FOR INSTITUTIONAL, PROFESSIONAL CLIENTS
AND QUALIFIED INVESTORS ONLY

BLACKROCK®

JUNE 2018

INVESTMENT ACTIONS | PORTFOLIO DESIGN | RISK MANAGEMENT | REGULATORY | MARKETS

The global energy and power transition

Implications for infrastructure investors

MKTG0618U-490624-1630928

Mark Florian
Global Head of BlackRock's Energy & Power Infrastructure team

Jim Barry
Global Head of BlackRock Real Assets

Alan Synnott
Global Head of Research & Product Strategy for BlackRock Real Assets

Contents

Summary

- The world is undergoing a deep structural shift in how it powers industry, homes and transportation. The main storyline is the move away from coal and nuclear and toward cleaner energy sources, notably natural gas and renewables.
- The economics of wind and solar power continue to improve, and the shale revolution in the U.S. and rapid expansion of liquefied natural gas (LNG) are giving rise to a global natural gas market.
- There is significant need for new energy infrastructure and the capital to finance it. With many big utilities and global energy companies in restructuring mode, investment opportunities are opening up for other capital providers.
- We highlight the major trends at work and note financing needs and investment dynamics in different parts of the global value chain.

A note on sources

Sources cited in this report include government bodies such as the U.S. Energy Information Agency, consultants such as McKinsey & Co. and E&Y and information providers such as IHS Markit and Bloomberg New Energy Finance. Our most frequently cited source is the 2017 edition of the *World Energy Outlook*, the comprehensive annual publication from the International Energy Agency, which works to ensure reliable, affordable and clean energy for its 30 OECD member countries.

The IEA generates projections of future energy demand using its World Energy Model, which models global energy demand in 25 regions of the world. The 2017 *WEO* offers projections for three distinct, policy-based scenarios. The New Policies Scenario incorporates existing government policies and measures as well as the likely effects of announced policies. It is the IEA's central scenario, or base case, and is the basis of the projections cited here unless otherwise noted. The IEA's other two scenarios are its Current Policies Scenario, which considers only the impact of policies in effect as of mid-2017, and its Sustainable Development Scenario, which posits additional steps toward sustainability goals.

Scenario-based analysis makes sense given the large number of variables involved in long-range energy projections, and is used by most of our sources. As with the IEA's data, we cite the base case unless otherwise noted.

MKTG0618U-490624-1630928

Four themes to follow

The global energy and power sectors have always adapted to changes in technology, resource availability and demand. Today an especially dramatic transition is underway. Technological innovation, demographic shifts, new government policies and the rise of sustainability and environmental concerns are driving a deep structural shift in how the world powers industry, homes and transportation.

The implications for infrastructure investors are significant. Energy and power (including renewable power) already accounted for 62% of global infrastructure investment activity in 2017, valued at US$177 billion*, according to Dealogic. But the large capital appetite in these sprawling sectors, together with the scope of the change that needs financing, point to much more activity ahead. Total energy investment worldwide in 2016 was more than $1.7 trillion, or 2.2% of global GDP, according to the International Energy Agency (IEA), with energy infrastructure accounting for a significant slice.

The transition spans a vast value chain extending from the extraction of hydrocarbons and the capture of wind and solar energy through transport, refining, storage and the generation and delivery of electricity. The main storyline is the move away from coal and toward cleaner energy sources, notably natural gas and renewables, but there are also several important subplots. The shale revolution in the U.S. and the rapid expansion of liquefied natural gas (LNG) are giving rise to a global natural gas market. While global energy demand will grow 30% by 2040, according to the IEA, the growth will be driven by developing economies and tempered as economies (particularly China's) reduce their reliance on heavy industry. In the developed world, investment will be needed to replace aging plants and pipelines, reap new efficiencies and, in the U.S., build the infrastructure to support large-scale natural gas exports.

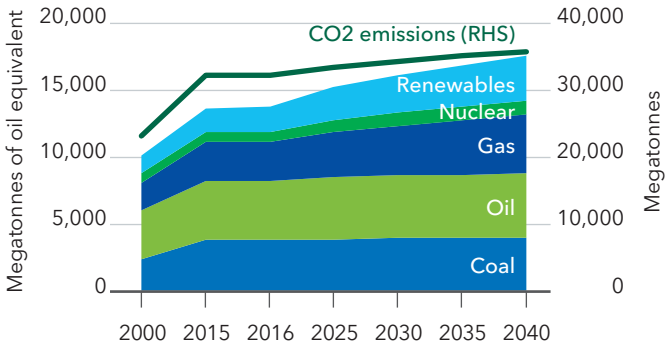
We believe infrastructure investors should focus on four main aspects of the transition:

The shifting mix in energy supply

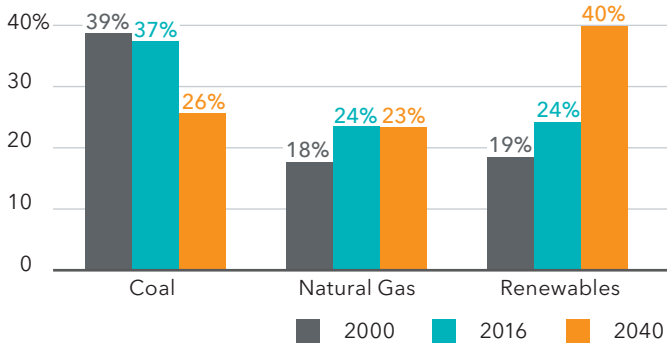
Although coal remains the world's biggest source of electrical power, that is changing—rapidly in some countries, more gradually in others. See the chart below. Both economics and policy, including regulatory measures taken by the 195 signatories to the 2015 Paris Climate Agreement, are driving the shift. India and other developing countries continue to add coal capacity to meet their rapidly growing demand for power, and India and China are also adding nuclear. OECD countries, however, will see a major reduction in coal generation by 2050, with McKinsey forecasting a 46% falloff in Europe and a 77% decline in the Americas. Nuclear is also declining in many of the countries employing it. Germany, for example, plans to close all of its reactors by 2022, while most Japanese nuclear plants remain shut following the 2011 Fukushima disaster.

Coal plateaus while natural gas and renewables grow

World primary energy demand by fuel



Proportion of total global electricity generation by fuel



Source: International Energy Agency, *World Energy Outlook 2017*; New Policies Scenario; Renewables include Hydro, Bioenergy, Wind, Geothermal, Solar PV, CSP and Marine

*$ = USD throughout this paper

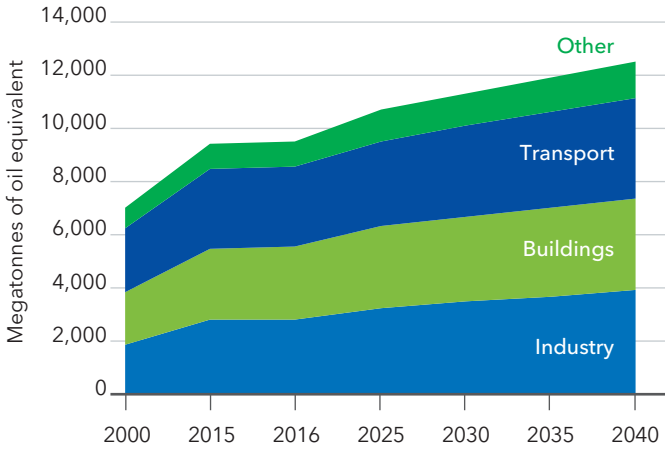
MKTG0618U-490624-1630928

Renewables and natural gas, meanwhile, continue to gain share in both developed and developing economies, including India and China. Wind and solar power, initially boosted by subsidies, have seen consistent declines in their cost of production. The decrease for utility-scale solar photovoltaic projects has been especially dramatic—a 73% reduction in LCOE, or levelized cost of electricity, between 2010 and 2017, according to the International Renewable Energy Agency. Although the U.S. pulled out of the Paris Agreement last year, market forces—lower-cost generation from gas-fired and renewable power—as well as commitments at the state, local and corporate level continue to boost cleaner energy sources. Last year, for example, wind capacity passed coal capacity in the state of Texas, according to the state's Electric Reliability Council.

Renewables will account for 40% of the increase in primary energy by 2040, according to BP's 2018 Energy Outlook. Because of the intermittent nature of wind and sunlight, however, wind and solar power cannot independently meet 24-hour baseload power needs. The continuing development and commercialization of battery storage technology will likely make up for this limitation over time. But for the medium term, natural gas-fired generation is serving as a baseload, fully dispatchable power source to replace aging coal and nuclear facilities.

Changing demand drivers

Total energy demand by end use



Source: International Energy Agency, *World Energy Outlook 2017*; New Policies Scenario.

The changing character of energy demand

In the developing world, energy use is rising on the back of higher population and economic growth. Developing Asia will generate two thirds of global energy growth between 2017 and 2040, the IEA projects, with India alone accounting for about half of that. In the U.S. and Europe, meanwhile, increased energy efficiency amid slower economic growth is expected to reduce demand. Both rising demand and the push for efficiency require infrastructure investment, with developing economies more focused on new construction of energy projects and developed countries mixing new construction with replacement and restructuring of existing assets.

Most countries around the world are consuming more and more of their energy in the form of electricity. The IEA expects electricity to account for 40% of the rise in final energy consumption by 2040, replacing oil consumption as a driver of growth. The electricity will go to industry and also to new consumers, says the IEA, noting that as access expands, the world adds an average of 45 million electricity consumers a year. Accelerated adoption of electric cars and trucks will further boost electricity demand. The global preference for electrical power likely means the expansion of transmission grids in the developing world and the development of smarter, less centralized ones in developed countries.

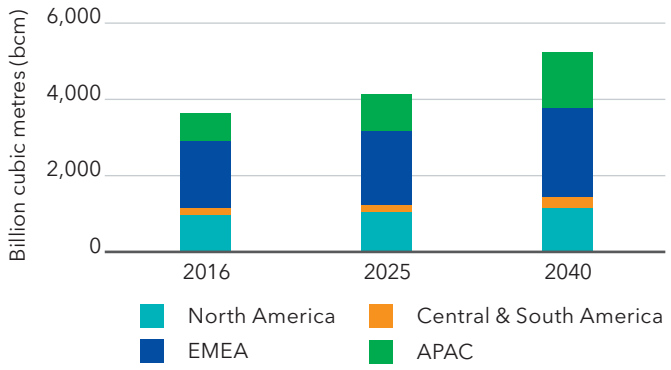
Renewables and gas will account for a majority of new and replacement electrical capacity. Natural gas demand is also being driven by its use in heating and in industries such as chemicals, refining and primary metals. See the chart at left. The U.S. Energy Information Administration projects a 43% increase in global natural gas consumption between 2015 and 2040, with growth greatest in non-OECD countries using it for both industry and electricity.

The rise of a globally integrated market for gas

Led by prolific resource production in the U.S., the global flow of natural gas has burgeoned in the 21st century. Since 2007 U.S. natural gas production has more than tripled, making the country the world's largest producer, followed by Russia and Qatar. This abundance is beginning to transform gas from an energy source consumed and priced locally to a globally traded commodity increasingly anchored by U.S. prices. The share of gas consumed where produced

Global growth in natural gas use

Expanded natural gas demand by region



Source: International Energy Agency, *World Energy Outlook 2017*; New Policies Scenario

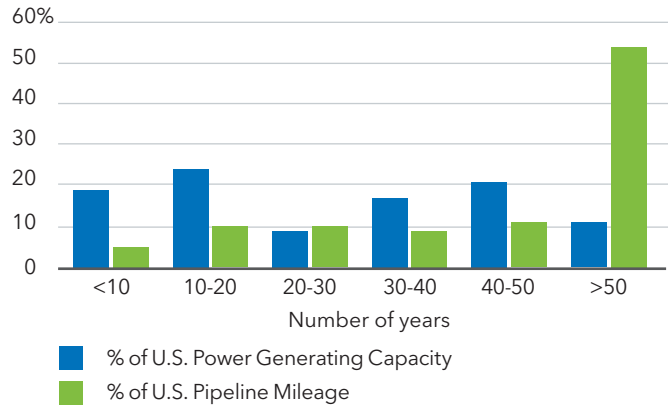
is now ratcheting downward, with McKinsey forecasting a fall from 76% in 2017 to 74% in 2022. Both pipeline flows and shipments of liquefied natural gas (LNG) will drive the globalization, with LNG playing a larger role as the necessary infrastructure is built. The IEA expects inter-regional gas trade to expand 2.4% a year between now and 2040.

Abundance of this resource has kept prices down in much of the world, though prices in Europe are still around twice those in the U.S. LNG has been in oversupply, largely because a buildup in export facilities is not yet fully matched by import infrastructure. Moody's looks for an LNG rebalancing as soon as 2019, while other forecasters expect one a few years later. The vast extent of cheaply recoverable natural gas reserves makes it unlikely that prices will increase much in decades to come, most observers think. The prospect of long-term affordability encourages the construction of gas-reliant electrical plants and manufacturing facilities and related infrastructure.

Developing Asia, led by China and India, will see the greatest growth in gas imports in the next 25 years, the IEA projects, with both electrical and industrial use driving demand. See the chart at left. Although new cross-border pipelines will play a role—Russia is building one to China and two more to Europe—most of the increased trade will take the form of LNG, creating a major need for new LNG infrastructure around the world. See the sidebar on page 9.

Aging infrastructure

Average age of U.S. generating fleet and pipelines



Source: BlackRock, 2018, using data from U.S. Energy Information Agency (2017) and the U.S. Pipeline and Hazardous Materials Safety Administration (2016).

The revision of business models and replacement of aging assets

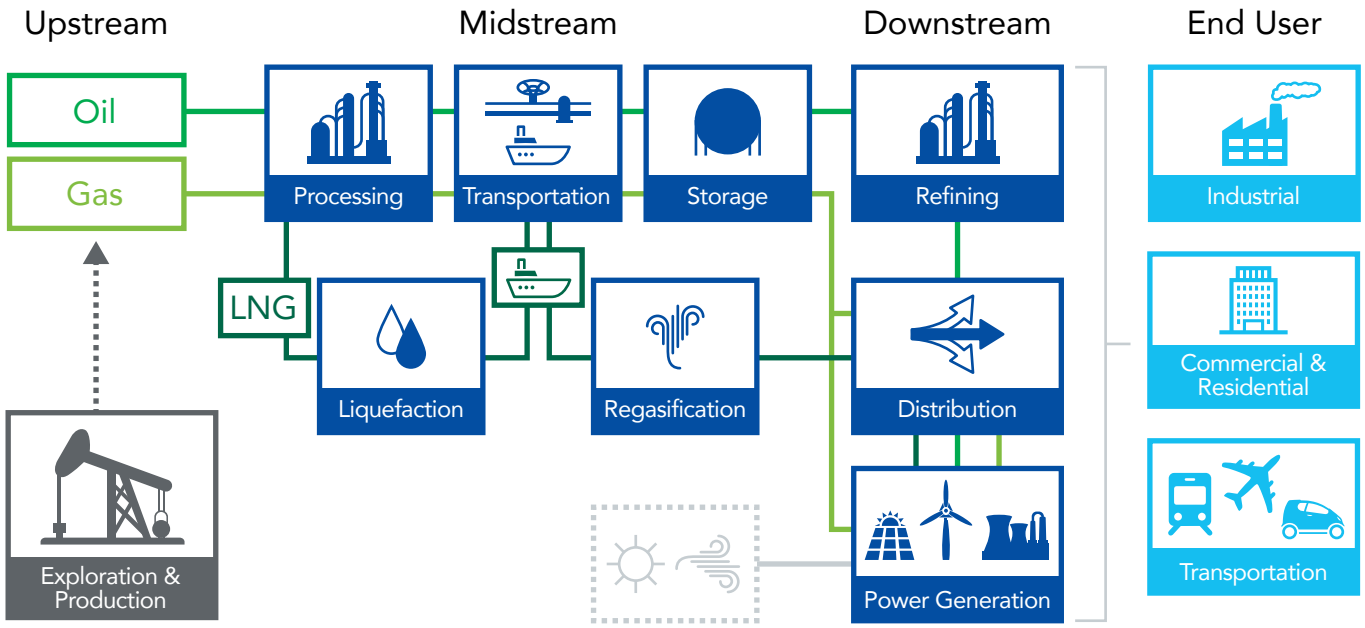
The energy transition is pushing utilities and other large energy companies to unbundle, changing from vertically integrated enterprises operating in multiple segments of the value chain to more focused models. They need to adapt their core businesses to a world of changing power sources, lower prices for oil and gas and greater energy efficiency. With revenues subject to volatility, they are selling non-core assets so they can reinvest in growth businesses.

For the energy majors, this means divesting pipelines, terminals and other assets, as in BP's sale of some its pipeline assets in 2017 and Shell's spinoff of Shell Midstream in 2014. As for utilities, the pressure to change has grown especially acute in Europe, where the sector's market cap fell more than €500 billion between 2008 and 2013. According to E&Y, global utility M&A totaled $200 billion in 2017, an eight-year high.

Much of the energy infrastructure in developed countries—some of it owned by large companies, some of it held in other structures—is due for replacement. Nearly a third of the U.S. generating fleet is more than 40 years old, as the chart to the left shows. More than half of the U.S.'s gas pipelines were constructed before 1970, according to a 2016 report from the Pipeline and Hazardous Materials Safety Administration.

Opportunities across the value chain

Energy value chain



Source: BlackRock, 2018

The energy and power world is broadly divided into three sectors. The upstream sector generally refers to activities around energy exploration and production. The midstream sector comprises activities involving the transportation, storage and wholesale supply of energy and power, while the downstream sector refers to activities around refining and processing of gas and oil, generation of electricity, and the marketing and distribution of these outputs. See the chart above.

All these activities are capital-intensive, and they offer opportunities for multiple types of investment. For example, debt investors have long provided project finance for midstream projects. Private equity investors provide higher-risk capital in the upstream part of the value chain and finance buyouts of energy companies. Venture capital investors may fund companies developing new energy technologies. The public capital markets are an active source of finance for utilities and master limited partnerships holding midstream infrastructure such as pipelines. Public markets also provide capital for yieldcos, dividend-oriented companies that hold power generation assets usually spun off by a development sponsor.

Given this variety, there's no general consensus on the characteristics that define an energy infrastructure investment. In our view, they are the same traits that make assets in other sectors infrastructure investments. We define energy infrastructure assets as hard assets with long-term revenue stability, controllable expenses, a conservative capital structure (typically including long-term, fixed-rate, amortizing debt) and good visibility on long-term cash flows.

In practice, the ability of a particular asset to meet these criteria depends largely on its degree of exposure to the main risks in the energy and power sector. Among these key risks are exposure to commodity prices, the possibility of regulatory change, and country and counterparty risk.

Continued on page 8

MKTG0618U-490624-1630928

The global LNG buildout

A massive amount of infrastructure is required to support the global mobility of natural gas. Much of it will facilitate the growing trade in liquefied natural gas (LNG).

A quick walk-through of a generic LNG value chain indicates the scale of the need. Start with a cubic foot of natural gas produced in the U.S, Australia or the Middle East. That gas will be delivered to a large transportation pipeline and routed to an end-user market or a processing facility. If it is designated for export, the natural gas will be delivered to a liquefaction facility where it will be cooled to -260 degrees Fahrenheit to get it to a liquid state that is 600 times denser than its gaseous form. Such liquefaction facilities can cost up to $2 billion each.

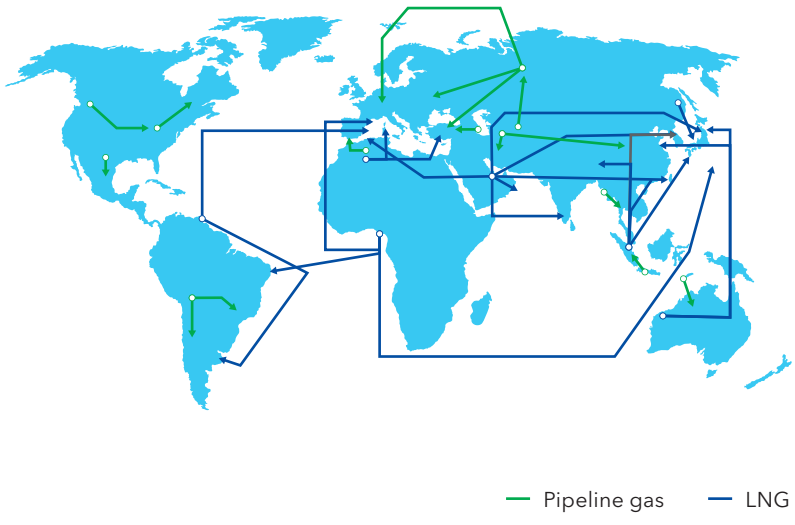
The liquid gas is then transported onto a specialized LNG tanker, which alone carries a capital cost of around $200 million. The LNG tanker will connect with a regasification facility (either offshore or land based, with a capital cost of around $500 million), where the gas will be returned to its natural state before being transported to another pipeline system for delivery to its ultimate customer such as a power plant, industrial user or retail consumer

The costs for all the components of this single, hypothetical value chain would be in the tens of billions of dollars, and LNG demand projections suggest that the potential real world need is many times that. World liquefied natural gas (LNG) imports are projected by IHS Markit to more than double by 2040, with Asia showing the biggest growth.

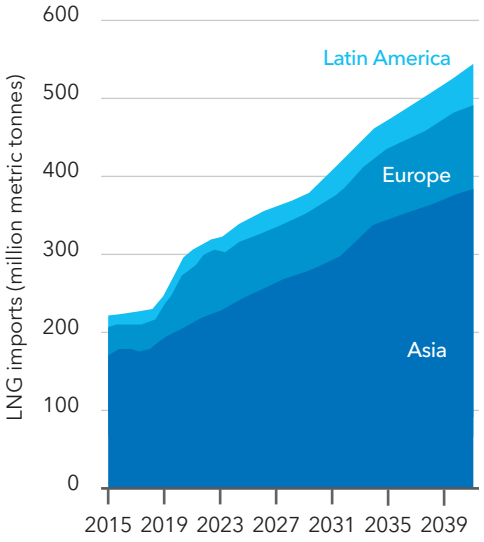
The U.S. is just beginning to build its export infrastructure. It currently has only one operational LNG export terminal, but five more are under construction and expected to come online by 2019. On the import side, a September 2017 report in the *Nikkei Asian Review* estimated that East Asia needs $80 billion in investment by 2030 to build the infrastructure required to keep pace with anticipated LNG demand.

Rise of a global commodity

Major trade movements of natural gas in 2016



Projected global imports of LNG



Sources: BP Statistical Review of World Energy 2017, CISStat, FGE, MENAgas, IHS Markit

What follows is an overview of the infrastructure opportunity set in the primary segments of the energy value chain. As in most other infrastructure sectors, there is currently a large amount of capital seeking investments, exhibiting a wide range of risk tolerances and creating some uncertainty around appropriate risk/return targets. See *Extracting returns in private markets* from the BlackRock Investment Institute, 2017, and *Global real assets outlook*, 2018. Such ambiguity inevitably impacts pricing and investment terms. Given the global scope of the energy transition and the regional variations within it, however, we believe it's still possible to source attractive investments of various kinds. Here, our main focus is on investments in the middle of the risk/return spectrum where commodity price risks can be largely mitigated, putting most upstream investments outside the scope of our discussion.

Midstream

Segment snapshot

Midstream assets handle transportation, storage and processing, with the central mission of moving hydrocarbons and electrons from the source of production to refineries and downstream distributors. Asset types include gas gathering and processing facilities, pipelines, rails, barges, tankers and storage and export facilities.

There are multiple models for building and operating assets in this diverse segment. In general, the owners of these assets would prefer to be paid based on take-or-pay/fixed fee contracts and/or throughput-based arrangements. Many customers, however, prefer percentage-of-proceeds contracts, where the midstream asset owner is more exposed to commodity price and volume risk.

Many midstream assets have the ability to grow revenues, and this often figures into strategies. For example, a contracted anchor customer can provide a revenue base and a minimum return on investment for the owners of a new local gas pipe. Once the pipe is operating, the owners then have an opportunity to add more customers and revenue.

Financing needs

As new resources are tapped in new locations, substantial new additions to the network of pipelines, storage, and other facilities are needed. In the U.S. and around the world, there's a major need for new midstream infrastructure to transport and process oil and natural gas, in support of growing domestic demand as well as global trade in LNG. The U.S. trade association INGAA, for example, estimates the financing need for North American midstream natural gas infrastructure by 2035 to be between $447 billion (their low case) and $597 billion (their high case). Restructuring and balance-sheet management by large energy and power companies—related to oil, gas and electricity—also help to make this an especially active segment.

Increasing LNG demand has led to a spike in capital investment throughout the entire midstream sector, including storage, pipelines and export/import terminals. There's activity on nearly every continent, with the U.S., the Mideast and Australia the most active. On the restructuring front, energy companies are now outsourcing the construction and operation of new pipelines as well as divesting older ones. Some new pipelines are needed to transport U.S. shale oil, much of it currently moved by truck or rail.

Investment dynamics

Counterparty risk is especially important in midstream investing. Unlike the power segment, where off-take contracts are typically with governments or highly rated utilities, midstream counterparties may be medium-size and are often exposed to commodity prices. Investors need to understand a counterparty's financial profile, assets and other relationships, bearing in mind the adage that "the counterparty of my counterparty is my counterparty." Understanding a counterparty's economic position related to their own exploration and production activity (i.e., production costs and "well economics") becomes an important diligence item for midstream investors. A highly rated anchor counterparty for a project is much to be desired, but that, in turn, means a different balance of power in negotiating whether the contract will be take-or-pay or percentage-of-proceeds. As in other asset classes, an investor can sometimes require more favorable terms in developing markets.

Power generation

Segment snapshot

The power generation segment comprises infrastructure for the generation and transmission of electrical power from fossil fuel, nuclear and renewable sources. Generation assets employ a variety of revenue models, from fully contracted, where the power is pre-sold for a set term to a government, a utility, or a corporate user, to generating power for sale on a "spot" basis at prevailing power prices. Other revenue sources may include the sale of renewable energy attributes (via tags or certificates) and the provision of ancillary services that ensure reliability and support the transmission of electricity from generation sites to customer loads.

Some models may entail input price risk—exposure to changes in the price of the fuel used to generate the power. Where input price risk exists, it is sometimes mitigated by cost-plus power-purchase agreements pegged to the price of the input.

Financing needs

Construction of renewable and gas-fired generation capacity, along with extensions or modernization of transmission infrastructure, are the overarching trends. In a 2017 report Bloomberg New Energy Finance (BNEF) forecast $804 billion of new investment in global gas-fired generation, as well as $2.8 trillion of investment in solar and $3.3 trillion of investment in wind, by 2040.

The regional backdrops for this investment vary considerably. In the U.S., retiring coal plants are the main driver and gas is playing a major role in replacing it. In Europe, it is mainly nuclear capacity that is being phased out, and with gas prices higher than in the U.S., new capacity is dominated by renewables. Over time, though, Europe is expected to use less coal and more gas. In Latin America, hydropower produces more than half of all electricity, but with most suitable rivers already dammed, the additional capacity needed by growing economies is coming from renewables as well as gas, which the region has in abundance. China, working to wean itself from coal, is looking to gas, renewables and nuclear.

Investment dynamics

In Europe, long-term contracted renewable projects are aggressively sought by local capital and usually most suitable for income-oriented core infrastructure strategies. In Latin America and developing Asia, where there's an urgent need for generation capacity, gas and renewables projects may offer opportunities for investors wishing to target capital appreciation as well as income.

For transmission investments, the picture is mixed. In the U.S., an outmoded, state-based regulatory framework presents obstacles in many though not all cases. Around the world, the need to adapt grids to a future of decentralized generation creates both opportunities and hurdles. In the right settings, development of transmission assets may potentially provide attractive opportunistic returns, and long-term ownership of them may potentially produce stable core returns.

Political risk, always a consideration, is usually higher in developing markets. In developed markets, power purchase agreements with 20-year terms, once the norm, are becoming harder to achieve; ten- or eight-year terms are becoming more typical, and investors need to consider whether they will be sufficiently rewarded within the shorter contract life to make the investment worthwhile.

Regulated utilities

Segment snapshot

Regulated utilities are involved in providing electricity or gas to a designated market, subject to the oversight of a regulatory body. They may operate in only one or in several parts of the value chain. For example, whereas in

MKTG0618U-490624-1630928

some markets a single electrical utility may handle both generation and transmission, in others the roles are split. The regulator generally sets prices, and in return the utility usually enjoys a monopoly or quasi-monopoly. Performance of regulated utilities tends to be relatively resilient, regardless of the ups and downs of the economy, due to the essential nature of the services they provide.

Financing needs

Although regulated utilities tend to be either state-owned or large companies with substantial balance sheets, private capital is being put to work in a number of areas. Activities include private-equity style buyouts of larger regulated utilities that need restructuring; roll-ups of smaller utilities that need scale; and the construction and operation of regulated transmission lines or pipelines that bring resources to areas that weren't previously served. An increase in natural gas supply, for example, may lead to demand for new pipelines to deliver it to customers for electricity production, industrial use or heating.

Developing countries may need new power lines to serve areas experiencing population growth, and developed markets are seeing privately financed (non-utility owned) transmission lines that connect new renewable resources to high demand markets. Wind power growth in Texas, for example, has been so robust that an $8 billion grid expansion completed in 2016 quickly reached capacity, necessitating further expansion.

Investment dynamics

On the most fundamental level, regulated assets are usually seen as a source of stable cash yield, with the regulatory framework reinforcing the predictability of the flows. An element of capital appreciation may be introduced where there's an opportunity to add customers or, on a larger scale, restructure a company.

Not surprisingly, the key risks are regulatory in nature. In transmission, regulators use various means to control tariffs and improve performance (for example, incentives for avoiding outages) and it's important to understand them. Moreover, both developed and developing markets have seen more than a few cases where investments have been disrupted by regulatory change, often in response to popular or political pressure amid changing economic conditions. Mitigating these risks requires not just a knowledge of the specific regulations, but also of their history and political context—as well as ongoing monitoring of the regulatory picture.

Other opportunities and risks

The scope and complexity of the energy value chain make for a variety of other investment opportunities. As in the segments spotlighted above, we think the most important initial screen to apply is to determine whether they have the long-term stability and other characteristics needed to qualify as infrastructure investments.

Oil refineries, for example, do not typically meet these criteria, mainly because they are exposed to commodity risk. On the other hand, assets used for the collection, movement, and processing of resources may be viable as infrastructure investments. Examples include floating oil or gas storage facilities, tanker ships or other equipment with longer-term contracts from large companies.

As the energy and power transition progresses, we expect that the global policy push for a lower-carbon energy sector, and the evolving business models of energy and power companies, will continue to generate both opportunities and risks. Investment in an oil-related asset—even though it may lack direct exposure to commodity prices—still requires thoughtful consideration of the gradually diminishing role oil is likely to play in meeting future energy needs, lest the asset end up becoming a stranded one. And while gas is a lower-carbon energy source than coal or oil, it has its own set of environmental issues, including the need to better control methane emissions from gathering and processing facilities as well as the high demand for water in the hydraulic fracturing, or fracking process and the cooling of natural gas fired power plants.

In our view, investments in these energy sources can be both environmentally responsible and potentially successful if they are in synch not just with long-term trends, but also with the intermediate steps in the global energy and power transition. In the next section, we take a look at some of those intermediate steps.

The next decade

Change on the scale underway in the energy and power sectors takes time. The major role renewable power now plays in many countries has been years in the making: wind and solar power have been reducing costs and gaining share for nearly two decades. The U.S.-led shale gas revolution, now about a decade old, is at an earlier stage of driving long-run change.

We believe this deep evolution is part of what makes energy infrastructure an attractive area for investment. Yet it's generally easier to identify big trends than it is to make specific decisions about how to invest in them.

Long-range energy and power projections usually present multiple scenarios, spelling out assumptions for each. (See "A note on sources," on page 2). Drivers of the scenarios may include assumptions about economic conditions, government policies and technological change, among other factors. The globalization of natural gas, for example, is unlikely to reverse, but how it unfolds will depend in part on the development of local reserves in countries such as Egypt and Argentina, which will depend, in turn, on other variables. Now a net importer, Egypt will be a net exporter by 2022, according to a 2018 McKinsey report, with Argentina joining the export club soon after.

Investors in energy and power infrastructure need to dig into these details as well as many others before they even get to the specifics of individual investments. Along with taking a view on where things are headed, investors need to think about what might happen along the way.

Policy paths

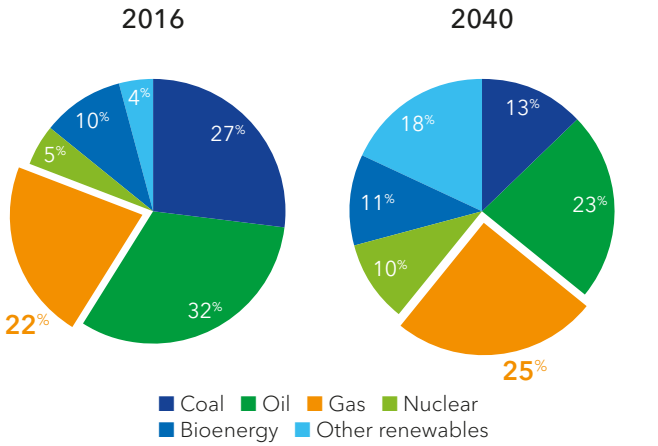
Anticipating what might trigger changes in government policies is especially important. For example, energy-hungry countries such as India are still comparatively receptive to coal-fired power plants, but coal's environmental costs—and in particular, its negative impact on water quality—could prompt restrictions in years to come, giving natural gas and renewables an additional boost.

U.S. rules on the use of fracking techniques to produce oil and natural gas in shale formations also bear watching. Fracking opponents cite possible threats to water quality as well as fracking-related seismic activity in Oklahoma and elsewhere. If major restrictions on fracking were implemented, the supply of natural gas would be limited, prices would rise, and even infrastructure assets that had mitigated commodity price risk could suffer.

Our view is that while regulation of this still-new activity will doubtless evolve, the overall record is positive and major constraints in the U.S. are unlikely. It helps that shale gas extraction is making a strong economic contribution to several states and has been welcomed by prior U.S. administrations as well as the current one (even if they disagree on specifics). The Sustainable Development Scenario of the International Energy Agency's 2017 *World Energy Outlook*—which assumes the most ambitious carbon controls—still projects natural gas as the largest global energy source in 2040. See the chart below.

Gas to the forefront

Projected global primary energy demand—Sustainable Development Scenario



Source: International Energy Agency, *World Energy Outlook* 2017; 2016 data as of New Policies Scenario, 2040 data as of Sustainable Development Scenario.

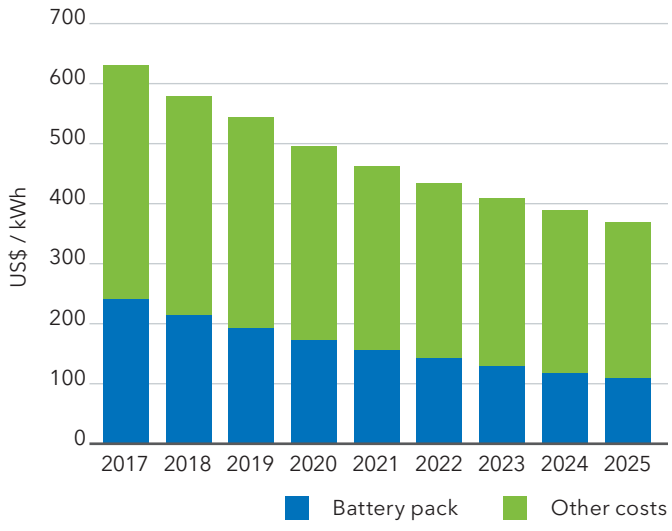
Government policies also play a role in the competition between gas and renewables in some markets—with the competitiveness of renewables depending as well on the pace of cost improvements and progress in developing more flexible grids and utility-scale battery storage.

Renewables have less and less need for targeted government support. According to a 2017 BNEF report, solar power is already at least as cheap as coal in Germany, Australia, the U.S., Spain and Italy. By 2021, BNEF forecasts, solar power will also be cheaper than coal in China and India.

Even so, more than 155 countries have adopted specific policies for renewables-based power, according to the IEA, giving renewables an additional tailwind. A leading example is China, already the biggest renewables user, and expected by the IEA to increase its global share of renewable power production from 15% in 2015 to 20% in 2040. India will become the second largest source of growth by 2030, according to the BP Energy Outlook.

Better batteries, cheaper storage

Projected costs, 2017 – 2025



Source: BlackRock, 2018, using data from Bloomberg New Energy Finance (BNEF), November 2017. Other costs include components such as the energy management system and construction

Progress in improving batteries and storage systems and integrating them into power grids and business models will also help spread renewable power. Government support around the world—including ambitious storage mandates in California and subsidies in Australia, China and elsewhere—is helping to speed development and deployment of batteries. Lithium ion batteries, currently the leading technology, have seen significant cost improvements in recent years, driven mainly by the auto industry's development of electric cars. Cost improvements are expected to continue: BNEF projects a decline of more than 50% in battery costs by 2025. See the chart below.

Deployment of utility-scale battery storage is growing briskly, but from a small base. In the U.S., for example, the U.S. Energy Information Administration reports 722 Megawatts (MW) of utility scale batteries at the end of 2017, most installed within the past three years, with another 69 MW planned for 2018. But this still represents less than 1% of utility-scale generating capacity. Globally, BNEF projects that more than 10,000 MW will be commissioned by the end of this year.

The battery storage picture is multifaceted, and there are varying projections on likely uptake. Batteries themselves account for only about a third of the cost of a storage system; components such as power conversion systems and controllers, along with construction, account for the rest. Grids around the world differ in both power mix and the specifics of the business model, and the fact that storage systems are both suppliers and consumers of power at different times makes for an unusual combination of cost and revenue streams. Some near-term growth may come in behind-the-meter applications—onsite at companies with locations and power-use profiles that make storage attractive. We think progress in storage should be closely monitored for its impact on renewables, and on investment opportunities in grid modernization.

Carbon pricing and emissions trading, which are not yet major factors, present yet another set of variables. Different approaches are already being applied in 42 national and 25 subnational jurisdictions, according to the Carbon Pricing Leadership Coalition. The list includes programs in California, Colombia and China. The European Union emissions trading system launched in 2005—the world's first and largest—has struggled with low prices and excess allowances, according to the Coalition, but reforms may be in the offing.

This is just a sampling of the many factors at work in the global energy and power transition. And even as investors keep an eye on specific technological and market developments, they must also bear in mind the macroeconomic and geopolitical trends that have always affected energy markets.

In sectors so multifaceted and so global, there's no shortage of variables to consider. At the same time, there's little doubt that the transition outlined in these pages is deep, lasting, and in need of a great deal of financing. In our view, this combination of complexity, global variety and capital need amid clear directional change can make for attractive investment opportunities.

Important information

This material is not intended to be relied upon as a forecast, research or investment advice, and are not a recommendation, offer or solicitation to buy or sell any securities or to adopt any investment strategy. The opinions expressed are as of May 2018 and may change as subsequent conditions vary. The information and opinions contained in this paper are derived from proprietary and nonproprietary sources deemed by BlackRock to be reliable, are not necessarily all-inclusive and are not guaranteed as to accuracy. As such, no warranty of accuracy or reliability is given and no responsibility arising in any other way for errors and omissions (including responsibility to any person by reason of negligence) is accepted by BlackRock, its officers, employees or agents. This paper may contain 'forward-looking' information that is not purely historical in nature. Such information may include, among other things, projections, forecasts, estimates of yields or returns, and proposed or expected portfolio composition. There is no guarantee that any forecasts made will come to pass. Reliance upon information in this paper is at the sole discretion of the reader. Past performance is no guarantee of future results. Moreover, where certain historical performance information of other investment vehicles or composite accounts managed by BlackRock, Inc. and/or its subsidiaries (together, "BlackRock") has been included in this material and such performance information is presented by way of example only. No representation is made that the performance presented will be achieved, or that every assumption made in achieving, calculating or presenting either the forward-looking information or the historical performance information herein has been considered or stated in preparing this material. Any changes to assumptions that may have been made in preparing this material could have a material impact on the investment returns that are presented herein by way of example. This material is provided for informational purposes only and does not constitute a solicitation in any jurisdiction in which such solicitation is unlawful or to any person to whom it is unlawful.

In the US, for use with institutional investors. In the EU issued by BlackRock Investment Management (UK) Limited (authorised and regulated by the Financial Conduct Authority). Registered office: 12 Throgmorton Avenue, London, EC2N 2DL. Registered in England No. 2020394. Tel: 020 7743 3000. For your protection, telephone calls are usually recorded. BlackRock is a trading name of BlackRock Investment Management (UK) Limited. In Switzerland, this material shall be exclusively made available to, and directed at, qualified investors as defined in the Swiss Collective Investment Schemes Act of 23 June 2006, as amended. Issued in Switzerland by the representative office BlackRock Asset Management Schweiz AG, Bahnhofstrasse 39, CH-8001 Zürich. In the Netherlands, issued in the Netherlands by the Amsterdam branch office of BlackRock Investment Management (UK) Limited: Amstelplein 1, 1096 HA Amsterdam, Tel: 020 - 549 5200. Dubai DFSA issue: This information can be distributed in and from the Dubai International Financial Centre (DIFC) by BlackRock Advisors (UK) Limited - Dubai Branch which is regulated by the Dubai Financial Services Authority ("DFSA") and is only directed at 'Professional Clients' and no other person should rely upon the information contained within it. Neither the DFSA or any other authority or regulator located in the GCC or MENA region has approved this information.

Issued in Australia and New Zealand by BlackRock Investment Management (Australia) Limited ABN 13 006 165 975 AFSL 230 523 (BIMAL) for the exclusive use of the recipient who warrants by receipt of this material that they are a wholesale client and not a retail client as those terms are defined under the Australian Corporations Act 2001 (Cth) and the New Zealand Financial Advisers Act 2008 respectively. BIMAL is the issuer of financial products and acts as an investment manager in Australia. BIMAL does not offer financial products to persons in New Zealand who are retail investors (as that term is defined in the Financial Markets Conduct Act 2013 (FMCA)). This material does not constitute or relate to such an offer. To the extent that this material does constitute or relate to such an offer of financial products, the offer is only made to, and capable of acceptance by, persons in New Zealand who are wholesale investors (as that term is defined in the FMCA). This material has not been prepared specifically for Australian or New Zealand investors and may contain references to dollar amounts which are not Australian or New Zealand dollars and financial information which are not prepared in accordance with Australian or New Zealand law or practices.

MKTG0618U-490624-1630928

MKTG0618U-490624-1630928

Why BlackRock

BlackRock helps people around the world, as well as the world's largest institutions and governments, pursue their investing goals. We offer:

- **A comprehensive set of innovative solutions, including mutual funds, separately managed accounts, alternatives and iShares® ETFs**
- **Global market and investment insights**
- **Sophisticated risk and portfolio analytics**

We work only for our clients, who have entrusted us with managing $6.31 trillion*, earning BlackRock the distinction of being trusted to manage more money than any other investment firm in the world.

* AUM as of 3/31/18.

Want to know more?

blackrock.com

Lit. No. CNEQ 51717 180615T-0418

BLACKROCK®

MKTG0618U-490624-1630928