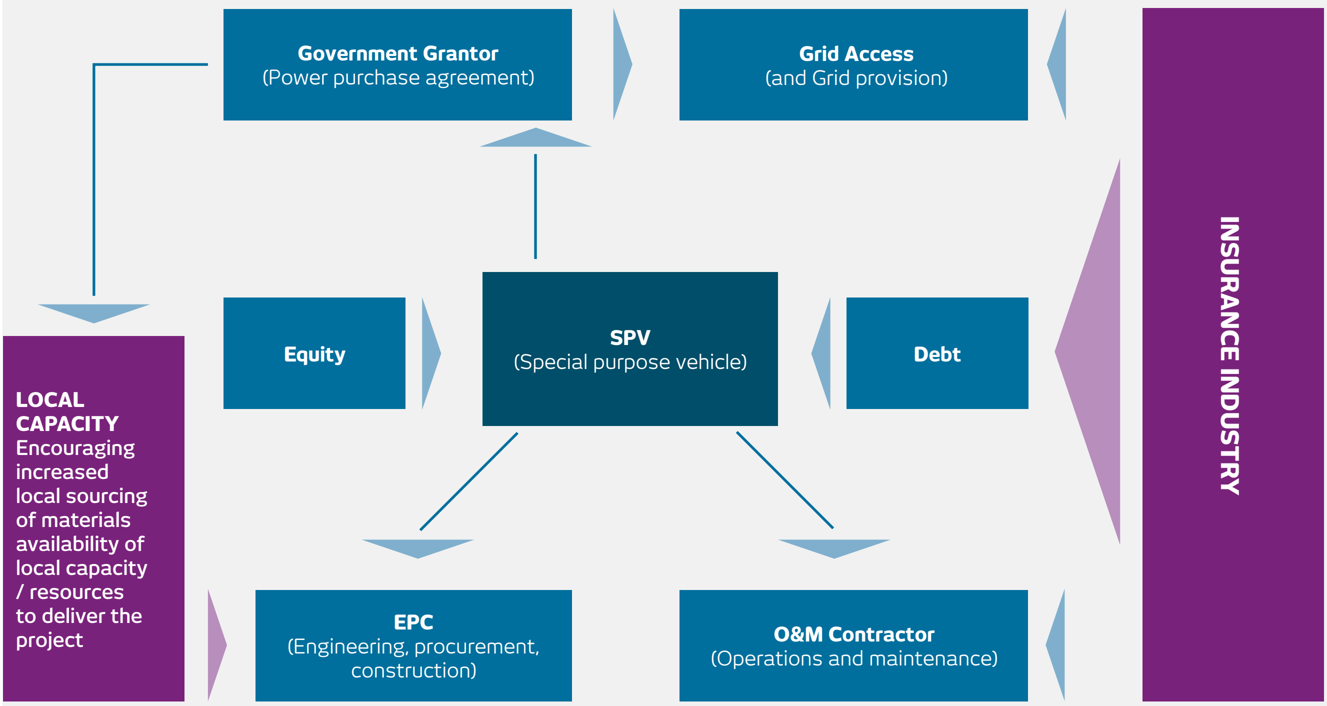
Carbon emissions from the power sector also fell in 2014 by 16 million tonnes – a 5 per cent reduction on the previous year – reversing a paradox that had seen power sector emissions climb between 2009 and 2013 as Germany stepped back from nuclear power, and returned to coal powered generation even as the use of renewables grew.

Energy use also fell sharply, by around 4 per cent, continuing a declining trend in power usage since 2007, while GDP grew simultaneously. In the US, the pattern is more striking still: the economy has grown by 287 per cent since 1973 whilst energy consumption has increased less than 50 per cent.

Denmark has gone even further. The nation's GDP grew 38 per cent between 1990 and 2012, but energy consumption actually went down 4 per cent during the same period. One reason for this is that there is a law requiring utilities to curb energy demand by 2-3 per cent annually. This has led other Governments in the EU and in 24 States across the US to follow suit.

In summary: where policy frameworks create the impetus, economic growth and electricity growth no longer need to be correlated.

Figure 24. Indicative model for structuring large project finance



In this structure, a Special Purpose Vehicle (SPV) is established through which finance can flow. Both debt and equity providers provide the capital into the SPV. The SPV contracts with the Engineering, Procurement and Construction firm to deliver the project and with the Operations and Maintenance firm to carry the completed project forward in operation. The Government provides a power purchase agreement, ensuring there is off-take of the generated energy at a price that makes the business case for investment viable. The energy is sold into the grid, and distributed to the paying consumers. The purple boxes represent potential enhancements to the standard model that would benefit the development of renewable energy projects.

4.4
Structuring the finance

There are many models for structuring the finance of larger projects. A representative structure is shown in Figure 24 opposite, which reflects the way in which investment risk is shared equitably amongst partners in large energy projects. There is extensive market experience with this structure, so it is likely to emerge as at least the initial model for large renewable energy projects as well.

Using this as an indicative model, a comparison can be made of the finance required for some of the technologies discussed in this report. In this example, coal, gas and solar PV facilities are considered, all providing power to the grid through the Power Purchase Agreement. The assumed size of the facility is 100 MW to allow comparisons across technologies.

The chart in Figure 25 highlights the price of power produced per unit energy sold to the grid, with units of US$/MWh. What is striking is the price for solar PV. Building on dramatic decreases in cost over the past six years, the most recent Dubai project came in lower than expected, at $60/MWh, establishing a new benchmark for utility scale solar PV projects.

The model of project finance introduced in Figure 24 has emerged as a leading way to finance large infrastructure projects that might otherwise be too expensive or speculative to be carried on a corporate balance sheet. The main advantages of project finance and adopting the structure shown are:

- Non-Recourse/Limited Recourse Financing: There is no or only limited recourse to the project sponsor's assets for the liabilities of the project. Thus, the project preserves the sponsor's debt capacity.

- Risk Sharing: By setting up a separate legal entity, the project risk is isolated and can be allocated to the parties that can best control, understand and mitigate the risks involved. Consequently, incentives for all involved are optimized. This includes political or country risk.

- Favourable Tax Treatment: Project Finance structures allow tax benefits to be allocated to entities that can make use of them.

- Improved Financing Terms: The project may obtain more favourable financing terms than it would based on the sponsor's credit profile alone. This way projects can be carried out that would be too big for one sponsor.

However, all of these benefits come at a high transaction cost, higher interest rates and insurance coverage. In addition, investments in the clean technology sector often combine capital intensity with new technologies thereby further raising costs.

When considering what actions could be taken to enhance this model to support more frequent and quicker deployment of renewable technologies, and to make project financing of renewable energy projects more attractive to industry players, two main areas emerge. First, improving the performance of existing actors in the finance community for project structuring and, second, considering the additional involvement of other actors to help reduce the risk premiums and cost of capital for projects. These priorities are outlined in more detail on the following page.

Figure 25a. Comparison of finance required for 100 MW project for different technologies

Technology	LCOE*	LCOE with CCS**	LCOE per unit power***
Coal	US$183M	US$382M	US$71/MWh (US$132/MWh)
Gas CCGT	US$90M	US$150M	US$104/MWh (US$130/MWh)
Solar PV	US$204M	US$204M	US$113/MWh (US$60/MWh***)

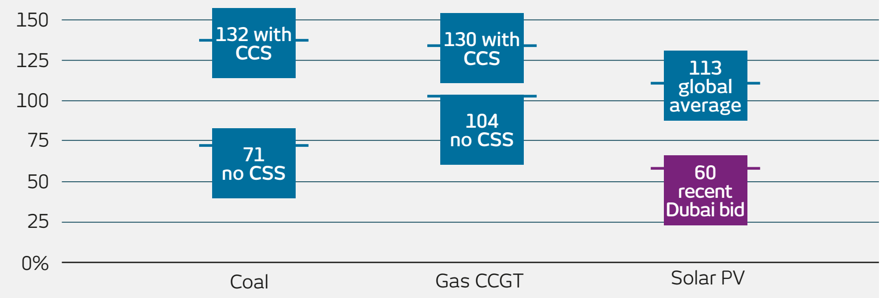
Costs of each project are from the 2014 Energy Intelligence Group levelised costs of energy (LCOE) reports, using Mideast values

*Levelised Cost of Energy. Units are 2014 US$, calculated as US$/kW x 100000 kW. These costs include capital, operating (O&M), fuel and carbon costs over the project lifetime. The values are averages of projects over the region in the past several years.

**This cost includes what would be the addition of carbon capture and storage technologies consistent with policies of carbon reduction in the region to reduce the carbon intensity of the economy as described in the report. The requirement of CCS would apply only to Coal and Gas facilities.

***This is the price of power produced per unit energy sold to the grid, with units of US$/MWh. Values in parentheses for coal and Gas are with CCS. For solar PV, the most recent Dubai project came in at US$60/MWh, much lower than the past regional average due to the dramatic decline in price of solar PV in the past 2 years. This is shown in the parentheses.

Figure 25b. Price of power per unit of energy in US$/MWh



4.4.1
Finance Community

The investment community has historically approached the renewables industry as just another investment opportunity, albeit with higher risk and uncertainty. Where markets are just developing, existing economic models for other infrastructure and energy opportunities have been used to determine key factors such as acceptable rates of return and mainstream instruments have been used to support the financing of renewable projects. Great strides have been made by more mature markets and key areas of focus in future should include:

- **Information sharing:** The investment community will price renewable energy investments on the quality of information that they have available about particular types of technology as well as individual project opportunities. If the investment community is better informed about the technology, the projects and the policy landscape then risk premiums associated with financing renewable projects will probably fall. In addition, better collation, sharing and use of industry-wide information on technology components, track records etc. will also be important in helping to attract more investors into the sector. There is finally also a need to review existing rating models and develop new approaches to bundle smaller scale projects.

- **Engagement:** There exists the opportunity to engage the wider investment community in the development of generation and transmission infrastructure plans at an early stage. By doing so, financial and investment constraints could be identified at the start and help to shape the optimal approach for timely delivery of the projects. Currently, investors are often approached at the end of a project development when many of the details are already in place and there is less opportunity for changes to be considered.

- **Tools and templates:** Another opportunity is greater customisation and standardisation of tools and templates used by the investment industry to support financing decisions. Appropriate business case and financial model templates could be developed for individual renewable energy technologies. These could be shared with project developers and technology companies to provide greater clarity on the acceptance criteria and supporting information needed to gain approval. Governments and utilities could also develop standard long term power purchase templates that would form the basis for the offtake.

- **Financial products:** In addition to tools, there is also a need to develop additional financial products to support the scale up of the renewable energy industry. Especially in the case of less mature technologies where track records are still short, the provision, for example, of insurance products that will guarantee the performance of components for 25 years will help to remove much of the perceived risk. Further products should be developed as short to medium term support as renewable energy technology becomes more established.

- **Project specifics:** In addition to the point raised above for the industry as a whole, there is also the opportunity to standardise and develop common standards for the development of project information. Better ways of[11] looking in detail at information on the financial viability / economics of the project, including whether 100per cent of the financing was assured (sovereign loan, guarantee agreements, support by manufacturers, equity participation etc.) and the cost coverage, could be developed. Information on a number of other metrics could be standardised to a greater extent, such as the likely cost of installed kW and grid connection costs, the capacity factor and plant availability, the purchase conditions of generated kWh (amount and duration of guaranteed tariff), the debt to equity ratio for the investment and expected return on equity rate, the CO_2 mitigation costs, the storage capacity and whether proven technology has been employed (including an analysis of the pros and cons of the technology). This would enable key metrics to be prepared more easily by project developers and understood more quickly by investors.

- **Loading of investments:** For many renewables, it is worth noting that most of the investment costs are typically front loaded when compared with other fossil-fuel options. There is no fuel supply 'tail' of costs that continues for the life of the generation plant. A fair evaluation of the whole life costing of a project, complete with an analysis of the time value of money, would help to provide a fairer assessment of relative value for money.

- **Risk mitigation mechanisms:** Governments and the investment community should work more closely together to identify other financial risk mitigation mechanisms that could make the financing of renewable energy projects more attractive to private investors. Public sector loan guarantees and credit enhancements are two examples of these. Further ones should be developed and promoted. In addition, exploring the opportunities for novel public-private and public-public contracting arrangements for large scale renewable energy and transmission opportunities would also help to reduce risks.

4.4.2
Lenders

Lenders play a vital role to promote the industry; they can participate though equity or debt. Building on some of the points raised above, to expedite the credit committee approval, lenders should:

- **Understand the technology process** and familiarize themselves with the available technologies.
- **Understand industry terminology:** Lenders should improve their understanding of solar industry terminology and key metrics such as Average Solar Irradiation and panel efficiency.
- **Engage at an early stage with Government** and policymakers on what is needed and how to create bankable projects.
- **Be familiar with key industry players:** Only work with companies with a proven track record.
- **Insurance:** Develop closer working relationships with the Insurance industry that will provide many of the warranties / guarantees for the technology.
- **Engagement:** Engage on a more frequent basis with Government and the Insurance industry to align policies, support and products to specific RE technologies. Help policymakers in particular understand the role and appropriateness of different financial investors and instruments.
- **New Lenders:** The regulatory pressure from Basel III may result in a reduction of infrastructure loans from banks. However this creates opportunities for insurance companies, pension funds and other long term investors to become more involved in financing renewable energy projects.

4.4.3
Governments

At an overarching level, the key role of policymakers in this context is to focus on implementing the regulatory and policy frameworks to encourage investment and reduce political and regulatory risks. Governments must have a clear vision for renewable energy and a master plan with clearly defined energy sustainability goals and policy frameworks which help deliver those in practice.

In addition, Governments can also make a real contribution to ensuring that investing in projects becomes more attractive. So as well as the points raised above, they could consider the following specific areas to further support development of renewable energy projects in the region.

- **Guaranteed offtake:** Government could take the project's produced power or make a payment to the SPV in lieu of purchase. This will reduce cost, attract bidders and give comfort to lenders. Recognise that investors are not going to provide capital without an attractive profit.
- **Compensation on termination:** A termination sum should be paid to the bank / equity in case of early default events.
- **Standard risk allocations:** Across IPP projects in the region, there is a generally accepted risk allocation matrix. Similarly Government should develop risk sharing principles for renewable energy projects ahead of announcing projects.
- **Standard payment mechanism according to technology:** Government should study the different technologies and prepare a standard payment mechanism for each one.
- **Localisation:** Supporting early development of local supply chain and human capacity that can reduce the costs of component manufacturing and underpin the services provided all of which will ensure that more benefit remains in the region.
- **Local support:** As shown in the Figure 24 above, Governments can influence the availability and sourcing of local materials required by the projects through economic incentives and regulation. They can also play a role in ensuring that there are adequate local skills and resources available to deliver the project. By supporting public and private initiatives that enable R&D and local innovation, local project costs can be further reduced.

Ultimately, countries are in competition for private sector investment and can only differentiate themselves by how well they have addressed the areas outlined above. If successful, this will also help to build the longer term trust that the financial community requires to invest at scale.

4.4.4
Insurance Industry

Insurance documents are a key requirement during the project finance process. Insurance companies are the other player that we propose should play a more prominent role. They could be more familiar with risks associated with financing renewable energy projects, such as:

- **Project risks** during the project life cycle.
- **Shipment and storage process** in order to have a better assessment on project components.
- **Warranty terms** offered by the panels' manufacturers.
- **Products:** There are opportunities for the insurance industry to develop products that address specific risks that the finance sector has with renewable energy projects e.g. if GWh produced for the year fall below PPA requirements etc.

4.5
Global trends in solar financing

Since solar energy and, at this time solar PV, is so important to the region's future energy mix, we summarise here the major global trends in solar financing which may serve to influence the decisions of the financial sector in the Gulf.

Around the world, solar technology has experienced tremendous growth in the last 4 years, with global installed capacity jumping from 45GW to 140GW. Solar PV module costs in particular have fallen significantly making it a cheaper and more competitive technology for consideration by Governments and utilities. While technological advancements and manufacturing developments have of course played a large role in reducing the costs of solar energy, the innovation that has happened in the finance arena to support the rollout of projects also needs to be recognised.

It is well known that cost effective capital can have a disproportionate effect on the viability of projects, and what has been particularly important is the way in which a number of new approaches have emerged to ensure that demands for capital by projects can be met. Set out below are summaries of some of the more established mechanisms that are now being deployed at scale around the world. It is currently an exciting time for solar finance – not just because of the application of existing models to the solar industry, but also because we can expect significant further financial innovation in the coming years. A recent paper by Garrard Hassan and Partners Ltd analysed the main changes that have occurred in the last few years and what the future might bring.[38]

- **3rd Party Ownership and Securitisation.** In November 2013, Solar City, an American solar service company raised US$54m through the issuance of asset backed securities based on the income generated by more than 5,000 solar systems located across the US. Through the company's leasing model, it retains ownership of the solar systems installed on homeowner's roofs thus providing the certainty and security of returns. This represents an exciting new way of bridging the gap between renewable energy consumers looking for clean and affordable energy and investors looking for dependable returns. As a concept it has global application as individual country markets mature. It also opens the door to participation of mainstream financial investors in a low risk investment through the issuance of asset backed securities built on a large pool of underlying assets. Factors that could constrain growth at the moment are largely around the quantity and quality of data available to properly assess and price the risk associated with a pool of projects.

- **Direct Ownership.** Third-party ownership remains the dominant model for financing a residential solar installation in the U.S., but that's changing. Direct ownership via loans is gaining traction, because solar PV systems continue to get cheaper while financing options continue to improve and homeowners increasingly want to own their system. Expectations are that in the coming years we will see a greater proportion of individual homeowners provided with access to new sources of large-scale capital via direct lending platforms. If successful, this will upset the status quo in the residential solar market but also lead to further significant growth in the market and perhaps represent a model that can also be deployed elsewhere around the world.

- **New Equity Offerings, Corporate Structures and Bonds.** By placing solar PV systems into liquid and tradable investment vehicles, there is an opportunity for a broader investor universe to become involved in the renewable energy industry. This is not a new concept, having been used for decades for other infrastructure projects, what is new is the application and adaptation to the solar sector. If successful, it brings to bear the deep pockets of global equity markets to support future development of solar projects. Examples of these equity vehicles are yield co's and investment trusts that directly invest in and own solar assets and trade as a stock on an exchange. Alongside these structures we are also seeing increase issuances of green bonds that look to channel the funds raised by bond issues into environmentally friendly investments.

Sales of new green bonds reached US$36.6 billion in 2014, more than triple the previous year.

- **Yield Cos:** these are companies into which a developer bundles a number of purely operational solar assets. The company is floated through an initial public offering (IPO) and the shares are traded on an exchange. A significant benefit for investors is that the majority of cash flows from energy sales are distributed as dividends. This is currently popular in Europe and North America where markets are more mature. There is the opportunity for this concept to also be applied to markets at earlier stages of development, but this depends on local business conditions and clear demonstration of the concept in other markets.

- **Investment Trusts and Partnerships:** Tapping the available capital in equity markets has been a common approach for the renewable energy industry for some time. Investment in other tradable investment vehicles such as investment trusts and tradable partnerships has to date been less common, but given favourable tax treatment and liquidity, could become an important source of capital in certain markets in future. The last few years have seen the emergence of more and more dedicated energy trusts, with the potential to combine Solar PV assets into Real Estate Investment Trusts holding particular promise. In a number of cases, changes in legislation, regulation and political support will be required to allow these structures to advance.

- **Green Bonds:** The market for Green Bonds has grown significantly in the last few years. Sales of new green bonds, which help pay for low carbon energy, reached US$36.6 billion in 2014, more than triple the issuance from the previous year. The increase brings the total number of green bonds outstanding to US$53.2 billion as of the end of the year. The increasing demand for investments with ethical and environmental credentials by pension funds, other institutional investors and asset managers who require greater transparency, higher social and environmental standards, could result in this becoming a significant source of new capital for the solar industry. However the viability of green bonds depends on a very solid understanding of the projects being funded – this is true whether the bonds are on the basis of an investment in a portfolio of green infrastructure projects or as project bonds associated with individual projects. The vast majority of green bonds issued these days have been raised by supranationals, development banks and Governments, but corporate issuance is also on the rise representing an important new source of debt finance. Europe and the US have led the charge to date in this area, but there are signs that demand is also building in other parts of the world. Factors that could constrain further issuances include the credit ratings of corporations, a requirement for guarantees, an unwillingness by investors to take on construction risk and the need for larger project sizes to justify high transaction costs.

Emerging financing models

Alongside the development of new investment products to support solar PV project development, the way that solar PV projects interact with the electricity market is also undergoing reform and creating opportunities. Alternative electricity off-take structures such as direct sales, captive projects and merchant solar plants are on the rise. Around the world we are seeing the role of the traditional utility being challenged, and new types of off takers stepping in. To some extent these developments have been driven by reductions in Government Feed in

Green Sukuks

The growing Sukuk market is well suited to channel capital to fund renewable energy and climate change projects. Sukuks are tradable Islamic finance instruments, consistent with the principles of Shari'ah. Sukuks represent an ownership in underlying assets or earnings from those assets. While Sukuks are often described as Islamic bonds, there are also types of Sukuk that have equity type risk-sharing structures.

The Climate Bonds Initiative recently outlined how Fixed-income Sukuks with no risk sharing are increasingly seen as an alternative to conventional bonds, and account for the largest share of the Sukuk markets. Green Sukuks are a subset of Sukuk that are focused on environmental assets, such as solar parks, biogas plants and energy-efficient buildings. Green Sukuks can allow Islamic investors to more easily address Shari'ah concern for environmental protection in their investment choices. It also has the potential to attract non-Islamic investors who otherwise would not have invested in Sukuks but invest due to the green credentials.

The rapid growth of the green bonds market in the last few years further underpins the potential for a green Sukuk market. Green bonds are bonds where the proceeds are earmarked for green projects. This is how a green Sukuks would be structured as well. The green bonds market has shown that this "use of proceeds" structure can work well but that robust and trusted standards of what is green are needed. The green standards that are developing for the green bonds market can be used.

Tariffs (FiT) or high local market prices. With the drop in solar technology costs in many cases already at grid parity, it makes complete economic sense to put private power purchase agreements (PPA) in place. The self-usage of solar generated electricity to reduce electricity bills makes sense and removes the risk of future reductions in FiT's. The application is viable in both mature and less mature markets, and provides a hedge against rising electricity prices for energy intensive users.

- **PPA Innovation:** There is increased use of derivatives based offtake agreements. These synthetic PPA's are load-following swap agreements in which the solar plant sells the electricity into the competitive market and settles the difference between the spot price and the pre-agreed swap price with the swap counterparty. Provided there is a credit worthy counterparty on the other side of the transaction and the swap rate generates an acceptable return, financiers and investors should be comfortable funding projects under this arrangement. Further development of this mechanism will rely on a greater convergence of the costs of renewable energy and those of wholesale electricity prices.

- **Corporate investment:** We are seeing major corporations like Google, IKEA and Apple taking equity stakes in solar projects, developing their own captive projects and committing to being 100per cent renewable powered. Many of these projects have had the corporations providing the equity, primarily to projects with offtake agreements already signed for or for portfolios of systems under third party models. Corporate investment in renewable energy looks to become another major international source of capital.

- **Crowd funding:** This represents the most recent and exciting development in solar finance. Through online platforms, project promoters are able to connect with millions of small investors looking for a return. Growth has been explosive, during 2014 the rate of global crowd funding was doubling every 60 days. The scalability, diversity and reliability of solar's returns means that as in other areas of finance, solar technology is leading the energy pack in the adoption of crowd funding with several models emerging. Compared to more conventional means, the total amount of capital raised for investment is still small and it has yet to prove it can make a difference. In a number of jurisdictions changes in regulation and legislation may be required to support further growth.

- **Aggregation:** Many renewables projects tend to take place in small 'units' rather than at very large scale. This can cause the transaction costs to be high, as even small projects require legal, planning and financial scrutiny that all involve costs. The solution is to bundle together many projects in a community, driving down the 'per project' transaction costs and attracting better terms for provision of materials and labour. As portfolios of projects become established, as they are for example is the US or the UK, the finance community can serve as an 'aggregator' of projects along the value chain of energy supply and demand.

New sources of investment such as municipalities, small businesses and households continue to come forward. These will all require new financial instruments and mechanisms and innovation to existing models. Following a decade of technological innovation, we can expect the next decade to perhaps be one of renewable energy finance innovation.

Changing worlds and opportunities for institutional investors

Institutional investors have recognised that there is significant media attention on the 2015 UN climate conference in Paris and the possibility of a global agreement that may change the landscape for business. Practically, this could result in changes in prices for fossil fuel assets (in particular by the debate on stranded assets), or manifest itself in greater outflows from their investments as investors look to divest from carbon intensive assets. As a result some institutional investors are beginning to review and reduce the exposure to carbon in their portfolios.

When looking at whether this shift in investments can be aligned with the energy technologies of the future, the news is good. In many markets, solar and wind have already reached parity with new fossil fuel powered generation alternatives. There is 39 per cent growth expected between 2013-2018 for renewable power generation globally. For large institutional investors, the opportunity exists to share in this significant growth in future energy demand by investing more in those companies that are either developing or delivering new renewable capacity. However, this will require institutional investors to look beyond their current "thematics" allocation.

4.6
Conclusions

Chapter 4 establishes that the region needs to make improvements to its energy system if it is to reach its ambitions for global leadership in economic development, energy supply and energy use. These improvements can be delivered through private sector finance, but only if policies and planning procedures are in place – and enforced – that can both stimulate and de-risk investments.

Several points can be taken away from this discussion on the role of Governments in supporting private sector finance decisions:

- While Government ambitions for economic and environmental sustainability are high, there is inadequate translation of these ambitions into specific policies that provide regulatory stability on which finance institutions can rely in directing capital, and in planning procedures that encourage sustainable energy provision and use. To achieve their ambitions, Governments will need to offer greater stability and support in order to improve and sustain investor confidence.

- While the private sector can deliver generation and end use projects, Governments will have primary responsibility for transmission and distribution grids. These grids are currently not able to carry a significant increase in energy. Governments must match the growth in energy generation with an equally ambitious programme of development of the grids in the region, including smart grid infrastructure.

- Government policies on support for oil and gas are distorting the market at present, weakening the business cases for, at least, energy efficiency improvements. Governments are already reconsidering their policies in this area; this doesn't require eliminating subsidies entirely, but rather shifting them to encourage growth of renewables and improvements in energy efficiency – for example, a 'nega-watt' programme in which energy efficiency improvements are given financial support equivalent to that of subsidies that simply lower the price of consumption.

- Governments should play an increasingly central role in connecting regional banks to the global finance mechanisms such as the Clean Development Fund[39] or the Green Climate Fund.[40]

- Governments should identify how they will enhance their role in the finance structure, strengthening the development of, for example, Power Purchase Agreements and linking these agreements to the carbon intensity of that energy.

Mirroring these requirements of Governments in their policies and planning procedures are requirements for the finance sector:

- The finance sector must send a clear signal to Governments that if they bring greater stability and support for sustainability ambitions and policies, the finance sector will be there to back projects that are consistent with that support.

- The finance sector can help to ensure energy generation capacity is increased at a rate consistent with the grid development by Government, and locates its projects in places where the gird can be put to best use for maximum efficiency.

- As subsidies for traditional energy are reduced, stimulating the business case for energy efficiency improvements, the finance sector needs to be ready to develop innovative finance packages for efficiency projects.

- Finance institutions must work alongside Governments to identify and support opportunities to partner with global institutions in the emerging global finance mechanisms such as the Clean Development Fund or the Green Climate Fund.

- Finance institutions have the opportunity to develop innovative finance structures and engage directly with policymakers and the energy sector to support the industry's ability to shift effectively to a new energy system.

39%

Growth in renewable power generation globally is expected to be 39 per cent between 2013 and 2019.

Moving Forward

The opportunities for the finance community to play a major role in development of the energy system needed in the GCC Region and the West-East Corridor – as well as globally – has been established by the four pillars of the argument developed in this report.

The argument points towards the next steps which need to be taken, as follows:

Pillar 1:

There is a pressing need for investment/finance of both energy generation and energy efficiency improvements over the next 10-15 years, both to secure the needed energy and significantly improve its sustainability. Meeting that need will ensure continued economic growth of the region(s) affected and improved quality of life for citizens. It opens finance opportunities on the scale of tens of billions of US dollars per year in the region and hundreds of billions (to a trillion) US dollars per year globally.

Pillar 2:

We do not need to wait for the required technologies to appear. Low carbon, sustainable technologies are already on the market, with costs that are dropping rapidly as the industry matures and grows. They are already market-tested and cost effective, especially for solar PV and on-shore wind. This situation is robust against changes in the price of oil.

Pillar 3:

The West-East Corridor offers a significant opportunity to extend the GCC region's finance expertise onto the global stage. This corridor will require very large increases in energy generation as well as innovations in energy efficiency so that energy can be used wisely in these fast growing economies. The current lack of infrastructure, as well as the ability of low carbon solutions to attract supplemental finance through the Clean Development Mechanism and related international programmes, means there will be continued growth in renewables, which already represent more than half of the global investment in new energy generation over the past several years.

Pillar 4:

Government policies both in the GCC region and along the West-East Corridor are not yet optimal to unlock this potential finance. Working together with Governments, the finance community can play a crucial role in defining the next generation of policies to deliver on the ambitious economic, energy and sustainability visions of the region.

What do these four pillars suggest is the path forward for the finance sector to turn aspiration into reality? Several conclusions spring from the data and from the stakeholder interviews conducted while developing this report:

1. The costs and difficulties of bringing low carbon energy to the GCC region and along the West-East Corridor are dropping rapidly. Anyone who has not followed this trend in the past few years will be surprised by the new landscape of costs. The finance community needs to develop the capacity to review and revise cost estimates on at least a yearly basis or information used in taking decisions will be rapidly out of date.

2. Energy efficiency improvements must go hand-in-hand with new energy generation. As the world's economies grow, there will be increasing competition for a limited energy supply. And it simply makes no sense to pour energy into buildings, transport and industries only to have it wasted. The balance between projects on efficiency and generation will change over time, but at least at the moment they should be receiving equal attention.

3. Governments along the West-East Corridor are gearing up for deployment of energy projects, and are looking for partners. Now is the time for the finance community to begin conversations with first the Governments and then the project developers, creating and testing a finance model that ensures delivery while distributing risk equitably.

4. To unlock the greatest opportunities for finance of energy projects, the regional finance institutions must form collaborations with large international groups such as the World Bank, European Investment Bank and Global Climate Fund. At the moment, only these international groups can access the finance available through the international energy and climate mechanisms – finance that will be critical in de-risking projects that involve either low carbon energy or improved energy efficiency.

5. Government procurement provides a reliable way to move technological advances forward at scale into the market. Public–private partnerships must be encouraged, as they both create an initial demand for technologies as Governments meet their own energy needs, and the attraction of private finance and R&D to projects that deliver on that demand.

6. Policies that combine ambitions for energy, economy and environment are few and poorly coordinated. Some form of public-private sector committee is needed in the GCC region to define and assess the portfolios of policies needed to encourage these ambitions. Equally importantly, the recommendations of that committee must migrate down into the planning and other formal procedures of Government – and of businesses – so ambitions show up eventually as standards, planning rules and create the framework to influence the decisions of consumers.

Glossary

Balance of System (BoS) costs: all components of a photovoltaic system other than the actual panels, including wiring, switches, support racks, inverter, installation costs, planning costs, design costs, etc. This can include batteries in the case of off-grid systems and land in some instances.

Capacity factor: the ratio of a power plant's actual output over a period of time to its potential output if it were possible for the plant to operate at nameplate capacity indefinitely

Cleantech: Cleantech or clean technologies are a diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and cut or eliminate emissions and wastes. They are competitive with, if not superior to, their conventional counterparts and many also offer significant additional benefits, notably their ability to improve the lives of those in both developed and developing countries.

CSP: Concentrated solar power (also called concentrating solar power, concentrated solar thermal, and CSP) systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight, or solar thermal energy, onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine (usually a steam turbine) connected to an electrical power generator.

Dispatchable generation: sources of electricity that can be dispatched at the request of power grid operators; i.e. generating assets that can be either switched on or off or can adjust their power output on demand.

Final energy: Energy in the form that it reaches consumers (such as elec¬tricity from a wall socket)

FiT: A feed-in tariff (FIT, standard offer contract), advanced renewable tariff, or renewable energy payment, is a policy mechanism designed to accelerate investment in renewable energy technologies. It achieves this by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Rather than pay an equal amount for energy, however generated, technologies such as wind power, for instance, are awarded a lower per-kWh price, while technologies such as solar PV and tidal power are offered a higher price, reflecting costs that are higher at the moment.

Generation capacity: an asset's technical power output

Gigawatt: (GW) one billion (109) watts

Grid parity: when a technology can produce electricity at a cost roughly equal to the price of wholesale power from the grid, on a levelised basis. Whether or not this includes the cost of backup for intermittent renewables is controversial. [NB: hydropower projects and some geothermal technologies have been at grid parity for decades.]

Joule: A unit of measurement for energy, equivalent to one watt of power for one second.

Kilowatt: (KW) one thousand (10^3) watts

Learning rates: the observed, empirical rate at which the equipment costs of a given technology fall with every doubling of that technology's cumulative installed capacity.

Levelised cost of electricity (LCOE): the price at which electricity is generated from a specific source over the lifetime of the project. It is therefore an economic assessment of a technology's or project's cost which includes the full span of its lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital, etc.

Megawatt: (MW) One million (106) watts.

Micro grid: A highly localised, low voltage grouping of generation, storage, and demand, normally only for residential and potentially light commercial purposes. This can operates in connection with a traditional centralised grid, but can also function autonomously, in remote areas, etc.

Mini grid: An integrated local generation, transmission and distribution system serving more customers than a micro-grid, but not large enough to be considered full-sized. Mini-grids often have more generation (in terms of volume and diversity) as well as more demand (usually residential and light commercial).

MMBtu: MMBTU, or MBTU, stands for one million British Thermal Units (BTU). A BTU is a measure of the energy content in fuel, and is used in the power, steam generation, heating and air conditioning industries. One BTU is equivalent to 1.06 Joules.

Non-financial policies: A broad term for any government policy that does not require direct financial support. For instance the creation of intellectual property rights legislation, a minimum efficiency standard for wind turbines or the rules of a renewable energy auction.

Off grid: not being connected to a central grid, specifically used in terms of not being connected to a national electrical grid

Power generated: an asset's generation capacity multiplied by the time it runs. A generator with a rated capacity of 1 megawatt (MW) produces 1 megawatt-hour (MWh) if it runs at full capacity for an hour. It then has a capacity factor of 100 per cent. If it lies idle for the next hour, its capacity factor is 0 per cent for that hour and 50 per cent for the two together.

Power Purchase Agreement (PPA): a forward contract between two parties, one who generates electricity (the seller) and one who is looking to purchase electricity (the buyer). PPAs are the principal agreements that define the revenue and credit quality of a generating project and are thus a key instrument of project finance. [PPAs define the terms for the sale of electricity, including when the project will begin commercial operation, delivery schedule, penalties for under delivery, payment terms, termination, etc.]

Primary energy: A source of energy before any conversion has taken place, such as crude oil, natural gas, rays of sunshine and lumps of coal.

PV: Photovoltaics (PV) is a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect. A photovoltaic system employs solar panels composed of a number of solar cells to supply usable solar power.

Reference Case: In this study, the business-as-usual case under current policies and governmental plans.

Smart grid: an electricity supply network that uses digital communications technology to detect and react to local changes in usage

Socket parity: when a decentralised renewable energy technology can compete with the retail (delivered) price of electricity through the grid to the end user. This is particularly applicable for solar PV and micro-wind installations that power end-users directly.

Super grid: a large, often very long-distance transmission network that makes it possible to trade significant volumes of electricity across great distances. Technically more complicated than normal grids due to the need to minimise power losses over distance.

West-East Corridor: the rapidly growing economies which form a super-region, stretching from the West of Africa across the Middle East and to Asia in the East.

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- Renewable energy supply & demand: Working with Government and private sector players on Energy mix, Energy efficiency, Smart grid & metering, and renewable energy project development

- Integration of Sustainability into Business Practice: Supporting companies with the development of sustainable strategies, Sustainable procurement & supply chain, reporting and impact measurement.

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