IHS QUARTERLY

Q1-2015

GAINING FORESIGHT

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LESSONS FROM EBOLA

PREPARING FOR ALTERNATE FUTURES

POSSIBLE PATHS FOR RUSSIA

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Q1-2015

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Scott Key
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The fundamentals of foresight

Foresight is defined as the ability to predict the future. Of course, perfect foresight is unattainable. Companies must rely on imperfect information, they can't account for all variables, their analysis is incomplete, and hundreds of other limitations may impede their ability to see beyond the horizon. However, companies can strive to constantly *improve* their foresight by improving the quality and quantity of their data, refining analytical tools, and tapping new expertise. It follows that the better the foresight, the more competitive the company.

In times of heightened uncertainty and risk, such as today, foresight becomes even more elusive. There are more variables to consider and the number of possible "futures" increases. Yet it is in times like these when foresight is most critical to business success.

This issue of *IHS Quarterly* is all about foresight. In *Predictions for the new year*, IHS Chief Economist Nariman Behravesh plots the direction the global economy is likely to take in 2015. He draws on the insights and expertise of over 300 IHS economists from around the world and the data and analytics they use to develop their forecasts.

Heeding the lessons of Ebola examines the social and economic impact of the virus in West Africa as a regional case study for understanding the consequences of a global pandemic. Documenting the factors that led to the most recent outbreak and spread of Ebola, as well as the economic and social consequences, the article provides valuable insight into how governments and businesses must prepare for and respond to a global pandemic.

Similarly, *Where's Russia heading?* explores Russia's actions in 2014, the economic and geopolitical shifts, and the likely trajectory for the country through 2018, when President Vladimir Putin's term ends. The article draws on insight and expertise from three perspectives—economics, country risk, and energy—to tell this complex and nuanced story, presenting two scenarios that could unfold over the next four years.

Then there's *Alternate futures*, authored by Tate Nurkin, IHS Aerospace, Defense & Security. The article details a variety of alternative analysis techniques—such as scenario planning, war gaming, and red teaming—that companies can use to improve their planning and enhance their foresight. Utilized for decades by the military, these techniques are gaining traction in the business sector to help companies deal with risk and uncertainty.

Data, expertise, insight, analytics, tools. The right mix will lead to a clearer vision of the future and, ultimately, to competitive advantage. These elements are the foundation of foresight—and the foundation of IHS.

Unconventional drilling puts mature oil wells back in play

Oil companies have a problem—beyond the falling price of crude. It is the dearth of new high-performing oil wells around the globe.

The rate of oil discoveries was down again in 2014, after a near-record low in 2013 when only 13 billion barrels of oil equivalent were found—without a single billion-barrel oil field among them. With discoveries thinning out, oil producers face an age-old problem: new, profitable wells are in decline just as the financial resources needed for increased production are on the rise.

A potential solution for producers, which bypasses the uncertainty of making new discoveries, is to boost production from existing wells. Average recovery rates in conventional wells worldwide hover around 34%, meaning that two-thirds of all discovered oil remains untapped.

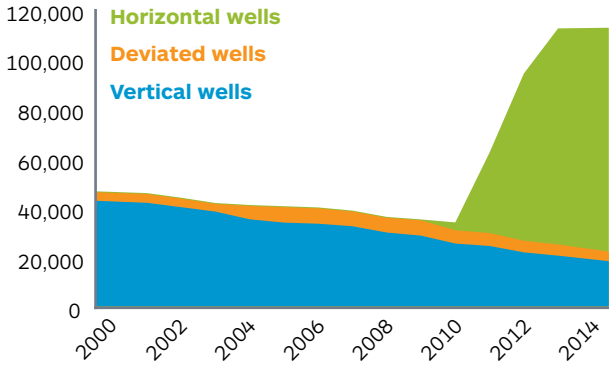
To that end, producers are turning to hydraulic fracturing and horizontal drilling to increase output from low-productivity conventional wells—and seeing substantial increases in recovery rates. Between 2010 and 2013, roughly 400 mature conventional plays in the United States and Canada were tested with at least one horizontal well. IHS Energy has identified 77 of these plays in which at least 10 horizontal wells have been drilled that have average initial potential rates greater than or equal to 100 barrels per day.

The Canadian Cardium play in the Alberta Deep Basin, for example, has been in production since the 1950s—but with steadily diminishing returns through the first decade of the 2000s. Since 2009, horizontal drilling has increased production from 33,000 barrels per day to almost 114,000, adding 82 million barrels of oil during that time (see figure). The newly energized Cardium is expected to produce 519 million barrels of oil and condensate, 1.6 trillion cubic feet of gas, and 96 million barrels of natural gas liquids by 2036, with most of that production rolling out by 2020.

The diversity of the formations, ages, and geologic settings of the North American plays that have been successfully revitalized with unconventional techniques suggests that these methods are applicable to over 2,000 low-productivity conventional plays worldwide. And because these plays have existing infrastructure, the uptake outside North America should be faster—and more economical—than for unconventional wells.

Horizontal wells are reviving conventional plays in North America

Barrels of oil per day produced in the Canadian Cardium play in the Alberta Deep Basin, 2000–14



Source: IHS

The potential for additional oil recovery via unconventional techniques is massive. If horizontal drilling and hydraulic fracturing alone, or combined with other enhanced recovery methods, can boost global conventional oil recovery rates even by 10%, up to 600 billion additional barrels could be produced. Since world production to date is just over one trillion barrels, that would be akin to the "discovery" of reserves totaling 60% of all world oil production over the past 150 years.

By Stephen Trammel, director, unconventional, IHS

on.ihs.com/StephenTrammel

For more information, visit ihs.com/Q21MatureWells

Integrated stock markets at forefront of Pacific Alliance

The Pacific Alliance is a regional integration initiative that Chile, Colombia, Mexico, and Peru formed in 2011. Costa Rica and Panama are also seeking membership. The alliance's main objective is to deepen economic integration among member states by enhancing free circulation of goods, services, capital, and people. The member states are also negotiating a free trade investment treaty. When fully ratified—potentially by the end of 2015—the Pacific Alliance will establish a tariff-free market for 214 million people with a total GDP of US$2.2 trillion. The new trading bloc will be about 70% the size of Mercosur (see figure). Approximately 92% of trade will be liberalized immediately and the rest gradually, with trade likely to increase among member states in many industries, including oil, petrochemicals, automobiles, financial services, and telecoms. Thirty-two countries have taken up observer status with the treaty, including China, Germany, India, Japan, Singapore, South Korea, the United Kingdom, and the United States.

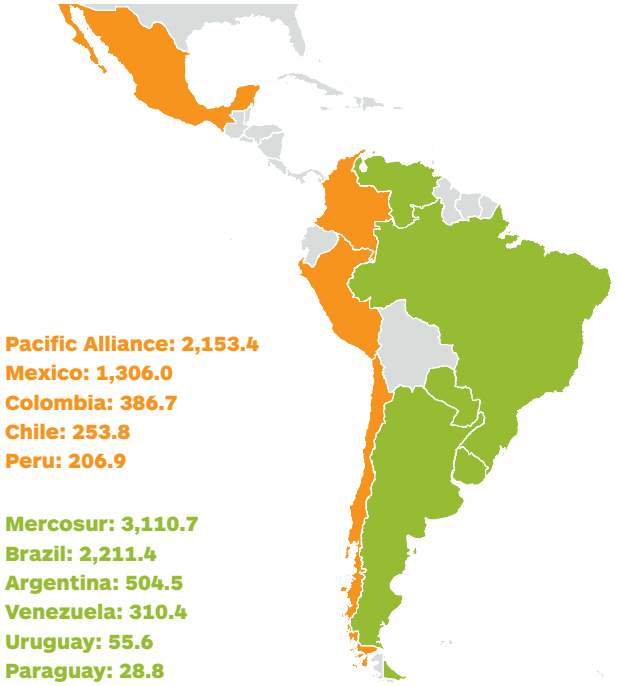
One area where progress has already been made is the co-ordination of the stock markets of the member states. Under the Latin American Integrated Market (Mercado Integrado Latinoamericano: MILA), common platforms allow trading in stocks and expand access to investment capital among Chile, Colombia, and Peru. The Mexican stock exchange is in the process of joining MILA.

The Pacific Alliance's guiding principles differentiate it from other regional blocs, notably the Bolivarian Alliance for the Peoples of Our America (Alianza Bolivariana para los Pueblos de Nuestra América: ALBA), which view such trade and market openness as likely to retard economic development. The Pacific Alliance has no headquarters, secretary-general, or independent budget and will operate through high-level summits. This lowers the risk that economic integration will become bogged down in arguments about the composition, control, and functioning of a centralized authority.

If the Pacific Alliance is to play a meaningful role in attracting investment and encouraging economic development, member states' current governments must drive progress. Peru is the only existing member that faces a presidential election before 2018. Current leaders therefore have a better chance to deliver regional integration compared with some previous initiatives that floundered.

Mercosur comprises bigger market, although Pacific Alliance has better political risk outlook

Country GDP comparison as of 2013 (US$ billions)



Source: IHS

Another key goal of the alliance is to achieve economic integration with countries in the Asia-Pacific region. However, with a plethora of existent bilateral deals and the nascent US-driven Trans-Pacific Partnership, there is little prospect of a Pacific Alliance/Asia-Pacific deal within two years. For example, Chile has free trade agreements at different stages of completion with China, Japan, South Korea, and Thailand.

By Laurence Allan, senior manager, Americas, IHS Country Risk

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‘Media buys’ help the Islamic State gain South Asia foothold

The Islamic State has shown considerable savvy in its use of social and online media to attract attention and converts as it has waged terror in Iraq and Syria. Moreover, the group has used these platforms to help it eclipse Al-Qaeda in notoriety and influence since the two groups formally split from each other 11 months ago.

With the international forces pullout from Afghanistan in December 2014—and the expected freeing-up of militants to carry out operations in India and Pakistan—the Islamic State is now buying up former Al-Qaeda media outlets in South Asia as it seeks to establish primacy among jihadist groups in the region. And it is using revenues from black-market sales of oil from areas under its control to fund these ventures (see figure).

Traditionally, the Global Islamic Media Front, one of the oldest English-language jihadist media houses, Ansarullah Media, and Bab-ul-Islam online forums have been controlled by Al-Qaeda or its affiliates—the latter two becoming umbrella media organizations for jihadist news because of their capacity to cover content in multiple languages, including Arabic, Bahasa Bangla, English, Pashto, Russian, Turkish, and Urdu. Al-Qaeda leader Ayman al-Zawahiri’s messages and exhortations have always been given priority.

In recent months, these sites have all drifted toward Islamic State content, to the almost total exclusion of Al-Qaeda or Tehrik-e-Taliban Pakistan (TTP) coverage. Notably, al-Zawahiri’s announcement of the formation of an Al-Qaeda branch on the Indian subcontinent received no coverage on these sites.

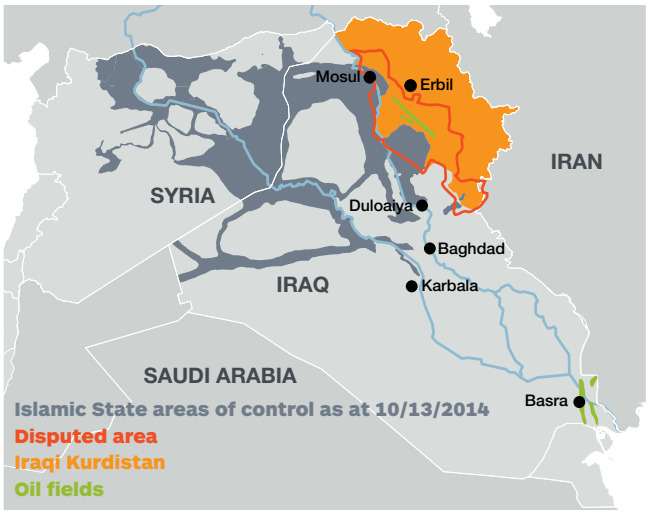
The Islamic State has greater financial strength than Al-Qaeda and the TTP, allowing it to offer militant factions and their media operations large sums of money to switch allegiances. The Karachi-based Tehreek-e-Khilafat has already publicly switched its loyalties. Social media monitoring indicates that Omar Khalid Khurasani, the deposed head of the TTP’s Mohmand Agency chapter, has entertained offers from the Islamic State and is likely to swear allegiance to them.

While, for now, it is unlikely that the Islamic State will be able to support such branches with material resources beyond money, obtaining the loyalties of these groups provides the Islamic State with an operational foothold in South Asia that could see these groups change their operational focus.

Ultimately, the groups may modify their target patterns to bring them more in line with the Islamic State—focusing on kidnapping Westerners, especially in Afghanistan; attacking Western targets such as hotels and embassies in Pakistan, rather than government forces and institutions; and pursuing high-profile targets in India such as parliament, the stock exchange, and locations where there are large contingents of foreigners.

Islamic State's oil sales fund its media operations

Revenues from the black-market sale of oil from areas under Islamic State control amount to $2 million per day



Source: IHS

By Omar Hamid, head of Asia-Pacific, IHS Country Risk

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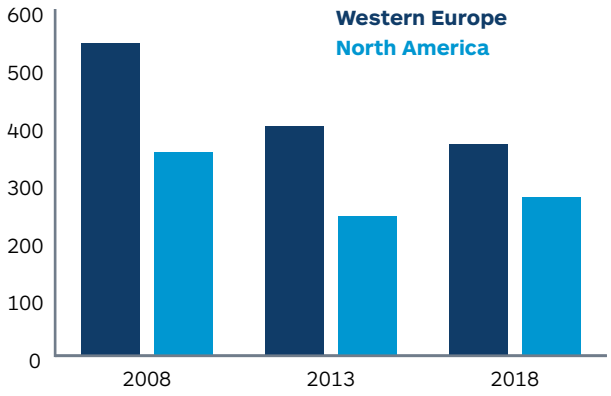
European chlor-vinyl consolidation boosts US export potential

After years of overcapacity, high operating costs, and reduced demand in end-use markets, the European chlor-alkali/vinyls (CAV) industry faces significant consolidation in the near future. EU regulations requiring manufacturers to convert production from mercury cell-based chlorine processes to the more environmentally friendly membrane technology by December 2017, or close down, are accelerating that process.

The CAV sector generates chlorine (as well as caustic soda) that is used to produce chlorinated compounds such as polyvinyl chloride (PVC), which is heavily utilized in construction industry applications such as pipes, windows, and flooring. Since 2008, largely as a result of the slowdown in construction, chlorine demand in Western Europe has declined by 9% and PVC demand by 21%.

North America maintains production cost advantage vs. Europe

Cost per electrochemical unit produced in North America and Western Europe (US$)



Source: IHS

Chlor-alkali production is hugely energy intensive—one plant can consume as much electricity as a small country—and power accounts for approximately 70% of chlor-alkali variable costs. The European sector is at a steep cost disadvantage to North American producers owing to the latter's access to cheaper electricity produced from abundant natural gas and coal. While the US energy cost advantage is forecast to narrow in the next five years, it will remain substantial (see figure). Ethylene production costs in the US are also substantially below those in Europe, which makes both US caustic soda and PVC exportable.

Converting plants to membrane technology—which does not pose any environmental risk of mercury contamination—yields energy savings on the order of 30% per ton of chlorine produced. However, early decommissioning of CAV plants can carry significant asset depreciation and investment costs—as well as remediation expenses. The payback time from the energy savings accrued following conversion is typically many years.

As a result, some portion of the 22% of European plants that now employ mercury cell production will be closed rather than converted to membrane technology. IHS projects that 1-2 million metric tons (mt) of chlorine capacity, and a similar amount of caustic soda production, could be lost by 2018. Merger and acquisition activity is also likely.

Major changes could also be in the offing for the European vinyls sector, as weak operating rates point to significant overcapacity in the market and the potential for capacity/player rationalization. Already, INEOS and Solvay are in the process of creating a joint venture of Europe's top two players. In one scenario developed by IHS Chemical, up to 2 million mt of PVC production could shut by 2018.

The European CAV industry, now characterized by a competitive and diverse marketplace with many producers, is poised for substantial structural change. A smaller, cleaner, more efficient production base with higher industry operating rates is likely to emerge—with capacity reductions in caustic soda, chlorine, and ethylene increasingly offset by imports from lower-cost producers in the US and Middle East.

By Stein Raae, global business director, chlor-alkali/vinyls, IHS Chemical

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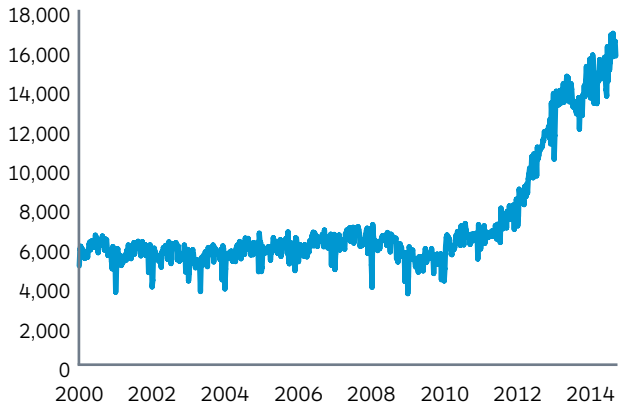
US railroads ride the shale oil boom

With coal use by US utilities in decline in recent years, the nation's railroads faced significant headwinds. Where coal once comprised over 40% of rail carloads, its share of rail traffic has dropped to nearly 30%. To offset that decline in tonnage, rail companies have begun capitalizing on the very sector that is undermining the coal industry: unconventional energy.

Petroleum rail traffic is up 150% since 2011, as crude oil from unconventional plays in Texas, Colorado, and North Dakota is moved by rail tanker cars to East Coast and Gulf refineries (see chart). Rail transport is required because sufficient pipeline infrastructure has yet to be built in these areas. Other materials used in the oil extraction process, such as fracking sand, are also being transported in bulk via rail.

Petroleum traffic on US railroads has more than doubled since 2011

Weekly carloads of oil and petroleum products, 2000-2014



Source: Association of American Railroads

Rail's movement into unconventional energy is not only influencing traffic, but also equipment purchases. Tanker cars comprised roughly 50% of the rail cars delivered in 2013, according to IHS, which expects similar production levels for 2014. Covered hoppers are also in high demand for their ability to transport fracking sand and other extraction materials. These two sectors are virtually alone in showing strength in the rail car industry, with most other rail car types exhibiting little or no growth.

While this activity has been good for rail companies and certain of their rail car suppliers, it has been causing headaches throughout the supply chain for other industries that ship commodities via rail. For example, Midwestern farmers shipping corn, wheat, and soybeans to market compete for rail space with shippers transporting crude from the Bakken shale play in North Dakota. Coal shipments to utilities are also potentially impacted by the explosion in petroleum freight on the rails.

Grain, ethanol, and coal producers are among those who have expressed concern to federal regulators over idled freight and delayed shipments, which they claim are the result of the burgeoning petroleum rail traffic. Their only recourses, they contend, are to slow production, store additional inventories on-site, or use alternative modes of transportation, such as trucks—all of which cut into profit margins.

To address the issue, the Surface Transportation Board, which oversees the rail industry, has requested that railroads provide greater transparency of operations, including weekly data on the number and types of rail cars en route, their average speeds, and other performance metrics. Freight railroads, which are built and maintained largely with private capital, are also under pressure to speed the buildout of new lines to accommodate the increase in demand.

Undercapacity in the rail system will not be resolved overnight. As winter set in, rail shipments of goods—from farm products to autos, chemicals, coal, and oil—were being watched closely for delays and other setbacks. The industry's performance may well determine the speed with which this increasingly valuable infrastructure is upgraded.

By John Scholle, senior economist, pricing and purchasing, IHS Economics

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Drug companies face challenges to expanding tiered pricing

Tiered drug pricing—in which pharmaceutical companies charge different prices across markets and market segments—is poised for expansion into the treatment of non-communicable diseases (NCDs). Already applied widely in the pricing of drugs that treat communicable diseases, such as HIV/AIDS and hepatitis C (see figure), it may soon be used in emerging markets to price medicines that treat conditions such as cancer and even rare diseases.

Similar to Apple's global product pricing model, tiered pricing strategies establish higher prices in affluent, developed markets and lower prices in poorer (even poverty-stricken) markets. On the surface, it appears to be a "win-win," expanding market penetration for drug companies as well as access to medicines for patients in emerging markets.

However, despite the adoption of sophisticated tiered pricing strategies by drug companies around the world, there is currently only a tenuous correlation between the prices of pharmaceutical products and the local economic conditions of the countries where they are launched. Recent IHS research reveals that drug prices are related to movements in purchasing power parity across different countries, but the correlation is small and generally confined to medicines that treat large patient populations.

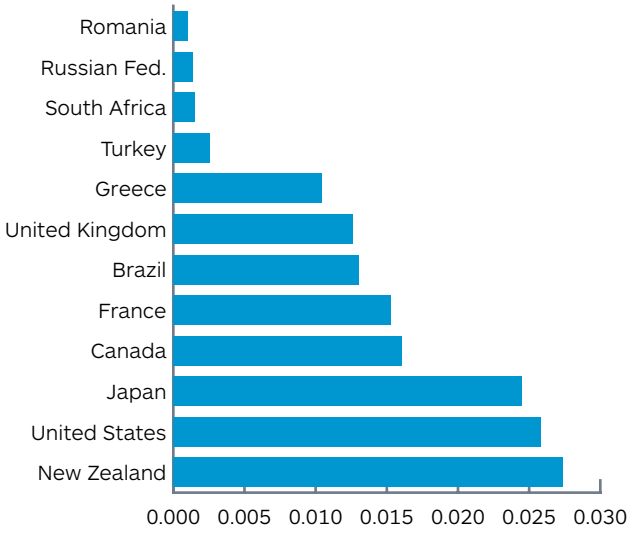
The pharmaceutical industry faces a number of challenges to successfully implementing tiered drug pricing for NCDs, including:

- Opportunistic payer behavior, wherein governments in advanced markets incorporate into their thinking—even if only informally—the prices of drugs in poorer economies during price negotiations.
- Product leakage, arbitrage, and the diversion of drugs intended for the public sector to private markets where they are sold at a higher price.
- Accepted practices that encourage homogeneous pricing rules in countries with heterogeneous populations and widely varying income distribution and public health care coverage.

The established economic indicators used for global tiered pricing strategies—GDP and GNI at purchasing power parity—are crude measures of affordability that do not account for intra-country income disparities. In out-of-pocket markets, for example, tiered pricing strategies generally cater to the top 20% of the income pyramid, with little access for lower-income segments.

Developing markets may pay substantially less for drugs than advanced economies

Mean price per milligram in selected countries for Stocrin, used to treat HIV (euros)



Source: IHS

Going forward, drug companies will have to balance demands from shareholders for return on investment against those from developing countries and non-government organizations for affordable access for lower-income patients to drugs that treat serious, life-threatening, often chronic diseases. Because these drugs have large market potential in both developed and emerging markets, a global policy consensus will be required to prevent global price erosion.

By Gaelle Marinoni, manager, IHS Life Sciences

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For more information, visit ihs.com/Q21DrugPricing

Ship glut portends continued low freight rates, consolidation

Prospects for the global shipbuilding industry in 2015 do not appear overly positive. With an already large order book in the three major merchant ship sectors—bulk carriers, containerships, and tankers—there appears little opportunity for shipyards to increase their relatively low, and in many cases unprofitable, prices as new orders decline.

Confirmed orders in Q3 2014 were down 30% from year-earlier levels, while the number of new contracts during the final quarter of 2014 was expected to be significantly lower than Q4 2013 (see chart).

In the midst of the current extended period of low freight rate earnings and significant hidden overcapacity caused by slow steaming, incentives for ordering new ships are becoming fewer in spite of efforts by national agencies in Asia to prop up ailing shipbuilders by either government aid or highly competitive credit terms in order to win new business. In addition, the significant boom in private equity financing for new ships that took off beginning in mid-2013 appears to have stalled at a time when conventional ship financing has become increasingly hard to come by.

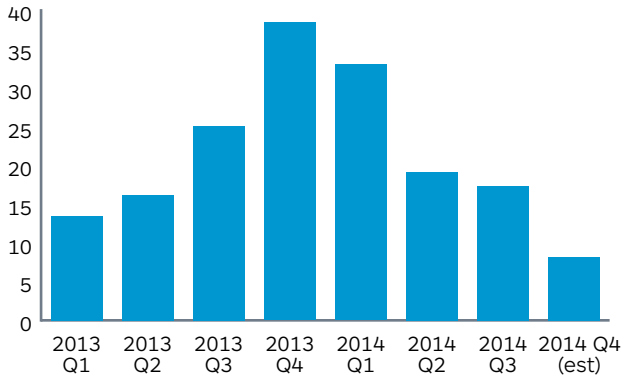
Meanwhile, the major shipbuilding groups in China and South Korea are focusing their marketing strategies on other vessel sectors, particularly those in liquefied natural gas (LNG) and liquefied petroleum gas (LPG). This sales strategy could in turn create further overcapacity in the gas shipping sectors over the longer term should an expansion of speculative ordering take place.

Against this backdrop, shipbuilders will likely be forced to consolidate in order to survive. This situation is already evident in the recent announcement by Hyundai Heavy Industries, the world's largest shipbuilder, to combine various back-office and sales functions with its affiliated shipyards Hyundai Mipo and Hyundai Samho.

In addition, yards will be forced to lay off contractors as order books start to thin out. In China, state support is now being provided to only the most efficient shipbuilders; backing of small- and medium-sized shipyards has been withdrawn.

Declining newbuild orders spell hard times for shipyards

Global new shipbuilding orders by quarter, 2013-2014 (millions of gross tons)



Source: IHS

Once the global order book thins, owners and operators are expected to return to the newbuilding market in late 2015/early 2016 to maintain market competitiveness. This is likely to lead to continued pressure on shipowners' earnings.

A consequence of this likely behavior is potentially a long-term era of low freight rates. While this would benefit shippers, it would result in lower service levels, in particular in the container liner trades.

By Robert Willmington, manager, data transformation, IHS Maritime and Trade

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For more information, visit ihs.com/Q21ShipBuilding

The destabilizing effects of lower oil prices

The oil cycle has peaked after sustained high prices made large volumes of new oil production economic to develop.

An underlying market imbalance has arguably existed for two years but was masked by temporary production outages in Libya and other countries. While the return of Libyan production in June 2014 coincided with the Islamic State's attack on Mosul, the many and continuing geopolitical risks were soon overshadowed by the realities of weakening fundamentals. By December, the US benchmark West Texas Intermediate was trading at five-year lows.

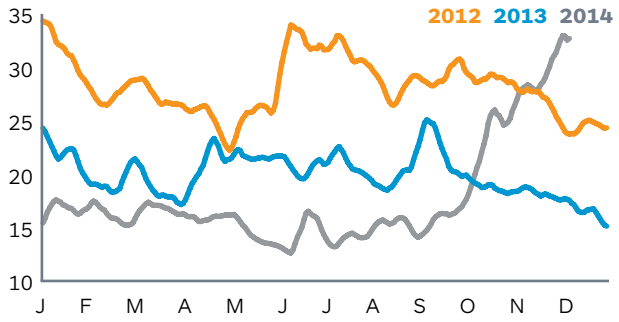
Compounding the oversupply issue is the Organization of Petroleum Exporting Countries' (OPEC's) November decision to maintain current production for now, even as its own balances suggest the need for a substantial production cut. The cartel still holds the potential to roil markets with a cut, and its sudden embrace of the free market to solve the supply issue is inherently destabilizing not just for markets but for the industry and national economies. IHS believes this price decline is not finished, and volatility will remain well above the low levels of 2013 and early 2014 (see figure).

With OPEC set to maintain production levels for the near term, the best chance for halting the price decline will likely come from US shale oil producers—as declining production rates from new shale oil wells, and a reduction in investment and drilling, will make it difficult to maintain prior growth levels. On the other hand, while drilling permits and capex plans have been cut, factors such as hedging, known sweet spots, and improved techniques such as super fracking will make US shale oil partially resilient to low oil prices—at least for a time.

Lower oil prices also create challenges for some OPEC countries and other big exporters—particularly those with weaker fiscal circumstances—as their revenues and foreign-exchange reserves decline. This may force cuts in social spending in some of these countries, increasing unrest and potentially causing production outages, which in itself would quickly increase prices.

Oil price volatility outlook soared in Q4 2014 as oil prices continued dropping

Historical implied option volatility (%), second-month futures (7-day moving average)



Source: Bloomberg

A positive impact of lower prices is cheaper fuel for consumers. While this will not translate directly into increased oil demand, it will help boost economic growth, the key driver of energy demand. Many consumers, mindful of price swings since 2007, will likely be slow to make lifestyle changes to fully take advantage of lower prices.

The destabilizing effects of a lengthy downturn could continue for many years as consumers and companies find their footing in this new era. Eventually, however, reduced investment in long-lead projects will create much tighter balances, leading to substantially higher oil prices.

By Jamie Webster, senior director, IHS Energy

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For more information, visit ihs.com/Q21OilPrices

A rising tide does not lift all boats

Since the Great Recession, US labor has seen an uneven recovery, as industries transformed themselves to adapt to the new economic realities. We hear much about new jobs created, but we hear less about how jobs are changing, specifically which occupations are needed and which are not. The lessons from these transformations can provide insights into sector-wide business strategies over the next few years.

By Doug Handler

Shutterstock

Manufacturing employment in the United States has taken a beating since the Great Recession, with the vast majority of the pain endured by blue-collar workers.

Between 2008 and 2013, total US manufacturing employment fell by 1.7 million, or about 14%. By occupation, production workers accounted for about 1 million, or nearly 60%, of the decline. Other blue-collar occupations, such as maintenance technicians and truck drivers, accounted for another 400,000, or about 24%. White-collar workers, on the other hand, accounted for the remaining 300,000, or just 18% of total manufacturing job losses.

Between 2008 and 2013, average salaries grew at a 1.7% annual rate. Blue-collar salaries, however, grew by only 1.5%, while white-collar salaries grew by 2.1%. About 70% of white-collar jobs were in science, technology, engineering, and math (STEM) occupations.

These trends did not apply evenly across manufacturing sectors during this period; employment levels and the share of employment by occupation both varied, as did wage and salary growth rates. Drilling down in a few capital-intensive sectors—energy, automotive, technology, and chemicals—provides insight into employment trends and projections for the next few years that are masked in the data at the aggregate level.

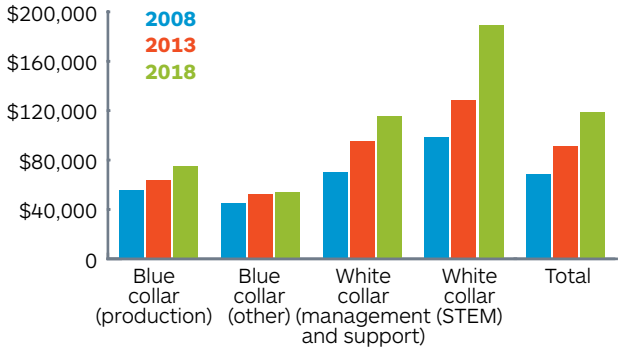
Boom times for oil and gas

The oil and gas extraction industry stands out as a success story in the aftermath of the global recession. The industry enjoyed a healthy employment rebound between May 2008 and April 2013 due in large part to the strong growth within the US unconventional oil and gas sector. Total employment over the five-year period grew at an annual rate of 5.2%, while output increased at a 5.8% annual rate. With the output-per-employee ratio holding relatively steady, there were no material productivity gains during the period.

Still, this was an era of innovation in the unconventionals sector, requiring significant investment in new technology and physical capital, which in turn required a different type of worker than the conventional oil and gas sector. US capital spending for mining and petroleum infrastructure

Average salaries in the US oil/gas sector are forecast to rise 5% per year; STEM workers see biggest gains

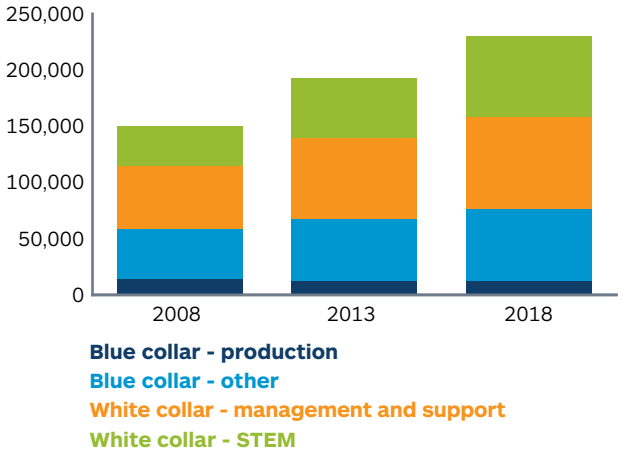
Average salaries in the US oil/gas extraction industry (US$)



Source: US Bureau of Labor Statistics and IHS

White-collar workers will see the biggest gains in numbers in the oil/gas sector

Number of employees in the US oil and gas extraction industry



Source: US Bureau of Labor Statistics and IHS

grew 67% between 2009—the nadir of the investment cycle—and 2013. STEM professions accounted for the vast majority of employment growth during this period, while the ranks of production workers declined (see chart above).

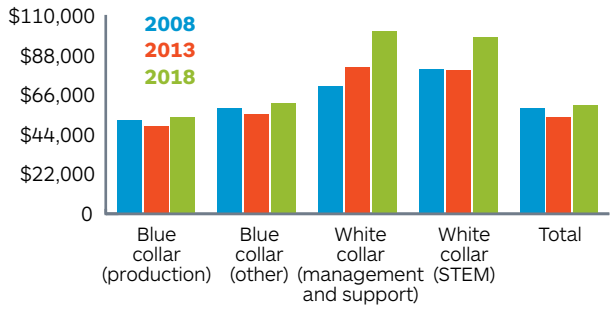
By 2013, there were 53,000 STEM professionals employed in the sector, 30,000 of whom were engineers. This included 18,000 petroleum engineers, whose ranks more than doubled from 8,000 in 2008. The second-largest STEM employment gains were among geoscientists, whose ranks swelled from 5,800

in 2008 to 9,000 in 2013. STEM employment growth over the five-year period totaled 51.2%, and STEM employment's share of total workers increased by about 4 percentage points to 27.6%. Countering this growth, the ranks of production workers fell from 9.4% of the total in 2008 to 6.5% in 2013, which translates to a contraction in relative size of the production worker labor force of nearly one-third—in just five years!

In assessing labor costs as companies plan for future growth, it is important to consider the impact on *cost of labor* from the strong demand for energy STEM professionals and the shifting *mix of labor demand*. For example, if the mix of labor had remained unchanged between 2008 and 2013, the industry's overall average labor cost would have increased by 5% per year. In reality, though, the mix did change, away from lower-paid production jobs to higher-paid STEM jobs, which boosted labor cost to 6% per year, a full percentage point higher than if the mix had remained the same.

White-collar workers in the US auto industry will see the biggest salary gains over the next few years

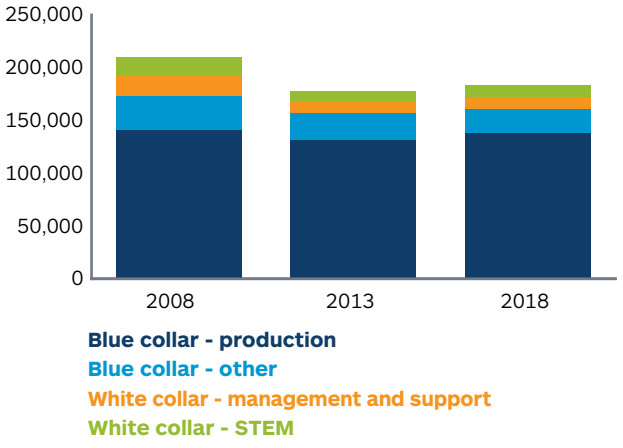
Average salaries in the US motor vehicle manufacturing industry (US$)



Source: US Bureau of Labor Statistics and IHS

Modest gains in hiring expected in the US auto industry through 2018

Number of employees in the US motor vehicle industry



Source: US Bureau of Labor Statistics and IHS

Auto's blue-collar renaissance

In sharp contrast to the employment gains in the oil and gas sector, employment in motor vehicle manufacturing fell 15.1% between May 2008 and April 2013, a decline averaging 2.6% per year. The number of production workers fell by 7%, from 141,000 in 2008 to 131,000 in 2013. Still, production workers' share of total employment rose from 67.0% to 73.9% because the share of white-collar jobs fell by a massive 30% over the same period, from 17.4% to 12.2% of total industry employment (see chart bottom left).

Looking more closely at the decimation of the back office reveals significant variability. The number of finance employees fell 51.3%; engineers were down 43.8% (mostly industrial and mechanical); and computer and math occupations contracted by 35.4%. However, the number of management employees fell by only 7%, making it one of the better-performing occupations in the sector. A management employee is defined as any white-collar employee not involved in a STEM profession. This includes specialties such as strategy, supply chain, legal, finance and accounting, sales and marketing, and general office support staff.

Unlike in the oil and gas industry, the value-add contribution of auto production workers on the factory floor increased substantially. Over the five-year period, output grew at a 4.7% annual rate, while average wages fell by 7.9%, making the industry's productivity gains one of the US economy's success stories for this period.

A major part of the story behind the numbers for US manufacturing of motor vehicles is the transformation of the industry's supply chain from region-centric to truly global. The data show that the manufacturing process now involves greater intensity and simplification of the assembly processes. That is, more

automation and fewer models. It also requires parts, sub-assemblies, and vehicles to be shipped around the world at a higher velocity from a global network of suppliers and manufacturers.

US employment trends are tricky to analyze since the sector includes the operations of US-based and non-US-based manufacturers. Global auto companies have the option to manufacture within and import motor vehicles to the United States. Related-party imports in the motor vehicle manufacturing sector—where at least a common, partial ownership exists between the two sides of the transaction, such as a Toyota Prius built in Japan that is shipped and sold in the United States—increased by $40 billion in five years, from $135 billion in 2008 to $175 billion in 2013. Japan, Canada, Germany, Mexico, and South Korea are the top five related-party import sources ranked in order of trade value. Imports from non-related parties are minimal.

At the same time, related-party imports of motor vehicle *parts* increased by $16 billion, from $36 billion in 2008 to $52 billion in 2013. For example, an engine that was built by Honda in Japan and then shipped to the United States for assembly at Honda's plant in Ohio. Non-related-party trade (pure arms-length transactions) increased by $14 billion, from $29 billion to $43 billion. The top five related- and non-related-party import sources ranked in order of trade value are Mexico, Canada, Japan, China, and South Korea.

There are two takeaways from this trade data. First, the top five countries and their rank order have a lower labor-cost skew for parts than for overall motor vehicle manufacturing by dint of the parts' top-five list being headed by Mexico, rather than Japan, and including China. Second, the share of trade in parts is increasing faster than US output of motor vehicles and imports.

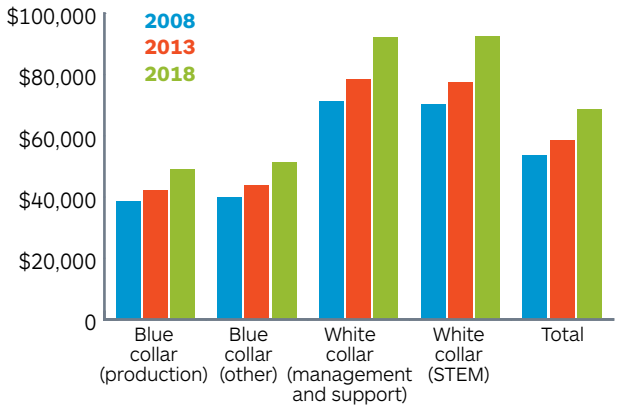
These trends explain the recent employment patterns in motor vehicle manufacturing. That is, managing the supply chain is becoming one of the most critical functions for gaining incremental profits in the motor vehicle sector. It requires highly skilled supply chain and finance professionals who can identify and continuously refine the build-vs.-buy parts-and-assembly mix on a global basis. US-based engineers and other STEM occupations do not play a role in this emerging global supply chain profit center.

Variations on the themes

Other capital-intensive sectors such as chemicals and technology had their own unique labor market stories, which are variations on the themes captured in the oil and gas and motor vehicle markets described above.

Salary growth strengthens throughout the US chemical industry

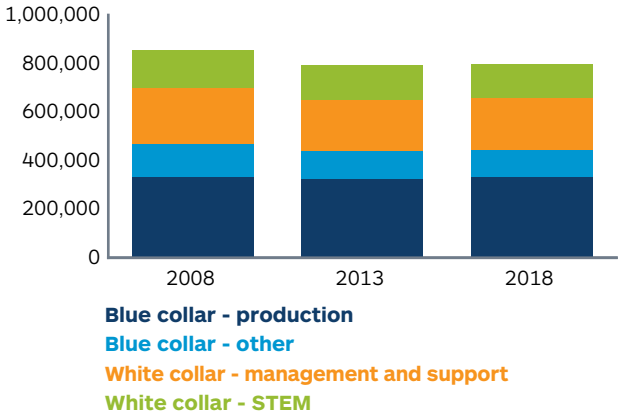
Average salaries in the US chemical manufacturing industry (US$)



Source: US Bureau of Labor Statistics and IHS

The US chemical sector will see modest gains in employment growth over the next few years

Number of employees in the US chemical manufacturing industry



Source: US Bureau of Labor Statistics and IHS

The US chemicals labor cuts followed the automotive manufacturing storyline but not quite as dramatically. Total employment fell by 7.4% between 2008 and 2013—from 855,000 to 792,000—but the number of production workers fell by only 2.8%. A large drop in employment occurred in the life, physical, and social science occupations, down 20.5% between 2008 and 2013. Medical scientists and chemical technicians led the way, each down by more than 6,000 workers (see chart bottom right page 17).

There were a few exceptions to the cuts. Engineering staff—mostly industrial engineers, but also chemical and biomedical engineers—increased by 6,700. The financial and business professions saw similar gains, with their ranks rising by 6,500 over the same period. Human resources specialists and logisticians saw the highest gains in this category.

Average salaries for the chemicals industry rose at a 1.8% annual rate, with most major occupations not varying substantially from this overall average, including STEM occupations. However, the overall employment contraction for the chemicals sector (-1.6% per year) during the five-year period exactly matched the rate of industrial output contraction, so overall labor productivity remained unchanged over the five-year period (see chart bottom left page 17).

Unlike chemicals but similar to automotive, the US technology sector—defined here as computer and electronic product manufacturing—had a positive productivity story. Total employment fell by 190,000, a 15.1% drop, between 2008 and 2013, with the number of production workers declining by 84,000, a 21.6% drop. Categories that fell the least included finance (down 1.9%), mathematical and computer (down 4.8%), and management (down 6.2%). At the same time, the sector's output grew by a stunning 28.8% over the period, which translates into one of the highest labor productivity improvement rates for the post-Great Recession period (see chart below).

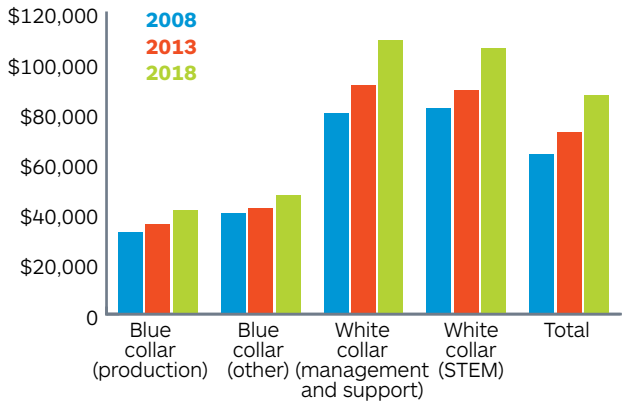
Looking ahead

Understanding the nuances of labor markets within specific categories of occupations and industry sectors offers a sound basis for projecting labor rates and productivity trends in the future. Combined with a robust macroeconomic forecast, they reveal insights that can lead to competitive advantage.

IHS is projecting overall US manufacturing employment growth to average 0.3% for the period from May 2013 to April 2018, which is essentially flat. However, the outlook for average salary gains is slightly better. Whereas average salaries grew 2% for all manufacturing sectors between 2008 and 2013,

Solid growth in salaries across the board for US tech workers in the next few years

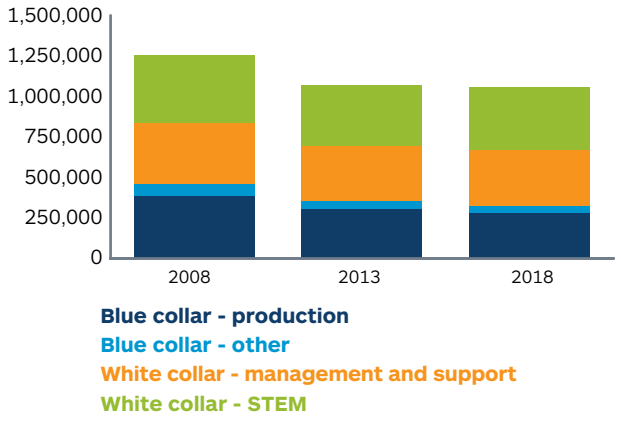
Average salaries in the US computer and electronics product industry (US$)



Source: US Bureau of Labor Statistics and IHS

Blue-collar workers in the US tech sector will see their numbers cut as STEM workers make some gains

Number of employees in the US computer and electronics product manufacturing industry



Source: US Bureau of Labor Statistics and IHS

IHS forecasts the rate to increase to 3% over the next five years as labor markets tighten and economy-wide compensation growth rates rise.

IHS expects these macro trends will be reflected in capital-intensive manufacturing sectors as follows:

- Total employment will remain flat or grow at less than the rate of output growth.
- Productivity gains will remain strong in the automotive and technology sectors and accelerate within the currently weaker sectors, including oil and gas, and chemicals.
- Growth in average salaries will accelerate through 2018 as the general economy improves and overall compensation rates grow. Average annual salary increases range from around 2% for automotive manufacturing to nearly 5% for oil and gas extraction. One factor that is driving up oil and gas extraction salaries, particularly in the STEM areas, is a geographic concentration of demand creating spot labor shortages. For example, Texas accounted for 59% of all petroleum engineers in 2013.
- Occupational employment and salary shifts between white collar (STEM occupations, for instance) and blue collar (production and maintenance occupations) within an industry will be a key forecast driver of total labor costs rather than just changes in headcount.
- Salary growth for key employees in selected manufacturing STEM occupations is more closely tied to overall compensation growth in the industry than any skills shortage-related labor supply tightness. While STEM skills may be in short supply, the salary reaction to this shortage has been muted. In fact, having STEM expertise is not a guarantee of employment within the manufacturing sector. Indeed, overall STEM employment in manufacturing has declined 4.7% since 2008. In fact, it may be the case that the supply-driven salary adjustments occurred years ago within many STEM professions.

For major capital-intensive industries—in the United States as well as globally—the central question is: to what extent will the transformations that occurred in the post-Great Recession era persist into the future? For the oil and gas industry, for instance, IHS expects employment growth to continue but at a slower pace as incremental investment in the unconventionals sector slows.

This potential for slower employment growth will be magnified if today's current low crude oil prices persist for an extended period. Improving productivity, and hence profit margins, will increasingly dominate labor hiring strategies, reducing the relative demand for high-paid management and support personnel. Whereas total employment in the oil and gas sector grew at an annual rate of 5.6% between 2008 and 2013, IHS expects this rate to slow to 3.6% between 2013 and 2018.

While there is much talk about the need for STEM jobs, the share of STEM employment in US manufacturing has seen little change over the past five years, and the absolute number is down by 5%. While there's no denial that STEM skills are important, it is quite possible that the tools used by STEM-dependent industries have evolved to improve the productivity of typical STEM employees. Thus, fewer STEM employees may be required in the future.

While IHS sees very little meaningful US manufacturing employment growth in the next few years, this flat-line outlook masks many trends—some quite dramatic—that exist within specific sectors and occupations. Globalizing supply chains, product and process re-engineering, and technological innovation are constant influences in the transformation of all industries. Any one of these influences could tip the balance for labor demand within a sector and perhaps result in a resurgence in demand for STEM workers.

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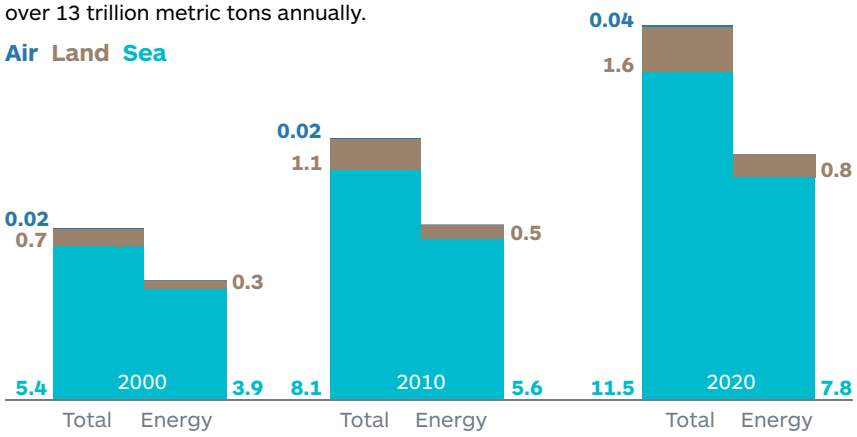
For more information, visit ihs.com/Q21USLabor

The dynamics of trade

Approximately 70% of global trade, as measured in metric tons, was transported by ship in 2014. Energy and mining commodities—liquefied natural gas, oil, coal, and minerals—accounted for 70% of all shipborne trade and will grow by 2.2 trillion tons by 2020. Successfully managing trade and capital investment requires keen insight into future commodity prices, supply and demand dynamics, cargo and insurance rates, and many other variables. New scenario-based analytical models are combining diverse data with deep multidisciplinary expertise to create accurate long-term forecasts of trade dynamics.

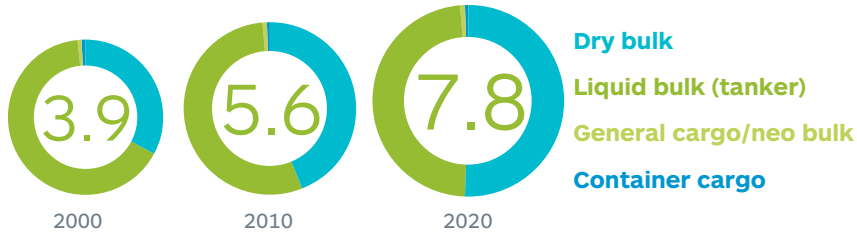
1 SEABORNE TRADE IS BIG AND GETTING BIGGER

Global trade is expected to more than double between 2000 and 2020 to over 13 trillion metric tons annually.



2 ENERGY AND MINING TRADE GROWS AND MARKETS SHIFT

Dry bulk trade overtakes liquid tanker trade in 2015. Trillions of metric tons.



3 FORECASTING AND MANAGING TRADE IN A DYNAMIC MARKET ARE COMPLEX AND RISKY

Energy and mining companies, ship operators, insurance brokers, banks, shipyards, ports, and others make big decisions daily.

Questions...

From and to which ports?

What will be shipped?

What infrastructure is needed?

In what type of ship?

Who will ship it?

Factors to consider...

Ship and cargo risk, physical and financial risk

Trade, arbitrage, market trends

Finance, infrastructure, insurance risk

Market opportunity, assets, fleets, customers, pricing

Fleet strategy and operational control

4 POTENTIAL EXTERNAL SHOCKS ADD MORE RISK: WHAT IF CHINA'S ECONOMY TANKS?

Companies must consider economic and geopolitical shocks. IHS scenario of a hard landing for China's economy, conducted in Q3 2014.

China's 2015 GDP growth declines by nearly **3%**

The ¥ depreciates

Construction of new ships in China may **slow** temporarily

Shipping rates and capacity utilization would drop

China's 2015 industrial production falls by **3.6%**

Global **commodity** prices would slump

Import and export **growth** declines sharply

China's fixed investment growth drops by nearly **5%** in 2015

5 FACTORING IN A CHINA HARD LANDING ON TRADE AND SHIPPING DECISIONS

By connecting the right economic, energy, shipping, manufacturing, and other relevant data with the appropriate expertise, analytics can be used to forecast the impacts of specific scenarios on the key industries concerned with trade. For example, how might a hard landing in China impact trade dynamics and decision-making?

Insurance companies

Revenues slow as a consequence of lower trade activity. Companies trim costs as they anticipate insuring fewer ships and shipments of cargo.

Energy and mining companies

As trade slows, commodity prices fall, squeezing margins. Companies will prepare to trim costs, including renegotiating shipping rates.

Ship brokers

Business will suffer as commissions drop due to trade slowing and fewer ships being bought and sold. Fluctuations in exchange rates will adversely impact operating costs. Brokerage houses will see more consolidation and M&A activity.

Shipyards

With a decline in the demand for shipping, some orders may be canceled. But unless the scenario develops into a full-fledged global recession, the impact on global shipbuilding should be minimal as the long-term expectations of an increase in global trade will muffle the effect of the short-term slowdown. On the positive side, if the yuan depreciates, it will make China's shipyards more competitive internationally.

Shipowners

No option but to cut freight rates as the situation goes from bad to worse, especially in commodity fleets, such as crude oil tankers and bulk carriers. If industrial production slowdown persists, the container sector will also suffer.

Banks

A fall in freight rates means lending slows. Investment in shipping would decline, prompting consolidation. As shipping asset values decline, private equity may invest at the bottom of the market to capture higher long-term returns.

Source: IHS. Data excludes intra-European trade.

Predictions for the new year

Shutterstock

While risks remain for the global economy, the 12-month outlook is generally positive. The IHS top 10 predictions provide insight for just how the year is likely to unfold and the implications for global businesses.

By Nariman Behravesh

The fundamentals are in place for the global economy to pick up momentum in 2015. For the past three years, world GDP growth has been stuck in the mid-2% range—2.5% in 2012, 2.6% in 2013, and 2.7% in 2014. During that time, the contribution from the advanced economies—especially the United States and Europe—has increased, while the additions to global growth from emerging markets have decreased. IHS expects a modestly better overall performance for the world economy in 2015, with an expected growth rate of 3% or slightly higher.

Solid and improving growth in the US and a slight pickup in the pace of Eurozone economic activity are among the reasons for this moderately upbeat assessment. In the same vein, much lower oil prices and more monetary stimulus—in particular, from the Bank of Japan (BoJ), the European Central Bank (ECB), and the People's Bank of China (PBoC)—will not only support growth, but could provide the basis for some upside surprises. The big drop in oil prices alone could add 0.3-0.5% to 2015 global growth.

Unfortunately, many of the downside risks that have plagued the global economy since the end of the Great Recession remain in place, including high public- and private-sector debt levels, persistent corporate risk aversion, and daunting geopolitical challenges. These have the potential to counterbalance the uptick in growth in the coming year.

What follows are the IHS top 10 predictions for the 2015 global economy.

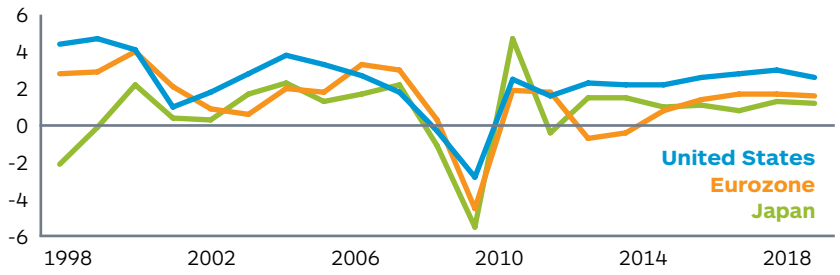
1. US growth will be solid

There are many reasons why the US economy is doing better than most other developed economies and will continue to outperform in 2015. At the top of the list is strong domestic demand, as consumer spending accounts for nearly 70% of GDP (see figure on page 24).

The good news is that the dynamics underpinning consumer spending remain very positive, including strong jobs growth, improved household finances—the best since the early 2000s—and low gasoline prices. While income distribution and wage growth issues will gnaw at the margins, generally consumers are in a good mood and their spending on goods and services will grow by around 3% annually for the next two to three years.

US economy will outperform both Japan and Europe through 2018

Real GDP annual percent growth for the US, Eurozone (excludes UK), and Japan



Source: IHS

While much has been made of the vulnerability of US exports due to feeble growth in other parts of the world, this weakness also helps the US economy by lowering oil prices and keeping interest rates low.

Capital expenditures and housing will contribute to economic growth in 2015 as well. In the case of capex, likely declines in energy investments due to plunging oil prices will be offset by strength in other sectors, such as automotive and chemicals. Housing, which has struggled recently, is also showing signs of revival. Unless government expenditures and net exports have a larger-than-expected drag on the economy, the foundation for solid growth in the 2.5-3.0% range is well established. While much has been made of the vulnerability of US exports due to feeble growth in other parts of the world, this weakness also helps the US economy by lowering oil prices and keeping interest rates low.

2. Sluggish Eurozone recovery, robust UK growth

The Eurozone managed to eke out positive, albeit slow, growth in 2014. A variety of factors will help to sustain this forward momentum in 2015, including a weaker euro, reduced fiscal headwinds, diminished sovereign debt tensions, and an accommodative monetary policy. Also, sustained low oil prices will provide much-welcomed relief, especially to crisis-battered Southern Europe.

While high unemployment is still worrying, labor markets are improving modestly in most countries. This should provide some support to consumer spending, in tandem with very low consumer price inflation. This is especially true for Germany and other Northern European economies. There will likely be a growing pent-up demand for spending by businesses to replace and upgrade their capital stock. Also, improved global growth combined with a weaker euro should help Eurozone exports.

All these factors will support a very modest acceleration of Eurozone growth from 0.8% in 2014 to 1.4% in 2015, even though significant problems persist. At the same time, and much like the US, the UK economy will post solid GDP growth this year in the range of 2.5-3.0%.

3. Weak growth momentum for Japan

Last year, Japan suffered through its fourth recession in six years. The latest downturn can be blamed on the April 2014 sales tax hike, which had a bigger and longer-lasting negative impact on consumer spending and investment than was anticipated. This has been especially tough for Japanese households, whose

inflation-adjusted income shrank by about 5% in 2014.

In response, the government of Shinzo Abe postponed the second round of sales tax hikes from October 2015 to April 2017. Additionally, the government will likely provide some temporary stimulus in 2015 and 2016. At the same time, the BoJ has pledged to further expand its quantitative easing program.

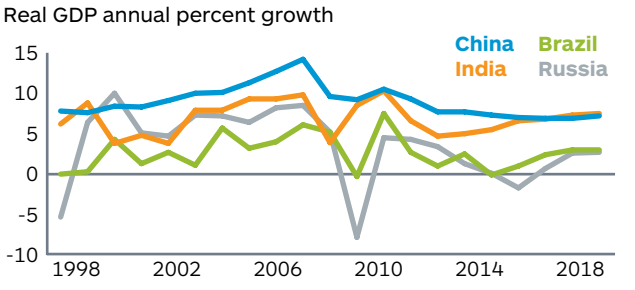
These policy moves, along with much lower oil prices and a substantially weaker yen, will push Japanese GDP growth back into positive territory in 2015—although only to around 1%. One of the upside risks for the Japanese economy is significant pent-up demand in the corporate sector, as evidenced by the massive cash hoard—44% of GDP, compared with 11% for the US.

4. China's growth decelerates

The recent wobbles in the Chinese economy can be attributed to a weak domestic economy—primarily because of the real estate bust—combined with a fragile external environment for China's exports. Thanks to government stimulus, there have been brief upticks in growth over the past couple of years. However, given government concerns over the glut of debt, industrial overcapacity, and the large inventory of unsold housing, the stimulus has so far been very modest and temporary. Unfortunately, every time the stimulus wears off, growth sags.

While IHS expects more, albeit limited, support from fiscal and monetary policy in 2015, including more interest rate cuts, it will not be enough to prevent GDP growth from weakening further. From 7.3% in 2014, IHS forecasts China's growth to moderate to 6.5% in 2015. With mounting evidence that China's housing recession is easing, growth will likely pick up to 6.8% in 2016. While poor by China's standards of the last three decades, these growth rates are robust by global standards.

Growth will stabilize for the big 4 emerging markets, but Russia faces challenges



Source: IHS

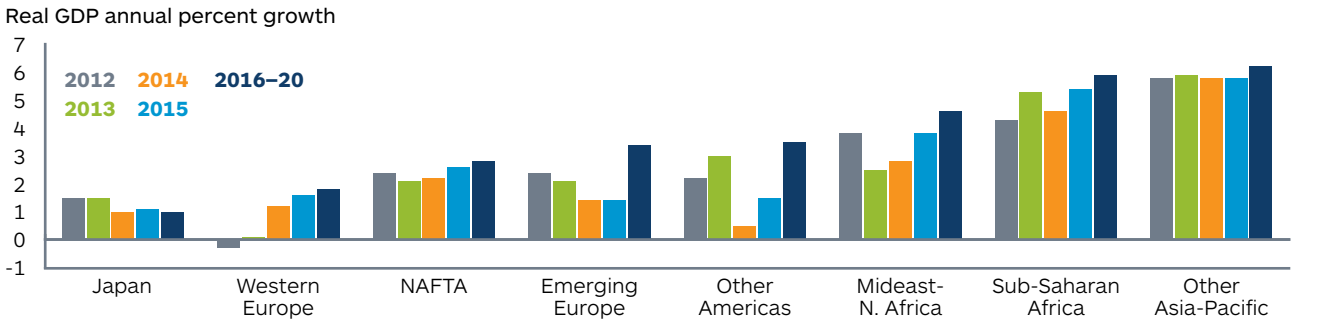
The drop in oil prices will help boost consumer spending and provide justification for further interest rate cuts.

5. Mixed bag for emerging markets

Two of the world's biggest emerging markets are either in or close to recession. Brazil suffered through two quarters of contraction in mid-2014, and GDP growth in 2015 will be less than 1%. Russia stayed out of recession in 2014 but will likely see a 1.5-2.0% decline in real GDP during 2015 because of the "triple whammy" of sanctions, plunging oil prices, and capital flight (see figure above).

The good news is that most other emerging economies will see stronger growth in 2015 compared with 2014 thanks to weaker oil prices, a boost in global liquidity, and stronger US and European growth. Regions that are likely to see the largest increases in growth during 2015 include emerging Europe, Latin America, the Middle East and North Africa, and sub-Saharan Africa.

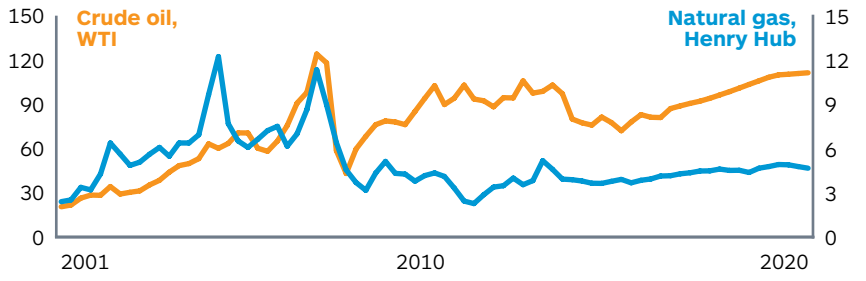
APAC and sub-Saharan African economies will grow the fastest through 2020



Source: IHS

Big drop in US crude prices, but for how long?

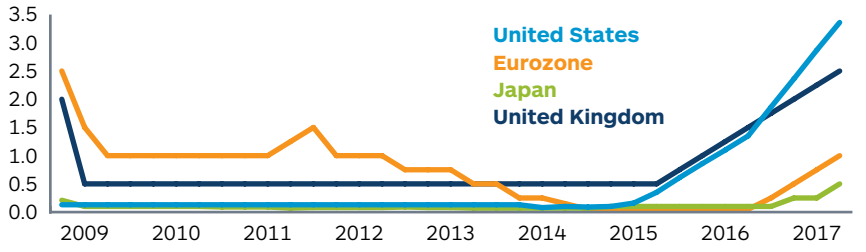
Price of West Texas Intermediate crude oil, US$ per barrel (left axis), price of Henry Hub natural gas, US$ per million Btu (right axis)



Source: IHS

UK and US will likely hike interest rates in 2015, not so Eurozone and Japan

Interest rates, percent at the end of the quarter



Source: IHS

Growth in the latter two regions and in Asia will be well above the global average. Some countries will do especially well, including India, Indonesia, Malaysia, and the Philippines in Asia; Colombia and Peru in Latin America; and Kenya in Africa. On the whole, growth in emerging markets will continue to lift the world average (see figure at bottom of page 25).

6. Commodity prices slide further

From the summer of 2014 through the end of the year, commodity prices plummeted. The IHS Material Price Index fell by more than 20%. Oil prices plunged around 45%. A combination of feeble global demand growth and strong supply growth is to blame. China remains key to the demand-side story. Any further softening of growth will likely translate into another round of price declines.

Unfortunately, if the Chinese government chooses to boost growth by encouraging investment to expand industrial capacity, the excess-supply conditions in sectors such as steel and chemicals could be exacerbated. Structural excess supply is especially acute in oil markets. Rising US oil production, along with an unwillingness and/or inability of OPEC to make large production cuts, is keeping prices low (see top figure above).

The dilemma is that if prices do eventually rise from current levels—due to OPEC discipline, for example—this will only encourage more US oil production. The US has effectively become a new swing producer of oil, although one that moves with market forces rather than government actions. In the meantime, the sharp drop in oil prices is likely to have a negative impact on oil sector investment over the next few years.

All this means that oil prices will stay low for the next couple of years and that commodity prices are likely to slide—by around 10% on average in 2015, according to IHS.

7. Deflationary worries persist

With commodity prices falling and global growth anemic, the risk of inflation rising significantly in 2015 from current levels is low. The exceptions are emerging markets that have experienced sharp drops in their exchange rates—such as Russia—and, as a result, a spike in inflation.

Disinflationary forces are the strongest in the developed world. US headline inflation, as captured in the consumer price index, fell in late 2014 because of the drop in gasoline prices. Core inflation, however, remained below 2% and has been remarkably stable in recent months. Neither headline nor core consumer inflation is likely to exceed 2% in 2015.

Eurozone consumer price inflation has fallen steadily over the past two years and reached 0.3% in late 2014. The danger is that a number of countries have already suffered deflation, most notably Spain. IHS expects Eurozone inflation to rise gradually in 2015, as the disinflationary pressures from lower oil prices are offset by a weaker euro and better growth prospects.

Inflationary pressures in the rest of the world—already muted—will also diminish further thanks

to the large declines in the prices of oil and other commodities, including food, as well as slumping growth in some large emerging markets.

8. UK, US raise interest rates, others will cut
The divergent growth prospects for the world's key economies mean that central banks will go their separate ways in 2015. The US Federal Reserve, Bank of England, and Bank of Canada are expected to hike rates in 2015—in June, August, and October, respectively (see lower figure on facing page). These economies are enjoying relatively robust growth, and central bankers are beginning to worry more about the potential for higher inflation and less about the fragility of growth. Weaker inflation due to falling commodity prices could, however, delay the first rate hikes in each case.

In contrast, the ECB, BoJ, and PBoC are on track to cut interest rates further (if they can) and/or provide more liquidity via asset purchases and other means. So far, the actions of the BoJ have been the most aggressive. The stimulus provided by the ECB and the PBoC has been more limited, but more is likely to come in 2015—possibly much more. Their actions may include aggressive quantitative easing.

Meanwhile, action by central banks in the emerging world will either be on hold or they will cut interest rates. This includes Brazil and Russia, where rates have been raised recently. Among other large emerging-market central banks, the Reserve Bank of India is also expected to lower rates in 2015. That said, if emerging-market currencies swoon again as the Fed begins to raise rates, the pressure on central banks in these economies to raise rates again will intensify.

9. US dollar will rise, euro and yen will fall
Exchange market fundamentals played a big role in movements of currencies during 2014 and will continue to exert a strong influence in 2015. This means that the dollar will strengthen more because of strong growth prospects and Fed rate hikes (sooner than most other central banks) along with a diminishing current-account deficit. IHS expects that the greenback, which rose by around 8% against major currencies in 2014, will rise another 3-5% in 2015.

The anticipated additional stimulus by the ECB and BoJ means that the euro and the yen will continue depreciating in 2015. IHS predicts the euro/dollar rate will fall from late 2014 levels of around $1.25 to a range of $1.15–1.20 by autumn 2015. Similarly, the yen is predicted to depreciate from about ¥117 at the end of 2014 to a range of ¥120–125 during 2015.

As in the case of the US dollar, early hikes by the Bank of England and Bank of Canada will put upward pressure on sterling and the Canadian dollar, although in the case of the latter, weak oil prices will exert countervailing downward pressures. Emerging-market currencies will continue to slide against the dollar. The currencies of oil-exporting countries will come under intense pressure—as happened to the Russian ruble in late 2014.

10. Perennial downside risk, but some upside too
The global recovery has been plagued by a multitude of "curses" during the past few years. Principal among these are high public- and private-sector debt levels, which have necessitated deleveraging by households, banks, and corporations, along with severe austerity programs by governments. In turn, this has resulted in feeble spending by households and businesses, as well as a big drag from government spending cuts and higher taxes. The good news is that these hindrances to growth are easing in some countries, notably the US and the UK, which explains their better-than-average performance.

Easing fiscal drag and better credit conditions will also help growth prospects in the Eurozone and Japan in 2015. Meanwhile, geopolitical concerns—the Middle East turmoil and the Russia/Ukraine conflict—have weighed heavily on business confidence in parts of the world, especially Europe.

Mercifully, the impact of these events on global energy markets has been nonexistent thanks to growing US production. In fact, prices have fallen precipitously. This drop represents a transfer from oil-exporting countries to oil-importing countries of about $1.5 trillion (or about 2% of world GDP). The good news—and potential upside risk—is that the latter have a much higher propensity to spend than the former, thus boosting world economic growth.

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Heeding the lessons of Ebola

One year into the deadliest outbreak of Ebola in history, the virus has killed over 5,000 people in West Africa. While the spread of the virus has been restricted, and fear of a global pandemic largely abated, questions remain. Could the international health community have done more to stop the spread of Ebola? Are global health agencies, governments, and companies prepared for the next pandemic?

By Gustav Ando and Mark Hollis

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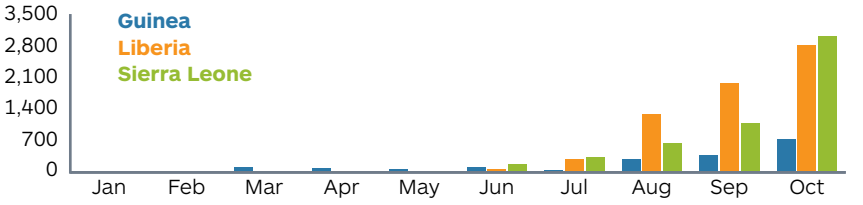
The last few months have seen an explosion in interest in what was, until 2014, a comparatively obscure virus that periodically broke out in isolated communities in the tropical jungles of equatorial Africa. The potential has always existed for an Ebola outbreak to spiral into something akin to what we are seeing now. It was only by chance that the majority of the 24 Ebola outbreaks in the last four decades occurred in isolated areas with little movement of people or in large communities where the virus could be identified rapidly—thus ensuring that the numbers infected never exceeded the roughly 600 patients who contracted the disease when it was first identified in 1976.

Although the most recent outbreak of Ebola also started in an isolated area, it is one crisscrossed by ancient trading routes. This allowed the virus to create a large patient pool before health authorities could detect it, enabling it to spread rapidly across countries and borders. As a result, the number of people infected grew quickly.

With thousands now infected by the virus across Guinea, Liberia, and Sierra Leone, which has captured the attention of millions more globally, its containment has entered a critical phase. After months of procrastination, the international community is scrambling to supply much-needed beds to meet the World Health Organization's (WHO's) 70% threshold target for care in isolation to stem the spread of the virus. WHO data through October 2014 (see figures below) are inconclusive as to whether this effort is working, as new-infection rates to that point were still climbing and recorded deaths declined over month-earlier levels only in Liberia. (Preliminary data released by WHO for November showed month-over-month declines

The rate of new Ebola cases in West Africa continued to grow through October

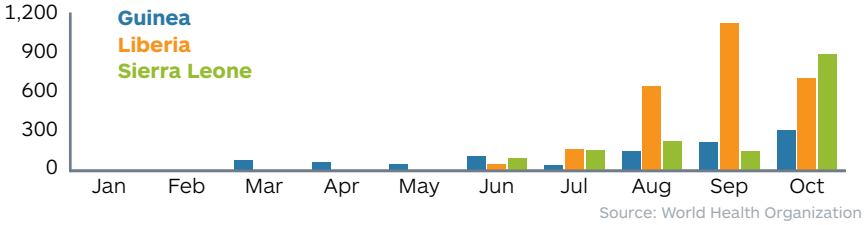
New cases of Ebola recorded in Guinea, Liberia, and Sierra Leone by month, January 2014-October 2014



Source: World Health Organization

Ebola deaths decline in Liberia in October, still grow in Guinea and Sierra Leone

Number of recorded deaths from Ebola in Guinea, Liberia, and Sierra Leone by month, January 2014-October 2014



Source: World Health Organization

in all three countries for both new infections and deaths but are subject to revision.)

The evolving threat

Humans have suffered pandemics throughout history from highly infectious viruses such as smallpox and influenza, which have killed many millions over the centuries. As recently as 2012, outbreaks of measles, typhoid, and tuberculosis killed several million worldwide without receiving significant media attention, since these diseases are well contained in the West.

It is only in recent decades that science has been applied to preventing the spread of pandemics. For instance, the outbreak of SARS (severe acute respiratory syndrome) in 2002–03, which killed 800, was contained comparatively quickly, although the economic cost was estimated at between $30 billion and $40 billion.

At the same time, societal advances are increasing the potential for new infections to spread rapidly. Air travel makes it possible for diseases such as Ebola and SARS to be carried quickly around the world. Populations are moving into unsettled areas and encountering unfamiliar animals and diseases. Ebola, for example, is believed to be transmitted by the handling of animals found dead in rain forests—and within the same forests there remains the risk that unknown infectious diseases could lurk in reservoir hosts (animals infected by a virus but showing no symptoms). Even known animal diseases can spill over to humans, as seen with bovine spongiform encephalopathy, more commonly known as mad cow disease.

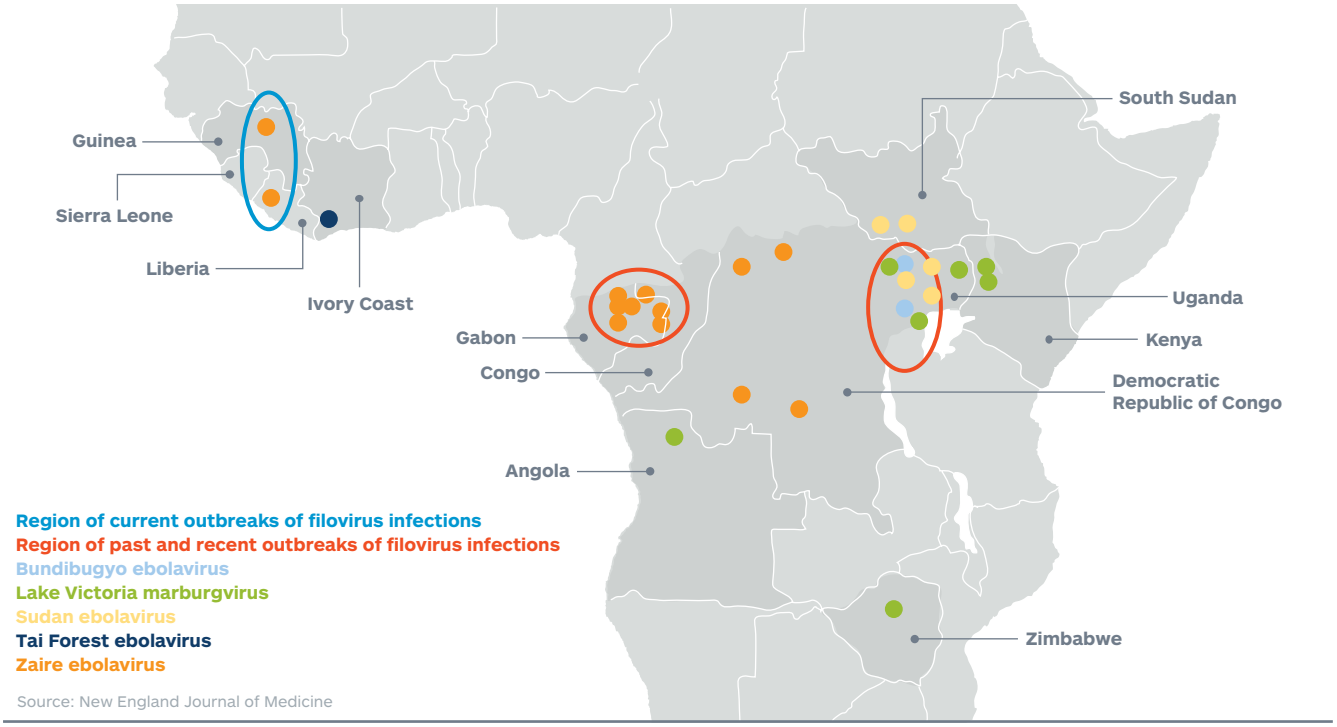
It is clear that growing megacities—with densely packed populations and, especially in developing countries, poor sanitation—provide ideal settings for infectious diseases to spread. At the same time, megacities provide some measure of protection for residents, as they often have the "mega resources" necessary to contain outbreaks as well as better sanitation than rural settings. The threat remains, however, that infectious diseases can establish a foothold in urban populations and spread widely in a short period of time.

The mathematics of transmission

All infectious diseases have a basic reproduction number (R_o) critical to understanding the level of communicability. The R_o denotes the number of people who are likely to be infected by any given carrier. Measles, for example, has an R_o of 18. Ebola has a much lower R_o of between 1.7 and 2.0. Clearly, compared with some major disease outbreaks, such

Africa: Fertile ground for Ebola

Current and previous outbreaks of filovirus (Ebola and Marburg) infections, 1976-2015



Source: New England Journal of Medicine

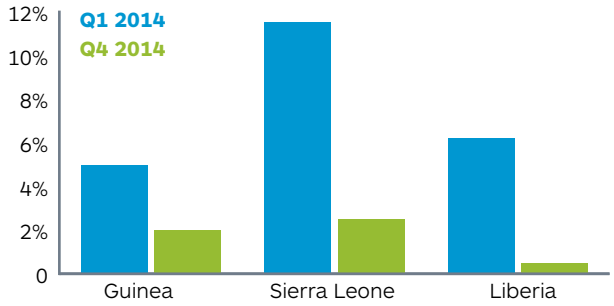
as the Spanish flu, H1N1, and SARS, Ebola presents a threat that is more containable, since it is far more difficult to transmit.

Given this lower R_o, Ebola requires a "perfect storm" of conditions to become a global threat. This exists in West Africa, where a shortage of doctors has forced family members into caring for relatives at the most contagious advanced stages of disease, public health messages are not well received, and tracing contacts remains troublesome. In Liberia, for example, there were only 50 doctors caring for a population of almost 5 million at the start of the Ebola outbreak.

Conversely, it is extremely difficult for Ebola to gain a foothold in the Western world, where access to isolation facilities is high, public health messages are easily disseminated, and disease surveillance practices are well established. In countries where even one of these conditions exists, epidemics can generally be contained. In Nigeria, for example, the mobilization of extensive contact tracing prevented Ebola from taking hold.

Ebola has curbed GDP growth dramatically in the three affected countries

Forecasts made in Q1 2014 and Q4 2014 of real GDP growth for 2014, on an annualized basis, for Guinea, Liberia, and Sierra Leone



Source: IHS

Social and economic impacts

The spread of Ebola is progressively straining the social fabric of the three countries principally affected while heightening their existing political and economic fragility (see figure above). Sierra Leone's and Liberia's infrastructures were almost completely destroyed by civil wars in 1991–2000 and 1989–2003, respectively, and constitutional government is only now returning to Guinea, which elected its first democratic parliament in a half-century in January 2014. Given their existing risk profiles, if the Ebola outbreak is not contained in the first half of 2015, these countries are at risk of government collapse, severe economic decline, and civil disorder.

In Sierra Leone, quarantine efforts and other measures taken to contain the outbreak have provoked civil unrest. In October, authorities imposed a curfew after youths opened fire on police officers attempting to quarantine an elder suspected of having Ebola. The following day, protesters attacked local health workers, and the ensuing confrontation with security guards resulted in two deaths.

In Guinea, measures to contain Ebola, including restrictions on the movement of people, have seriously affected subsistence farming and local economic activities. In October, a number of markets were closed along the border with Senegal, raising the risk of food scarcity. The prices of basic commodities increased nearly 40% between April and September, according to the UN Food and Agriculture Organization, which, coupled with high unemployment, could spur civil disorder.

Liberia declared a state of emergency in August to prevent Ebola from spreading across the country. State and economic stability could be undermined by the government's other actions, such as the suspension of all import taxes to cushion the rising cost of essential commodities, which will reduce government revenue.

The global perception of the three countries as "Ebola stricken" has negatively impacted their domestic business environments, dampening foreign direct investment and other capital inflows. Impacts have been felt across all economic sectors in the three countries. The slowdown in mining production and exports—particularly iron ore in Liberia and diamonds, rutile, and iron ore in Sierra Leone—as a result of the evacuation of expatriate personnel and scaled-back operations poses the greatest risk to economic growth.

Service-sector activities have been significantly affected and could worsen further in light of reduced local commerce and cross-border trade, as well as substantially reduced domestic transport and international travel. Additionally, tourism and foreign investment-driven construction activities have suffered from sharp drops in demand and

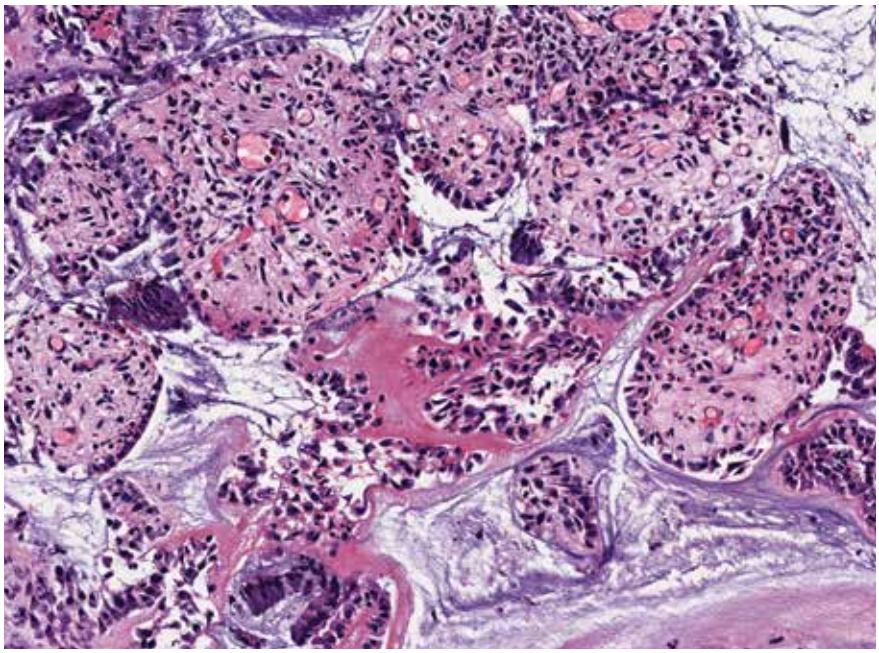
are likely to stagnate for the foreseeable future.

The tourism sector in Africa as a whole has been affected, even in countries that have experienced no Ebola cases. Gambia, for example, has reported a 65% cancellation rate for hotel bookings for the 2014–15 tourist season, and South Africa has reported significant cancellations since the beginning of the outbreak.

Are we prepared?

Even before a leaked memo from WHO became public on October 18, many observers suspected that the agency was questioning its response to the current Ebola outbreak. Were initiatives put in place fast enough? Did WHO hamper the work of partner agencies? Was enough emphasis placed on tackling the outbreak early? Without insight that could only have been gained on the ground, it is difficult to know the answers to these questions. All stakeholders are likely asking what lessons can be learned from the outbreak so that future responses will be more effective.

Against this background, pharmaceutical research and development (R&D) has come under the spotlight, attracting criticism from WHO Director General Margaret Chan. Ebola research—ongoing since the 1976 outbreak—has been slow to yield results, in part because Ebola has until now primarily affected a small number of poor patients in developing countries. Not only has that presented severe logistical challenges to conducting viable clinical trials, but it has also rendered return on R&D investment highly uncertain.



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Further, the disease has proven to be resistant to a wide range of current, innovative drugs—unlike the swine flu pandemic of 2009, for which Tamiflu was an existing, effective treatment.

The problem of how to encourage R&D into diseases like Ebola remains a challenge for the pharmaceutical industry—and governments and international organizations have a critical role to play here. Indeed, many of the candidates that are now emerging as potential Ebola vaccines and therapies are the result of government incentives to protect the population from the threat of biological warfare attacks in the post-9/11 era. However, while Ebola was part of Project Bioshield, a US bioterrorism initiative, government approval of vaccines and therapeutics to prevent or treat Ebola has not been a priority because the disease is not as contagious as anthrax or smallpox and thus is less likely to be weaponized.

One means of incentivizing this type of research is through allocation of government funding, as practiced by the Global Health Innovative Technology Fund, a partnership of the Japanese government and private industry to fund R&D into pharmaceuticals and treatments of infectious disease in developing countries. An alternative approach, and one favored by the charities IHS Life Sciences interviewed during research into international pharmaceutical pricing, incorporates prize money as an incentive. Rather like the XPRIZE, which provided a cash award to stimulate innovation in space technology, prize money could be offered to the first company to successfully develop a pharmaceutical candidate targeting a certain therapy area. In return for the prize, pharmaceutical companies would forgo patents, allowing low-cost generic products to be launched. It remains to be seen how this concept, which worked well for small-scale space technology, could be replicated for large pharmaceutical and biotech companies.

Despite the pharmaceutical industry's delay in reacting to

Ebola, it has begun to make up for lost time. Three new vaccines entered into clinical testing in October 2014 alone, including one each from GlaxoSmithKline and Bavarian Nordic. Once engaged, the pharmaceutical industry has had a high success rate in achieving significant advances in care. Effective treatments against HIV/AIDS, for example, were developed within years of the arrival of the disease.

Impact assessment

As of December, the worst-case scenarios of the Ebola outbreak were not playing out, and it continued to be confined largely to Guinea, Liberia, and Sierra Leone. Significantly, the outbreak had not impacted Nigeria—a potentially watershed event if it were to occur due to the country's demographics, mobile population, and energy industry. Questions are emerging as to whether media coverage and political discussions overstated the "real" risk presented by Ebola. In the US, some schools quarantined exchange students from parts of Africa that are far from the Ebola outbreak—and the response to the disease became a major political issue in the mid-term elections despite its limited impact on the country.

However, continuing concern is warranted, as it appears the incremental spread of Ebola is inevitable. The disease itself is likely to evolve—or new diseases will take its place. As evidenced by the outbreaks of SARS, H1N1, mad cow disease, and others, new pathogens emerge on a fairly regular basis, each presenting a unique threat to mankind.

Call to action

Which pandemic comes next—and how contagious and deadly it will be—remain unknown. But global businesses should be considering strategies to mitigate risk whatever the outbreak or disease. These strategies include:

- *Model outbreaks and match them to existing medical facilities:* Although the actual impact of communicable diseases is difficult to predict, monitoring the outbreak trajectory and how it fits into historical context is useful in analyzing specific threats to local assets and local economies. This information can be cross-referenced against knowledge of the medical facilities in that area, and the disease in question, to develop a picture of the ability of the resources in that area to tackle the outbreak.

- *Encourage R&D:* Although much of pharmaceutical R&D is focused on diseases impacting patients in the developed world, globalization and the increasing role that emerging markets play in meeting our demand for raw materials mean that we can no longer ignore R&D targeting "neglected" tropical diseases. Ebola has shown that a serious dialogue is needed on medical R&D of all kinds. As disease outbreaks impact all industries, these discussions need to cross industry lines.

- *Understand the local disease environment:* It can be relatively easy to identify many of the most common disease risks in the locations where companies are operating. However, some may not be immediately obvious. In many emerging and developing countries that were once inextricably linked with famine and malnutrition, non-communicable diseases associated with lifestyle choices such as high calorie intake and alcohol consumption often go unnoticed but are now becoming pervasive.

Questions are emerging as to whether media coverage and political discussions overstated the "real" risk presented by Ebola.

As much as companies plan for disease-related events, it remains crucial to have policies that can quickly be adapted for other diseases or situations. Perhaps the greatest lesson Ebola has shown us is that outbreaks can follow unexpected patterns.

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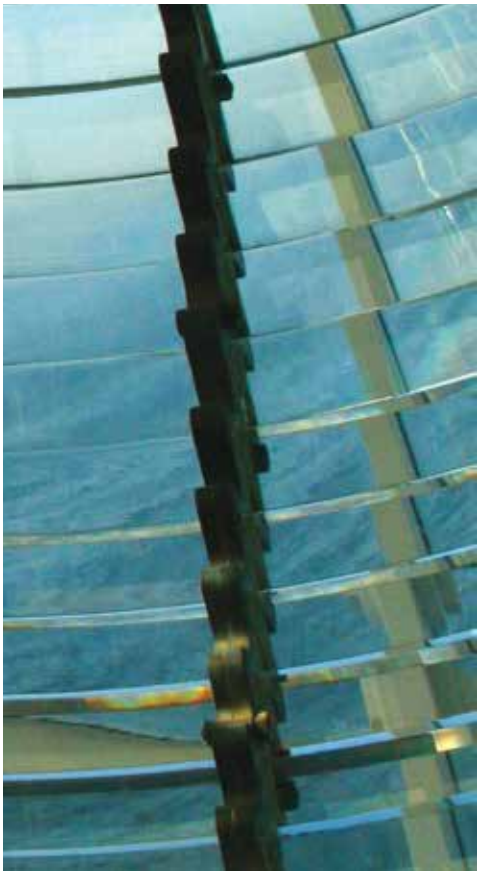
Alternate futures

History is not a reliable guide to the future—yet past experience informs how individuals and organizations moving into that future are likely to behave and why. Companies seeking competitive advantage must develop awareness of the full range of events that could impact them, and how they might respond, in advance. With the right tools, cultivating such foresight can—and must—be built into the business planning process.

By Tate Nurkin



"Whenever a theory appears to you as the only possible one, take this as a sign that you have neither understood the theory nor the problem which it was intended to solve."—Karl Popper

On October 26, 2014, UK and US flags over Camp Bastion, Afghanistan, were lowered for the last time during a ceremony handing control of the British base (and the US Marine Corps Camp Leatherneck contained with Camp Bastion) to the Afghan National Security Forces. The ceremony was an important milestone in the ongoing transition of NATO's role in Afghanistan from combat operations to a train, assist, and advise mission in 2015. It also provided a poignant reminder of the lessons of one of the most difficult and costly days of the nearly dozen-year-long NATO-led International Security and Assistance Force deployment to Afghanistan.

On September 14, 2012, Camp Bastion's fence line was penetrated by 19 Taliban insurgents who, once inside the base, killed two US Marines and destroyed six AV-8B Harrier jets while damaging two others. In addition to the loss of life, the attack led to approximately $200 million in damage to US Marine Corps assets. An April 2014 report released by UK members of parliament blamed the successful attack on a "high level of complacency" in the UK and US security system and noted that fewer than half of the guard towers were manned on the night of the attack.

In response to the post-attack critiques about Camp Bastion complacency, the US Marine Corps devised a creative approach to avoiding a repeat of the disruptive raid by establishing what was referred to as a "dirt track red team," a standing group of a dozen young Marines and NATO personnel focused on thinking like the Taliban and devising "bizzaro things" that could happen to the base. Colonel Peter Baumgartner, commander of the US Marine Task Force Belleau Wood, in charge of security at Camp Leatherneck, commented to the *Marine Corp Times* in May 2014 on the rationale for the red team: "The last thing I'm going to do is stand here after a successful attack has occurred and go, 'boy, I never thought they could do something like that.' I refuse to have failure of imagination here."

Colonel Baumgartner's instinct to address the potential for failures of imagination should be heeded and adopted by decision-makers from across a growing range of critical domains facing uncertain and risk-prone landscapes increasingly vulnerable to disruptive events that drive straight-line projections of current trends along wildly different trajectories.

The ability to implement decision-support tools designed to address the potential for a failure of imagination will be critical to determining resilience, agility, and ultimately success for national security, private sector, and critical infrastructure organizations in the complex and uncertain world of the early 21st century.

New environments and new modes of thinking

Four forces are particularly important in shaping the growing degrees of complexity and uncertainty in today's world:

Devolution of disruption: More actors, in command of more and better capabilities, have the capacity to affect strategic, operational, and market environments. In the national security sphere, this implies a broadening threat spectrum to security, sovereignty, and infrastructure protection—from competing nation states to transnational networks to ideologically imbued and technologically savvy individuals capable of using commercially available technologies in novel ways to massively disruptive effect.

In the private sector, this phenomenon manifests itself, in part, through the emergence of new and niche competitors as well as established actors seeking to penetrate new and adjacent markets; implement radical new business models or structures; or acquire new and disruptive capabilities (Google's acquisition of SkyBox and Titan Aerospace, for example).

For all domains and industries, though, the devolution of the capacity for precipitous disruption places a premium on a more nuanced understanding of the perspectives, capabilities, metrics, mindsets, objectives, and strategies of current and potential competitors, partners, customers, and other stakeholders that could shape or affect emerging challenges and opportunities.

Challenges in thinking about the future

Thinking about the future, much less predicting it, is inherently difficult, even for visionaries. Albert Einstein rejected the possibility of nuclear energy in 1932, for example, and former Microsoft CEO Steve Ballmer famously claimed in 2007, "There's no chance that the iPhone is going to get any significant market share. No chance." All decision-makers seeking to assess and anticipate the shape, scale, timing, and pace of disruptive change and innovation are affected by five particularly prominent temptations that reflect the enormous power of groupthink and a range of cognitive biases in constraining forward-leaning analysis and decision-making:

The end of history: Decision-making frequently incorporates analysis concluding that current environments suggest non-perishable trends are certain to endure, amplify, or accelerate indefinitely. For example, in the 15 years preceding World War I, a flawed, but prevailing, mindset emerged that held that unprecedented technological sophistication, lethality of military equipment, and economic interdependence made great power conflict impossible.

Straight-trend analysis: Trends are critical to diagnosing future outcomes, but simply projecting current trends forward without contextualizing them

Compressed timelines: Events are occurring and unfolding with increasing speed, from the initial signs of disruption to more urgent and pronounced crises or opportunities. The ability to anticipate and plan for a range of plausible challenges and opportunities—even those that are less likely—in advance of their taking place is increasingly required for corporate and government entities to develop signposts and hedging strategies that allow entities to anticipate and respond to dynamic, fast-moving challenges and opportunities.

Interconnected implications: Disruptive events and their proximate and secondary implications are rarely constrained by national, regional, or neatly defined industry or infrastructure boundaries. Anticipating the full suite of risks in such an environment requires a sophisticated understanding of the strength and complexion of a range of linkages and how decisions affecting one set of risks or actors may drive new or expanded risks that may not be intuitive.

Collisions and intersections: Risks and dynamics do not unfold in a vacuum. They collide and intersect in ways that are new, difficult to anticipate, and have consequences that are highly uncertain, stressing the need to examine and explore scenarios and responses to cascading crises or rapidly moving opportunities.

Risks and dynamics do not unfold in a vacuum. They collide and intersect in ways that are new, difficult to anticipate, and have consequences that are highly uncertain.

Alternative analysis tools offer analysts and decision-makers an effective means of planning for possible risk and uncertainty in increasingly vulnerable and unsettled operating environments. These tools are designed to achieve two linked goals.

First, alternative analysis methods ensure that core and frequently inherited assumptions about environments of interest are systematically challenged in order to overcome the perils of cognitive bias—including selection bias and confirmation bias—and groupthink, to which even the most

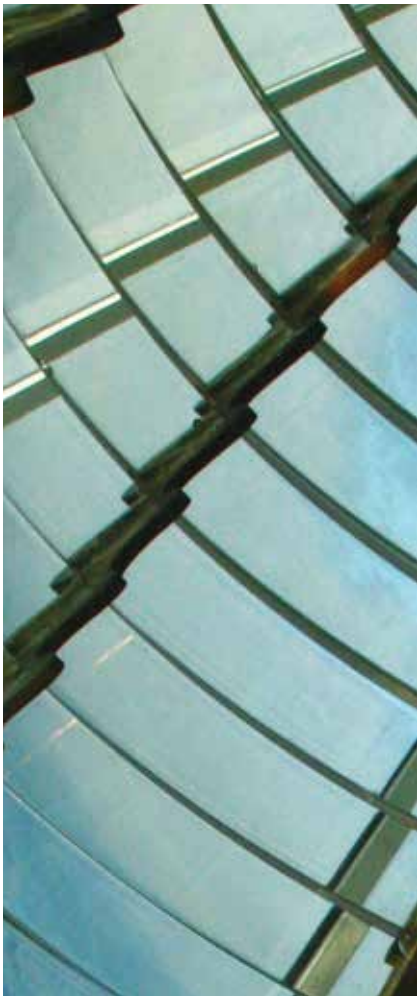
or searching for outcomes or implications not visible through analysis of these trends is likely to lead to assumptions about future environments that are incomplete or incorrect.

Single-outcome forecasting: Forecasts can be exceptionally useful inputs into any decision-making process. However, basing decisions solely or predominantly on a single outcome can inhibit the ability of organizations to anticipate and adapt to disruptions.

Preferred outcomes: Organizations and individuals frequently consider only the data and perspectives about the future that benefit them most. From US radio pioneer Lee De Forest's rejection of the future of television to former Vice President Dick Cheney's statement that the uptick in attacks in Iraq in 2005 constituted the "last throes of the insurgency," the temptation to see only what one wants to see can be strong and, ultimately, deleterious to good decision-making.

Always/never: Analysts and decision-makers should be wary of absolutist thinking and the use of terms of inevitability, such as "always" or "never." Even physical laws are challenged and revised—albeit rarely—as more evidence leads to better hypotheses.

Tate Nurkin



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sophisticated and reflective analysts and decision-makers are susceptible (see sidebar pp. 36-37). Second, these techniques also give decision-makers a structured means of expanding and exploring a broader range of alternative outcomes *other than* the most likely or the small subset of outcomes implied by current, observable trends.

Three categories of techniques are particularly useful in supporting decision-makers in better dealing with ambiguity and disruption: scenario planning, war gaming, and "red teaming."

Writing histories of the future: Scenario planning

"One thing a person cannot do, no matter how rigorous his analysis or heroic his imagination, is to draw up a list of things that would never occur to him."—Thomas Schelling, winner of the 2005 Nobel Memorial Prize in Economics

The term "scenario planning" is frequently conflated with "scenario modeling," but while they share some common elements, they are markedly different methodologies designed to achieve markedly different objectives.

While scenario modeling typically seeks to examine a set of scenarios in order to identify the most likely scenario(s) or the scenario with the greatest impact if it were to come to pass, scenario planning is, at least initially, agnostic about the probability of any one scenario occurring. The objective of scenario planning is not to predict a specific set of events that is likely to take place—though planning case scenarios *can* be incorporated into scenario planning—but to force decision-makers to consider a broad range of *plausible,* as opposed to merely likely, and distinct futures rather than low, medium, and high versions of the same future.

By accepting all scenarios to be "true" and encouraging participants in scenario planning exercises to "not fight the scenario," scenario planning allows for assessments of challenges, vulnerabilities, dynamics, drivers, personalities, opportunities, capabilities, relationships, strategies, operations, and tactics relevant not only to each individual representative scenario, but also across multiple scenarios considered (see sidebar on facing page).

Scenario planning is also an exceptionally valuable tool in helping organizations anticipate disruption or transition and in proactively responding to shifts in key environments of interest in order to mitigate risks or capitalize on opportunities. One of the most important outputs of any well-executed scenario planning exercise is the identification of signposts, or indicators, that one scenario or category of scenarios is more or less likely to come to pass. When signpost identification and monitoring are effectively matched with the development through collaborative and multidisciplinary scenario exercises of hedging strategies for dealing with each scenario examined, organizations can move to enhance resilience as shifts and disruptions are emerging rather than after they have already occurred.

Simulating the future: War gaming

War gaming (also called tabletop

gaming, policy gaming, or strategy gaming) is a dynamic process through which stakeholders "play out" scenarios that simulate possible real-world environments of interest to sponsor organizations in order to achieve one or more of the following core analytical and educational objectives:

- Challenge and test plans, strategies, policies, and tactics
- Explore new or uncertain landscapes, markets, or competitors
- Identify and anticipate risks and disruptions that could affect policies, plans, operations, or landscapes of interest

Tabletop games bring together key stakeholders and select multidisciplinary subject matter experts who are divided into teams for the purposes of the game. These teams then role play specific perspectives within the context of a given scenario over the course of multiple "moves" or segments of a particular game. Games are flexible tools—there is no one right way to design and run a game—and can be applied across multiple industries and domains to support a range of analytical and decision-making purposes. These include understanding

Applying scenario planning and alternative analysis: NATO futures

IHS Aerospace, Defense, and Security's ongoing *NATO Futures* multiclient study (to be released to subscribers in March 2015) provides a useful case study of when, how, and to what end to apply scenario planning exercises.

The topic of the future of NATO and European and trans-Atlantic security lends itself to a scenario planning exercise due to the enormous uncertainty surrounding these issues. For the third time in the last quarter century—the first two followed the Cold War and 9/11—NATO faces a radically shifting strategic context: Afghanistan, Russia, the Islamic State, Libya, extremism, cyberwarfare, and a range of internal challenges are all conspiring to create a new strategic context in which long-standing assumptions about security frameworks are being challenged in stark and destabilizing ways. This changed and complex context requires a radical rethink of the mission, role, structure, capabilities, and membership of an alliance that is likely to look fundamentally different in five years' time from how it has for the last 12 years.

IHS has tracked the evolution of this shifted context and assessed what this means for the future of this most resilient of alliances since January 2014 through a four-step process: in-depth, open-source, and multidisciplinary research to identify key drivers, uncertainties, and building blocks; scenario category identification and pathway generation; facilitation of collaborative workshops that bring together multidisciplinary expertise to discuss scenarios; and, critically, identification and monitoring of signposts that one scenario is more or less likely to come to pass.

Our work to date has identified several categories of potential scenarios to be developed and formally assessed over the remainder of the project, including:

- *Segmented alliance:* A cohesive alliance that seeks to play an active role as a geopolitical and military force throughout the world and effectively incorporates differing threat perceptions and prioritization by developing pockets of capabilities focused on specific threats.
- *Fragmented alliance:* An inconsistently effective alliance that is unable to fully marshal its deterrent and political capacity due to internal challenges and disagreements over the prioritization of issues facing NATO.
- *Overextended alliance:* An alliance that is unable to prioritize threats and takes decisions in the short term that may leave it vulnerable to longer-term challenges and competitions.
- *Inert alliance:* An alliance that gradually loses credibility and capability under the weight of a broadening threat spectrum, deteriorating security environment, fiscal and political realities, and the strains of aligning the interests of 28 allies.

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competitive procurements, assessing which technologies will be most likely to affect business and landscapes, assessing decision-making of clients or competitors, and understanding vulnerability to physical or cyber attacks (see below).

Through creating and asking participants to explore and navigate a simulated world that has ties to, but is not a duplicate of, existing environments, games create a collaborative and risk-free setting within which decision-makers are free to consider alternatives that they would not otherwise be able to address without fear of real-

War gaming for corporates: A case study

While "war gaming" is most commonly associated with military and national security planners, the practice—more commonly referred to as "tabletop" or "strategy" gaming outside of the military context—is increasingly being applied by private sector organizations seeking to test strategies, explore new environments, and enhance resiliency.

For example, IHS was recently asked to design, plan, facilitate, and provide post-event analysis for a one-day game for a technology company seeking to enter into a defense- and security-focused market. The game brought together 20+ stakeholders from within the sponsoring organization along with two IHS subject matter experts and a team of six IHS facilitators, note takers, and game controllers.

Participants were divided into two teams representing the client's interest and worked through two scenarios for distinct procurement competitions during two half-day "moves." Both teams, role playing the same entity with the same stated interests and objectives, approached each scenario in distinct ways, deriving valuable and, in some cases, counterintuitive insights. Indicative takeaways included:

Organizational challenges:
The client organization was not set up in a way that would allow it to efficiently operate in and penetrate the market of interest, which required a set of specific administrative capabilities.

Networking and learning:
The game served as a useful forum for stakeholders from across the company to learn more about who was doing what in an organization that was in flux at the time. Several participants noted that many of the capabilities and functions required to compete in this market were resident in the company.

Tangible recommendations:
The game suggested specific, tangible recommendations for addressing identified structural and branding challenges.

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world repercussions. Games also require participants to make decisions in highly time-compressed environments—scenarios designed to take place over weeks or months or even years are played out in games lasting one to several days—forcing participants to invoke their intuition and identify alternative decisions and outcomes that may not be readily identifiable until participants have immersed themselves in the game environment and observed how decisions affect landscapes and issues of interest.

Injecting critical and competitive perspectives: 'Red teaming'

"Red teams are quintessential heretics. They are constantly trying to overthrow expectation."—Dr. Jim Schneider, School of Advanced Military Studies, Fort Leavenworth, KS

Red teams and red teaming—much like scenarios and scenario planning—connote different things to different people, meaning that a wide variety of

The elements of war gaming

SCENARIO BASED

- Gaming uses scenarios to create one or more new landscapes that simulate dynamics shaping real-world challenges and opportunities.
- Development of scenarios can occur through a range of mechanisms, including a scenario workshop held during the planning and preparation phase of the game; game execution; the facilitation of a full scenario planning exercise; or less formal guidance from clients.

TIME COMPRESSED

- Games can compress events that, in reality, take weeks or months into hours, requiring participants to rely on instinct and experience to assess rapidly unfolding contingencies and make decisions under strategic or operational duress.

DYNAMIC

- The interactions of teams and their decisions and actions in this simulated world have direct influence on how scenarios evolve, creating a highly dynamic forum that allows for rapidly changing or evolving challenges.
- Metrics and other qualitative and quantitative information can be incorporated that allow teams to see the impacts of their decisions and how the landscape changes.

INTERACTIVE

- Participants in games are organized into teams that play a specific role. Teams are constraints posited by the scenario.

COLLABORATIVE

- Games provide an opportunity for alternative actions to be discussed and arrived at collaboratively for participants to gain broader insights through plenary discussions about key dynamics and actors that will not have been revealed in their individual team discussions.

SAFE

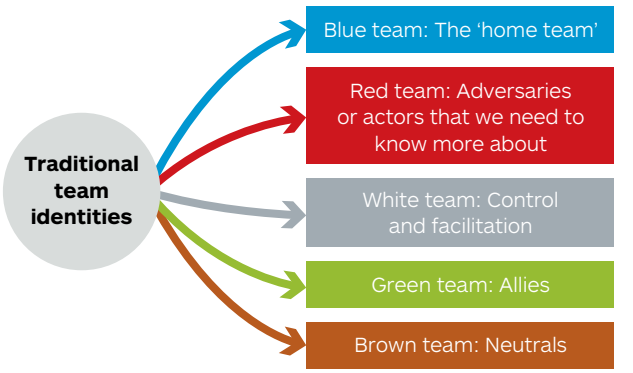
- Because the world of the game is self-contained and non-binding, participants can feel free to explore riskier approaches.

FACILITATED

- Successful games require active facilitation by a control team. This facilitation includes moderating breakout team discussions and plenary sessions as well as "driving the action" of the game to ensure that teams are appropriately challenged or exploring new environments. In this case, IHS resilience and other subject matter experts would participate to provide additional context and background on the scenario(s) being explored.

Source: IHS

Red teaming is derived from the color designations of the roles used in military and security war games



Source: IHS

applications for red teaming exists, including highly technical penetration testing or black hat/tiger team red teams designed to understand vulnerabilities in network security. As Dr. Mark Mateski, the editor of the *Red Team Journal* blog, has noted, "for every red team that exists, a slightly different definition for red teaming also exists."

The IHS Aerospace, Defense, and Security alternative analysis training team focuses its red team training and implementation activities around two distinct types of red teams: adversary/competitor red teams, designed to better understand competitor mentalities and objectives, and devil's advocate red teams, designed to formally incorporate and empower contrarian thinking into decision-making and deliverable review processes.

As with war gaming and scenario planning, the term "red team" is adapted from military and security contexts. Specifically, the term comes from the color designations of various roles used in military and security war games (see figure above). Red is used to designate adversary teams.

As a result, red teaming is most frequently associated with a dedicated and systematic effort to better understand adversary or competitor objectives, strategies, capabilities, interests, priorities, strengths, vulnerabilities, decision-making, behaviors, tactics, and operations. Assessing adversaries or competitors can be a tricky proposition without the help of a structured red team approach to overcome "mirror imaging"—the temptation to project one's own ordered preferences and views of the world on competitors.

Adversary or competitor red teams, then, are designed to bring together multiple individuals with very specific expertise about competitors of interest who are asked to perpetually think like the competition and devise new and inventive ways of creating challenges for "blue team" interests. By developing a more nuanced and accurate view of critical competitor attributes, perceptions, and objectives, blue team decision-makers can identify asymmetries to exploit, competitor processes to manipulate or influence, and specific internal vulnerabilities against which to mitigate.

For example, companies in the global defense industry frequently incorporate red teams into large proposal efforts. These teams can consist of a combination of internal and outside experts with specific knowledge of competitor mindsets, capabilities, and models. Red teams are called upon to work collaboratively to develop running analyses of "win themes" and bid strategy and tactics for each competitor of interest. These insights are then fed back to the capture team, which uses them to address vulnerabilities and capitalize on competitive advantages in their own proposal.

The second category of red team of particular interest to IHS is the devil's advocacy red team, in which a group of experienced, creative, empowered, and critical individuals is asked to regularly critique and challenge key assumptions, usually from the perspective of the consumer of analysis, decisions, or new products and services.

Many in the business world, especially in functions focused on proposal and capture management, will be familiar with this version of red team, particularly within the context of serving as a stage in color team proposal review processes. The red team stage is an opportunity for a draft document to be critically evaluated by a panel of individuals empowered to act as devil's advocates and ask hard questions of the draft that *are likely to be asked by the customer* during the actual evaluation process.

Regardless of the objective and structure, red teaming is a powerful and adaptable technique to allow organizations to improve decision-making by considering their own strategies, processes, value propositions, and views of the future from the perspective of other stakeholders that seek to

undermine or question these approaches.

A tool, not a silver bullet

Alternative analysis techniques—and the critical mindsets that buttress them—are vital elements of decision-making and strategy support in a world that is increasingly prone to disruptive geopolitical, political, security, technological, business, market, and natural events.

These techniques—if properly conceptualized and implemented—can help decision-makers by:

- Suggesting how a wide variety of trends, influences, and forces could shape risk environments
- Testing strategies and assumptions about risk environments and responses
- Considering in advance operational and strategic alternatives to managing and mitigating risk that would not be revealed through more traditional and conventional techniques

While alternative analysis techniques take different forms and seek to achieve different specific objectives, all alternative analysis techniques stress the need to improve decision-making through collaborative environments designed to incorporate multidisciplinary, critical, and creative perspectives into efforts to challenge assumptions and expand alternative outcomes considered.

However, alternative analysis techniques are not a silver bullet. Scenario planning, war gaming, and red teaming, in particular, are tools designed to challenge existing analysis and to expand thinking about that analysis. Therefore, they must be incorporated with more traditional analyses, including expert commentary, models, and trend analysis, to gain a more complete vision of current environments, future outcomes, and understanding of the critical uncertainties that are shaping this future.

Moreover, alternative analysis techniques are not without implementation challenges and require clear and well-articulated objectives, parameters, and designs in order to most effectively help organizations anticipate—if not fully predict—disruptive events. However, if alternative analysis techniques are effectively implemented, their underlying mindsets and instincts to ask "why" and "why not" embraced by decision-makers, and their outputs supported by organizational leadership, these tools can successfully prepare organizations to adapt to shifting environments in order to effectively mitigate novel risks and capitalize on fast-moving opportunities.

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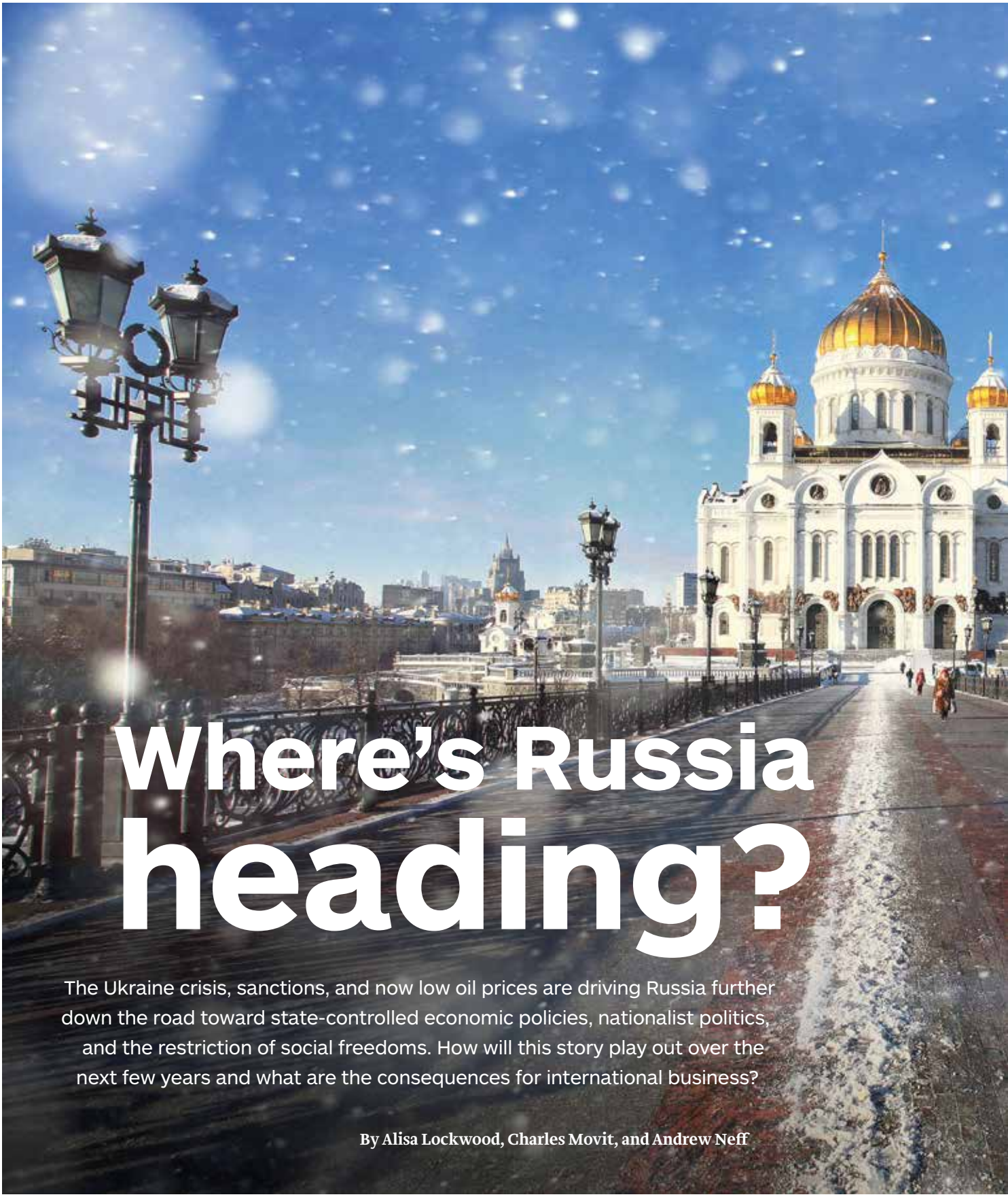
on.ihs.com/TateNurkin

For more information, visit ihs.com/Q21WarGames

Alternative analysis techniques—and the critical mindsets that buttress them—are vital elements of decision-making and strategy support.



Where's Russia heading?

The Ukraine crisis, sanctions, and now low oil prices are driving Russia further down the road toward state-controlled economic policies, nationalist politics, and the restriction of social freedoms. How will this story play out over the next few years and what are the consequences for international business?

By Alisa Lockwood, Charles Movit, and Andrew Neff

Shutterstock

On February 21, 2014, as Russia was wrapping up a successful Olympics in Sochi, Ukraine President Victor Yanukovych unexpectedly fled his country amid violent street protests. This was the culmination of Ukraine's "Euromaidan revolution," prompted by Yanukovych's decision three months earlier to pull Ukraine out of a deal that would allow closer ties with the European Union.

Russia refused to recognize the interim Ukrainian government that displaced Yanukovych. Soon afterward, government buildings in Crimea were seized by so-called "little green men," widely perceived to be acting on Russia's behalf. In March, following a controversial referendum, Crimea was annexed by Russia. Pro-Russian separatist movements emerged in the eastern Ukrainian cities of Donetsk and Lugansk. In subsequent weeks, the separatists expanded their territorial control inside Ukraine.

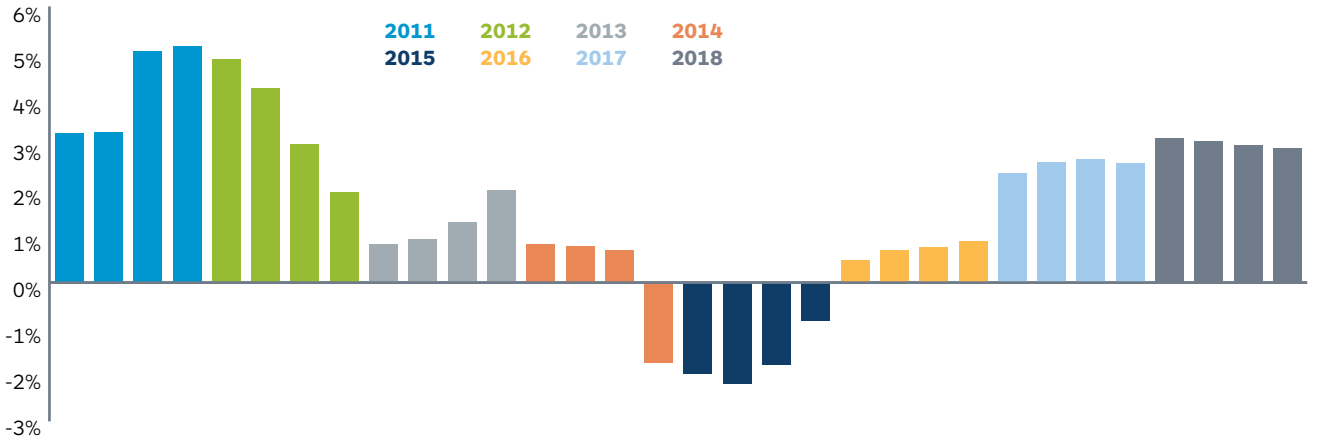
These actions were quickly followed by a round of sanctions against Russia from the United States, later joined by the European Union (EU), Australia, Japan, and others. The tragic downing of the Malaysia Airlines civilian flight MH-17 on July 17 over the rebel-held territories galvanized previously reluctant EU states to support harsher sanctions. In response, Russia banned agricultural imports, including meat, fruit, and vegetables, from Australia, Canada, the EU, Norway, and the United States.

In September, as the government in Kiev came to realize that an outright victory over the separatists was unlikely, it agreed to a cease-fire during negotiations in Minsk. However, hostilities continued and in November illegal elections were held in the self-proclaimed Donetsk People's Republic and Lugansk People's Republic, drawing further condemnation from the United States and EU.

Relations between Russia and the United States have now reached their lowest point since the end of the Cold War. The Obama administration appears resolved to increase pressure on the Kremlin by removing preferential trade treatment granted during previous administrations and has called for Russia to uphold and fully implement the Minsk agreement, aimed at a peaceful political solution of the conflict in Ukraine. Russian president Vladimir Putin has responded, accusing the United States of seeking to reshape the world for its own benefit.

Sanctions and low oil prices could mean recession for Russia this year

Year-on-year change in Russia's GDP by quarter, 2011-2018 (%)



Source: Russian Federal State Statistics Service and IHS

Domestically, Russian government policy is re-emphasizing "state capitalism," dominated by several large state-owned companies, with decision-making controlled by a small inner circle of conservative former security officials, the so-called *siloviki*. This inward-looking orientation encourages and builds upon rising nationalist and anti-Western sentiment within the Russian population. It also creates the perception of a more hostile environment for Western firms operating in Russia.

To reignite growth, Russia needs to diversify its economy away from its reliance on energy, which will require massive capital investment. The aging infrastructure in non-energy sectors also limits the potential for growth.

As ties with the West deteriorate, Russia is looking to strengthen relationships with emerging markets, including reorienting its energy trade by increasing oil and gas exports to China to offset its reliance on the European market. At the same time, it is cementing bilateral relationships along its western and southern borders with Armenia, Belarus, Kazakhstan, and Kyrgyzstan through the extension of the Eurasian Economic Union.

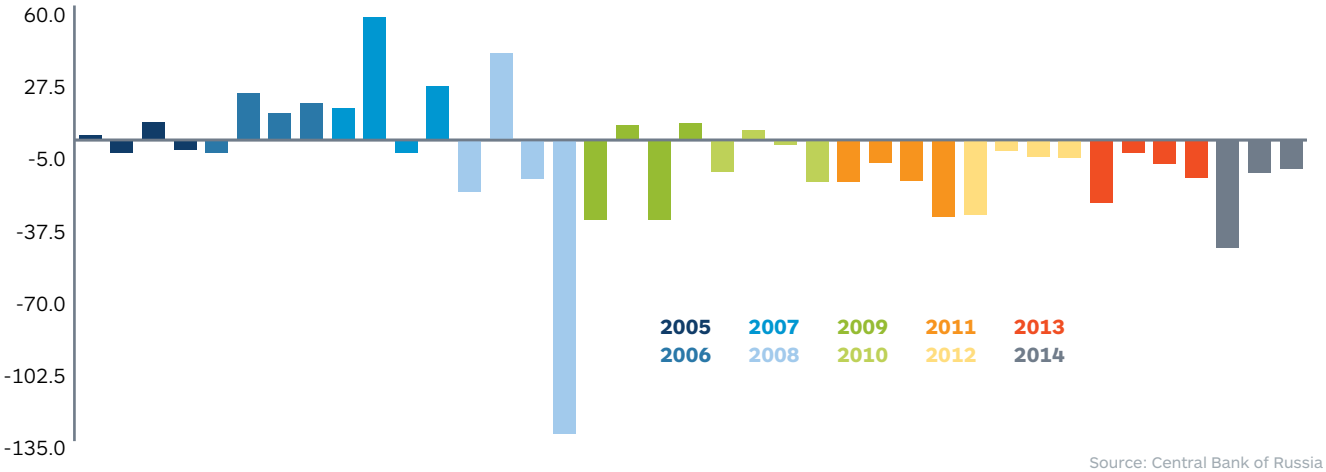
Russia's economic challenges

The past year has been a tumultuous one for Russia's economy. Sanctions by the West have resulted in a sharp decline in exports, a rise in inflation, and the flight of capital from the country. Falling oil prices have taken their toll on state revenue, of which oil and gas receipts account for about half. Combined, these shocks have caused the depreciation of the ruble by as much as 40% and required the Central Bank of Russia to intervene to prop up the currency.

Before the global recession of 2008, Russia's economic growth ranged between 6% and 8% per year. In 2013, Russian economic growth decelerated to just 1.3%. In 2014, Russia saw economic stagnation at best and recession at worst, with IHS forecasting the latter for 2015 (see figure above).

Russia's capital flight in 2014 was the highest since the Great Recession

Net capital flow for the Russian private sector, US$ in billions (Q1 2005-Q3 2014)



Source: Central Bank of Russia

To reignite growth, Russia needs to diversify its economy away from its reliance on energy, but this will require massive capital investment. Technological progress—what economists call "total factor productivity"—has been growing slowly in Russia compared with developed Western countries. The overburdened and aging infrastructure and obsolete productive capacity in non-energy sectors also limit the potential growth of Russia's economic output.

Moreover, Russia has human capital issues. One of the country's central problems in its ability to modernize is a lack of managerial skills in the public and private sectors. Separately, Russia's population is shrinking and aging, which has implications for the size of the labor force and new business development, not to mention the increased cost of care and pensions that will be borne by the state in the coming years.

The small- and medium-sized enterprise (SME) sector, which is an engine for growth in the West, is insufficiently developed in Russia. The challenges faced by SMEs, including corruption and red tape, discourage the establishment of new businesses. This reluctance is only compounded in the current environment. Not only foreign investors, but Russians themselves, are hesitant to make investments in the existing climate.

While there are certainly some success stories—Pepsi and Procter & Gamble, for instance, grew market share in 2014 and Russia is now among their top five markets globally, according to the US-Russia Business Council—the general sentiment among investors is negative. This sentiment has been shaped by recent high-profile cases of inadequate protection of private property rights and the rights of minority stockholders, the lack of an impartial judiciary, manipulation of the tax and regulatory regimes to further the interests of state-controlled or Kremlin-friendly enterprises, bureaucratic hurdles to business startup, and widespread corruption.

As a result, Russia has been chronically unable to stanch the large net outflows of capital from the country (see figure above). The Central Bank of Russia projects that net capital outflow from the private sector will reach $128 billion in 2014, up from just more than $61 billion in 2013. This would approach the $133.2 billion that left Russia on a net basis in the crisis year of 2008. In fact, during the past decade only two years—2006 and 2007—have seen a net inflow of capital into Russia. This inflow was driven by the enthusiastic investment in emerging markets generally that immediately preceded the global financial crisis.

However, several recent developments have served to additionally discourage potential investors, resulting in heightened capital flight. Early in 2014, international investors became increasingly averse to emerging markets, Russia in particular in light of its unattractive investment environment and the increasing instability in Ukraine. It had been cheap money in the developed West that had sent investors to emerging markets in search of higher yields. With the US Federal Reserve announcing its intention to taper its program of quantitative easing, the prospect for higher interest

rates increased. Combined with disappointing economic performance from a number of major emerging markets, including Russia, this drove a sell-off of ruble-denominated assets.

In March 2014 came the sanctions, first imposed against selected Russian individuals and their associated banks and investment vehicles, but later extended to a number of major Russian state-owned banks, energy companies, and other enterprises. The increased uncertainty generated by these developments—including the prospect of retaliation by Russian authorities against Western interests in Russia and potential capital controls—further motivated capital flight.

Overreliance on oil and gas industry

The third blow to Russia's faltering economy came from the decline in the world market price for crude oil. Over the course of the second half of 2014, the price of Brent crude—to which Russian oil prices are closely tied but with a discount of some $2 to $3 a barrel—fell by more than 30%, to below $80/barrel at the end of November. OPEC's decision on November 27 not to cut back production in order to support prices triggered a further decline in oil prices in early December. Oil and gas represented around two-thirds of the total value of Russian exports in 2013, with crude oil and petroleum product exports making up the bulk of this total. At the same time, the oil and gas sector in 2014 provided about 50% of the federal budget revenues. The impact of sharply lower oil prices will very likely tip an already stagnating Russian economy into recession (see figure below and figure on facing page).

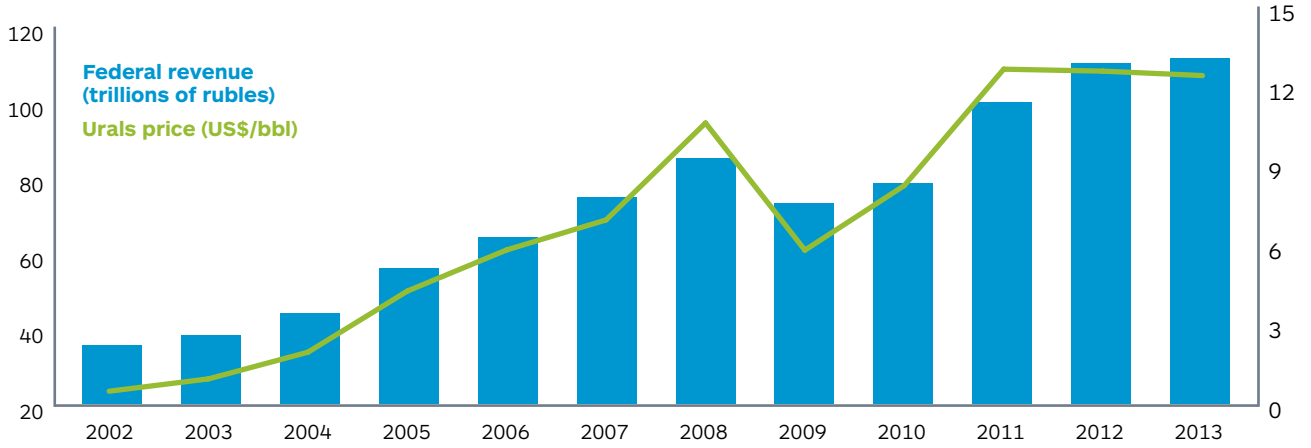
The importance of the oil and gas industry to Russia's economic growth has been the driving factor behind the state's pursuit of more control of the sector over the past decade. At the center of this pursuit is Rosneft, the world's largest publicly traded petroleum company in terms of production and reserves following its 2013 acquisition of TNK-BP. Russia owns a 69.5% stake in the company and uses this control to advance the state's interests in the oil sector.

Rosneft is a major contributor to the federal budget in its own right, and the $64.1 billion in taxes it paid into the state budget in 2013 made the company the country's single-largest taxpayer. Rosneft also paid out 25% of its net profits in dividends to its shareholders in 2013, with total dividends of $2.2 billion, more than double the previous year. As the majority shareholder in Rosneft, the Russian state is the main beneficiary of these dividend payouts.

Of course, Russia's dependence on oil and gas revenues makes the economy vulnerable to price swings. After a period of 53% oil production growth from 1998 to 2004, the Russian government enacted major changes to its oil taxation regime, ensuring that the bulk of "windfall profits" from rising oil prices at the time were directed to state coffers and the National Wealth Fund, one of two "rainy day funds" set up to absorb oil revenues and help stabilize the economy in times of crisis.

Russia's federal government revenue gained from a decade of rising oil prices

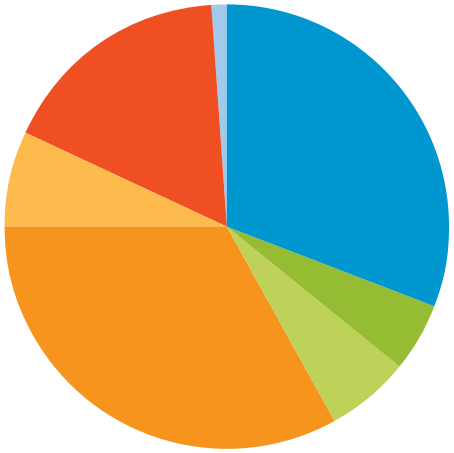
Urals oil price per barrel, US$ (left axis), Russian federal government revenue from oil, Russian rubles in trillions (right axis)



Source: IHS and Russian Ministry of Finance

As oil prices fall, so will Russia's tax revenue

Hydrocarbon-sector tax revenue in Russian federal budget by type (2013)



Source: Russian Federal State Statistics Service

Under the oil taxation regime put in place in 2004, at an oil price above $25 a barrel, incremental taxes—including tax receipts, export duties, import tariffs, and other income—take an estimated 85% of the additional gross revenues, so the state captures virtually all of the upside of higher oil prices. However, this also means that a sharp drop in prices puts the government's fiscal revenue base in jeopardy. In 2008-09, the collapse of world oil prices forced Russia to dip into these stabilization funds to bail out domestic industries in the midst of the global financial crisis.

Russia's economy is reliant on oil price escalation to deliver on Putin's spending priorities, so lower prices will force Russia to curtail its spending plans or operate with a larger budget deficit. Russia's 2014 budget was based on a Urals blend export crude price of $93 per barrel and a budget deficit of 0.5% of GDP, with escalation to $100 a barrel between 2015 and 2017 generating an even wider deficit of 0.6% of GDP per year.

What's more, the domestic Russian oil industry itself increasingly requires higher oil prices in order to offset rising exploration and production costs. As production from mature oil fields declines in West Siberia—the heartland of the industry and the source of the majority of Russia's oil output—oil companies are having to move farther afield to secure volume growth. In addition to exploration costs incurred in frontier basins in East Siberia, in tight oil reserves, and offshore in the Arctic region, the need to invest in new road and pipeline infrastructure for monetization of resource discoveries places additional pressure on finding and development costs.

The government is trying to stimulate investment in new projects to ensure stable oil production in Russia over the long term by providing targeted tax breaks for certain regions. However, the Ministry of Finance is keen to avoid any loss in revenue to the Treasury from tax holidays granted to the oil and gas sector.

Western sanctions, particularly those targeting shale oil and offshore Arctic development (among the primary potential future sources of new Russian oil production growth), have clouded the outlook for Russia's oil sector, with output expected to decline this year from 10.6 million barrels per day in 2014. The deleterious effect of sanctions in curtailing upstream investment in the near term could have an even larger long-term impact on Russia's oil sector, although production levels will also depend on world oil price dynamics and Russian tax terms.

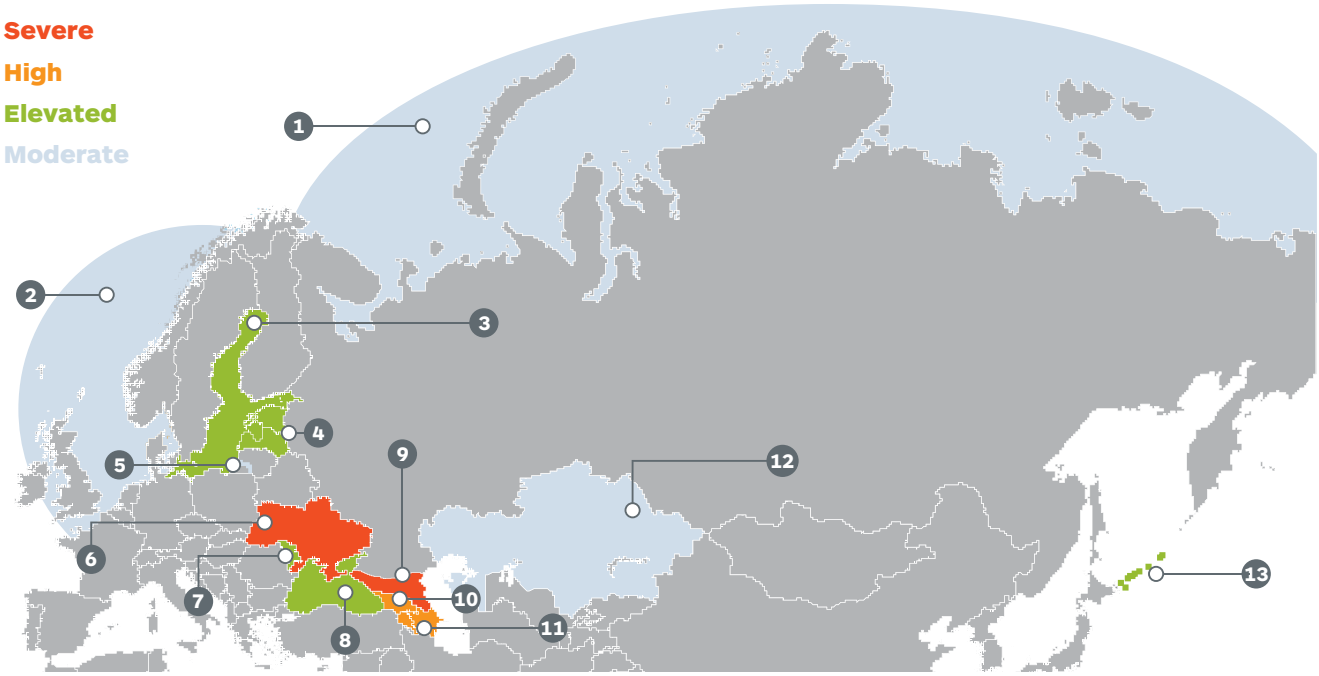
Russia's social challenges

The economic challenges Russia faces carry the risk of social unrest. As economic stagnation and sanctions start to affect wages and employment, the risk of protests will rise and Putin's approval ratings are likely to suffer. For example, some 5,000 public health sector workers and their supporters protested in Moscow on November 30 over planned layoffs of 10,000 doctors and hospital closures. The government's standard response to such challenges since Putin returned to the presidency in 2012 has been to crack down on protests, imprison opposition leaders, and appeal to nationalist tendencies and Russian patriotism.

Nationalism has been reinforced by a surge in Great Russian patriotism and anti-Western sentiment caused by the annexation of Crimea, the conflict in Ukraine, and sanctions by the West. To shore up the government's popularity and deflect any blame for domestic ills, government officials, including Putin, have portrayed the Ukrainian government as "Western-supported fascists,"

Russia's hot spots

Russia's increasing assertiveness is likely to manifest itself in increased support for regional separatist movements and pro-Russian minorities in its "near abroad," as well as in military incidents such as the increasingly frequent airspace and marine incursions witnessed in the Baltic region, northern Europe, and the Black Sea in 2014.



1 The Arctic

Unresolved territorial claims, increasing militarization. Risk of disruption to maritime cargo.

2 Norwegian and North seas

Territorial violations in the form of airspace and marine incursions. Disputed Russia-Norway sea boundary settled in 2010.

3 Gulf of Finland/Baltic Sea

Territorial violations in the form of airspace and marine incursions; harassment of vessels in international waters.

4 Estonia and Latvia

Civil unrest by Russian-speaking minorities encouraged or fomented by Russia.

5 Kaliningrad/Lithuania border

Disputes over cargo transit to Kaliningrad.

6 Ukraine

"Frozen conflict" in east with risk of expanded Russian intervention, annexation of more territory, or renewed conflict over Crimea.

7 Moldova

Civil unrest by pro-Russian minorities encouraged or fomented by Russia; escalation of conflict over pro-Russian Transnistria separatist region.

8 Black Sea

Territorial violations in the form of airspace and marine incursions; harassment of vessels in international waters.

9 North Caucasus

Resurgence of Islamist militancy, with IED and firearm attacks against government targets and transport infrastructure.

10 Georgia

Renewed conflict over Abkhazia and South Ossetia separatist regions; Russian annexation of one or both of the regions.

11 Nagorno-Karabakh

Azerbaijan-Armenia war over the separatist region pulling in Russia as an ally of Armenia and fellow CSTO member.

12 Kazakhstan

Civil unrest by pro-Russian minorities encouraged or fomented by Russia.

13 Kuril Islands/Sea of Okhotsk

Unresolved territorial dispute with Japan over the Kuril Islands; increased territorial violations in the form of airspace and marine incursions.

Source: IHS

called for solidarity with Russian-speakers in eastern Ukraine, and claimed victimhood in the face of sanctions.

The success of the appeal to nationalist and patriotic sentiments, as indicated by Putin's soaring approval rating following the Crimea annexation, means that the government is likely to repeat those appeals whenever its popularity is under threat. The official line remains one of so-called "civic" nationalism rather than the more ethnically charged nationalism of the Russian far right. Nevertheless, the approach risks alienating non-Russian minorities in important oil-producing regions such as Tatarstan and Bashkortostan.

Combined with a probable diversion of resources from development work and counterterrorism operations in the majority-Muslim North Caucasus republics to more pressing economic and military challenges, there is a risk that the Islamist insurgency in that region will strengthen in the coming years, potentially bolstered by returnee militants currently fighting alongside the Islamic State. Islamist-inspired unrest could also unfold in Crimea, where the Crimean Tatar population has experienced increasing harassment and marginalization following Russia's annexation (see map on facing page).

Governance challenges

The consolidation of the conservative factions at the top of Russian politics since Putin's return to the presidency has been accompanied by a worsening of the judiciary's independence and private property protection. The former was indicated by the merger of the Supreme Court and Supreme Arbitrage (Commercial) Court, approved in early 2014. The commercial courts system is generally recognized as more independent, while the general courts system has often acted as an enforcer for the executive branch of the government rather than a counterbalance on its authority.

Regarding protection of private property, the September 2014 arrest of billionaire Vladimir Yevtushenkov—the majority shareholder of the conglomerate Sistema—and the confiscation in October of his shares in oil company Bashneft, a Sistema company, indicate that the government is willing to expropriate assets outright in order to serve political purposes. In the case of Yevtushenkov, the motivation was likely twofold: to pre-empt any potential disloyalty within the business elite as a result of the Kremlin's Ukraine policy and to expand Rosneft's portfolio in order to buttress the company's threatened production capacity.

This trend is likely to continue, with a particular risk to foreign investors from countries imposing sanctions on Russia. While a draft law threatening to seize foreign assets as compensation for Russian individuals affected by Western sanctions was deemed unconstitutional, businesses are at increased risk of government intervention, primarily in the form of regulatory changes introduced to squeeze foreign players out of the market. The multiple sanitary inspections and fines for McDonald's restaurants across the country are indicative of the less-intense type of

The success of the appeal to nationalist sentiments, as indicated by Putin's soaring approval rating following the Crimea annexation, means that the government is likely to repeat those appeals whenever its popularity is under threat.

intervention that is more likely for most investors in the coming months, as long as sanctions persist.

Russia's path through 2018

Given the anticipated developments in Russian politics, civil society, and foreign relations, Russia faces two scenarios for the remainder of Putin's six-year term, which ends in 2018. The first might be dubbed "more of the same." That is, strengthening of the central state, concentration of economic power in the hands of large state-controlled monopolies and Kremlin-allied financial-industrial groups, and continuing to shore up Russia's sphere of influence in Eurasia while pivoting east toward China and south toward Turkey, South Africa, and Brazil. There would likely be few new approaches taken to meet the mounting set of challenges to the economic and social well-being of the mass of the Russian population, and attempted reforms would in any case be stifled by bureaucratic inertia. This scenario becomes more likely the longer sanctions are in place (or if sanctions grow) and as NATO entrenches its presence in Central and Eastern Europe.

An alternative scenario might be called "renewed reform." It would be "renewed" because when Putin first took power in 2000, his advisors formulated an impressive slate of economic reforms aimed at further market liberalization. These plans were gradually diluted, deferred, or abandoned. When Dmitri Medvedev became president in 2008, he too set out an ambitious reform agenda. Some progress was made, but even this has largely been rolled back in the two years since Putin returned to office.

Consequences of 'more of the same'

The costs of "more of the same" are already in evidence as the economy has ground to a halt. The relatively high world market price of oil that provided for windfall profits and government receipts in past years helped the regime avoid meaningful reform. However, those receipts are now dwindling, which could lead to social discontent. Staying on the current policy course is likely to mean an extended period of economic stagnation for Russia. This would be in stark contrast to the rapid improvement in living standards seen in the middle years of the last decade that served to boost Putin's popularity and would slowly undermine Putin's sources of popular approval. The "statist" response to poor economic performance would be characterized by a centrally directed program of budget-funded investment resulting in a further concentration of control over productive resources by large state-controlled enterprises.

This, however, is not a recipe for accelerated productivity growth, which is the only answer to the myriad problems Russia faces. Slow expansion of aggregate output means that fiscal pressures would become more severe. The current fiscal framework established for 2015–17 calls for an average fiscal deficit over that period of 0.6% of GDP and assumes an average price of Urals blend crude oil of $100 per barrel. That framework also incorporates plans for massive investment in the military, hefty increases in social transfers and public sector salaries, and large infrastructure development initiatives in the Far East.

These measures are in keeping with the campaign promises made by Putin in the runup to the 2012 presidential election. However, the so-called non-oil deficit—the budget balance excluding the contribution of oil and gas to tax revenues—is in the range of 10% of GDP, which the International Monetary Fund has called unsustainable. In a lower-oil-price environment, Putin will have difficulty in delivering on these promises without, at a minimum, expending the fiscal reserves of about $170 billion that Russia accumulated

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during the period of relatively high global oil prices.

Moreover, given the high priority Putin has placed on Russian geopolitical ambitions—namely, the annexation of Crimea and support for pro-Russian separatists in eastern Ukraine—and how these have trumped economic concerns, it is likely that investment in the armed forces will take precedence.

'Renewed reform' path

Russia's political leadership is well aware that the business and investment environment in Russia is unattractive while the country's productive potential hinges on the injection of massive amounts of capital investment. It is also aware of the changes that are necessary to attract that investment back, foreign and domestic. The most immediate reforms must address issues of governance and transparency. This would require an impartial judiciary, evenhanded enforcement of tax laws and environmental regulations, guarantees of private property and minority shareholder rights, and removal of bureaucratic hurdles for business startups.

At the same time, the quality and compensation of the local and regional public sector apparatus would need to be improved in order to limit incentives for corruption. Incentives for entrepreneurs, together with lower barriers to entry and a well-regulated banking system, would invigorate the SME sector. In order to attract foreign investment—which brings with it injections of technology and commercial know-how—a more accommodative foreign policy would be necessary.

Yet the costs of such a reform path to the current power structure, in the form of a loss of influence by certain factions and greater political instability, are likely to be seen as too high. For this scenario to materialize requires a trigger that shifts public sentiment. One such trigger, for example, would be a prolonged economic decline resulting in the non-systemic opposition gaining support within the wider population—on a scale that is difficult to contain with repressive methods—forcing the government to pursue appeasement through more liberal policies. Externally, a rollback of sanctions and rapprochement with the West would be necessary in order to change investor perceptions and make investor-friendly reforms worthwhile from the Kremlin's perspective.

The barriers to these developments are, however, significant, given the entrenched interests of the highest circles in the Kremlin in the status quo. Nevertheless, in the face of serious economic and social challenges, together with severe constraints on state resources, this scenario has the potential to unfold in the next several years.

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Seeing the IP trees *and* the forest

Corporate intellectual property is an asset. It is created, developed, nurtured, protected, and ultimately retired in a continuous cycle. Each stage requires specific strategies to maximize the value of IP to generate growth. Much like a leaf on a branch upon a tree in a forest.

By Matt Coates, Michelle Lynch, and Ian Mitchell

From the embryonic to the iconic, companies and whole industries are defined by the intellectual property (IP) they own. In our increasingly convergent world, a startup with one key patent can grow exponentially while mega-companies dominating whole patent classification codes can be displaced and, if they don't adapt, rendered obsolete.

Investors value the strength of a company's IP portfolio and its ability to defend and grow it; but it can be a risky business. There is a large and growing global legal industry—both internal legal departments and independent law firms—whose purpose is to engage in the defense and dismemberment of IP. Knowing when to "lawyer up" and when to move on is rarely an easy decision, and even a legal victory is no guarantee of a successful business strategy.

In parallel, companies face the challenge of developing and evolving their IP portfolios: that is, creating an environment or framework in which investment consistently produces value for stakeholders in the form of new products or processes. As with any strategic asset, managing and protecting IP is core to revenue growth and company valuation.

Understanding the evolution of IP and its trajectory can produce insight into how and when it can be leveraged to create new market opportunities—whether in an already-crowded landscape or an as-yet-to-be-defined new product category.

A visual analogy for understanding this evolution is to consider the global patent collection as an IP "forest." Each "tree" represents a unique product category based on a patent classification code, such as the International, or IPC, code. For example, the code H04Q7/00 is "selecting arrangements to which subscribers are connected via radio links or inductive links." This particular product category has seen an explosion of activity due to the growth of cellular communications. Individual product category trees, such as H04Q7/00, sprout from foundational "seedling" patents that grow with the addition of new patent "leaves." These new leaves may be derivatives of the original patent or come from other disciplines.

Peter Beddow

The sprout grows into the market-driven "sunlight"—that is, market demand for products utilizing the IP. As a seedling becomes a "sapling," new patent leaves are introduced to absorb new market light. As the tree thrives, it matures and the proliferation of leaves produces branches that support growth to new market light. Over time, the lower branches receive less light, becoming backward citations. They are the necessary building blocks that ensure the growth of other branches that are now pursuant of the strongest market light and defining the latest iteration of product innovation.

Mature trees produce seeds that will themselves grow into new trees. Sometimes these sprouts fall adjacent to the parent tree and sometimes they plant their roots in a distant part of the IP forest.

The portability-of-sound patent tree

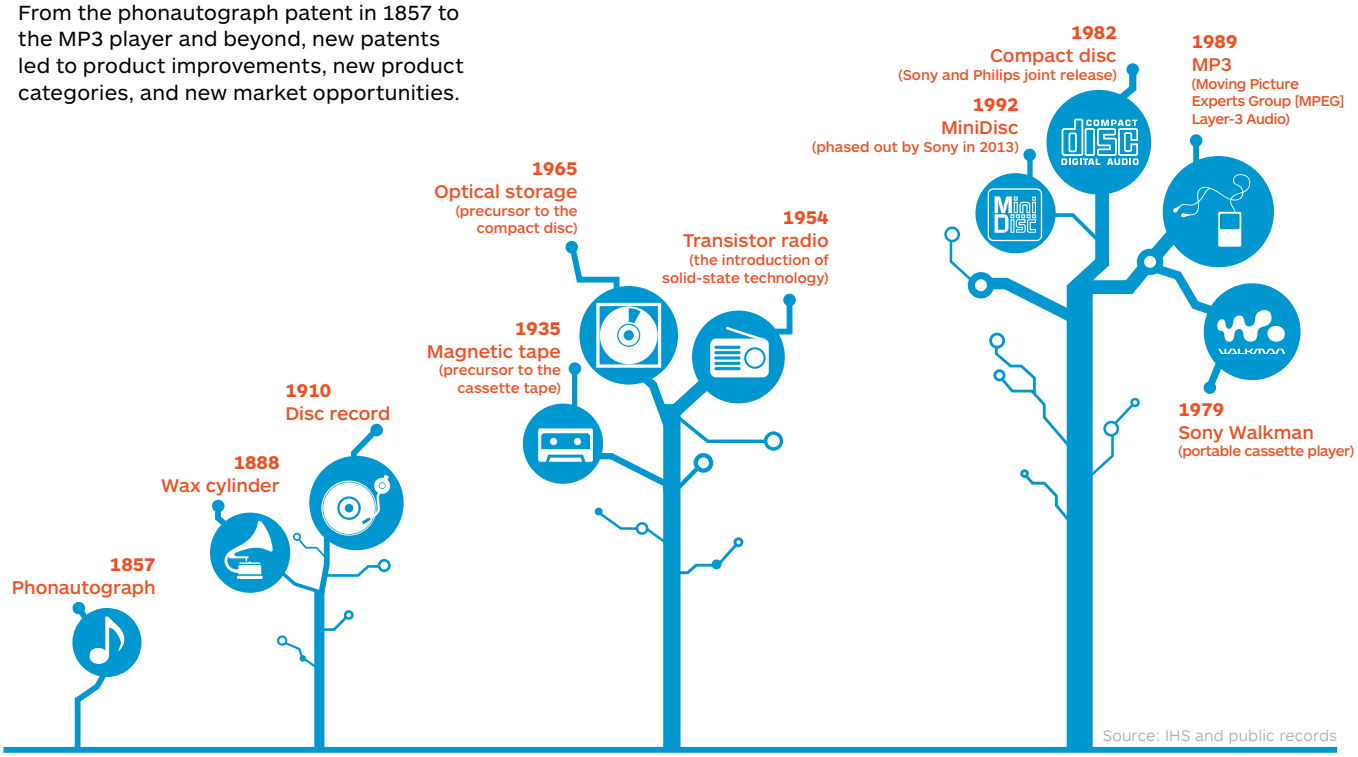
To ground the leaf-tree-forest metaphor in reality, consider the "portability of sound" product category (see figure below). The original seedling broke through the fertile soil on March 25, 1857, when Édouard-Léon Scott de Martinville received a patent for an invention he called the phonautograph, a device intended to record sound but not play it back. Scott's invention predated Edison's patented wax cylinder by some 30 years. Edison's wax cylinder, in turn, was disrupted by the invention of the disc record in 1910.

If Scott's invention was the founding patent for the portability-of-sound sprout, then Edison's cylinder was the first fully formed patent leaf, which grew into a branch on the sapling. But the cylinder was soon overshadowed by the disc record branch, which received the lion's share of the market light in the early decades of the 20th century. Many incremental innovations were introduced and patented as the branch grew.

In 1954, a new branch emerged on the portability-of-sound tree when Sony released the TR1 transistor radio, the first in a series of disruptive technologies from Sony that utilized solid-state technology. The idea that music could be recorded in one place and simultaneously heard on an inexpensive portable device in another was revolutionary at the time. The TR1 put a serious dent in the market for vinyl discs with prerecorded media stamped into the surface. However, ownership of produced sounds on vinyl and the ability to "play on demand" remained a strong branch on the tree and continued to grow in the coming decades.

Chronology of some of the major patents that influenced the growth of the portability-of-sound patent tree

From the phonautograph patent in 1857 to the MP3 player and beyond, new patents led to product improvements, new product categories, and new market opportunities.



While sound over the air competed, vinyl's greatest threat came from the emergence of magnetic tape media. While the earliest patents connected with this format were filed in 1935, it wasn't until the technology to create low-cost portable tape players appeared—thanks again to solid-state technology—that vinyl looked to be in a precarious position.

The introduction in 1979 of the Sony Walkman TPS-L2—the world's first low-cost, truly portable stereo sound player—marked a turning point in the evolution of the portability of sound. Consumers could buy or record their favorite artists on low-cost cassette tapes, put them into a handheld device that ran off now-standardized AA batteries—the alkaline dry battery was patented in 1957—and walk around enjoying all manner of content only they could hear at a quality that matched the increasingly obsolete vinyl disc.

Innovation rarely sleeps and, while the consumer appeared content, Sony was at work trying to unshackle itself from the patent and licensing confines of its rival, Philips NV. The result was a joint announcement in 1982 by Sony and Philips that disrupted not just the music industry, but the movie and nascent computer industry as well: the release of the compact disc.

Along the way, other portable music storage technology branches would emerge. For instance, the MiniDisc was released in 1992 but never took off due in part to the inexpensive storage available on the personal computer's hard disk drive. Of course, the PC product category is a large tree that at this time is growing in a different part of the IP forest.

A victim of its own success, the portable sound device industry has essentially innovated itself out of existence. Obsolete is the IP that once was so coveted, replaced by the ubiquitous smartphone, another fast-growing tree with its own branches dense with patent leaves reaching for ever-more-lucrative market light.

While the IP for the phonautograph has long passed its brief period of commercial value, its DNA is deeply ingrained in the audiophile's tree. One can imagine that Édouard-Léon Scott de Martinville would be proud of the evolution of IP that traces back to his invention.

Three options for IP and patent evolution

As the portable music industry IP tree reveals, many factors influence the development of new IP—factors both within the industry and far outside it. Using the tree analogy, there are three main trajectories for IP development companies can pursue:

- Add a new leaf on the same branch of the tree by filing patents immediately adjacent to one another that result in incremental product improvements.
- Add a new leaf on a different branch of the tree by filing patents that spawn new but related products that threaten exposure to the market light for other patent branches.
- Plant a seedling elsewhere in the forest by filing patents that could eclipse current technology.

Three strategies that follow from these three trajectories will determine a company's growth and market valuation potential for years to come. To balance the risk, many companies pursue a combination of the three strategies. For a case study of the three strategies in the chemical industries, see page 58.

Strategy 1: 'New leaf, same branch,' or inward innovation

Filing adjacent patents is an inward-looking IP strategy intended to defend, protect, and incrementally grow market share for existing products. For instance, Apple's introduction of iPhones with colored casings enticed a subset of customers to upgrade.

In truth, defending and protecting market space is largely a litigation strategy rather than an innovation strategy. Indeed, the majority of IP litigation that companies engage in is infringement defense from patents that occupy the same classification code. Companies will defend (or attack) their space on the branch where they currently have the most market light. In many respects, litigation is the default IP strategy, as it is familiar ground. Companies know their products, their competitors, and their markets. Still, the strategy is generally short term, protectionist, and can be more time consuming than finding new branches on the tree or planting seedlings that will grow into new industry trees.

It can also be very expensive. Consider the "smartphone patent wars" between many of the major manufacturers—most notably Apple and Samsung—that continue to rage today over devices that have long since faded from the shelves and out of trendy pockets. Millions of dollars were spent on litigation with very little, if anything, to show for it. Bottom line: the

A case study in innovation: Growing the lactic acid IP tree

By Michelle Lynch

Up until the 1990s, the primary end market for lactic acid was as a feedstock in the production of ester or salt derivatives used as preservatives for food and in medicines; it was also used in a variety of industrial applications. Since then, the global market for lactic acid has grown steadily, reaching 560,000 tons in 2014. IHS predicts that lactic acid demand will double over the next decade.

The primary reason for the newfound growth is the polylactic acid (PLA) market, a new branch on the lactic acid IP tree. In the early years of the 21st century, demand began to grow for renewable feedstocks to produce biodegradable plastics. One of these plastics was PLA: a derivative of lactic acid discovered in 1932 by Wallace Carothers, a scientist at DuPont, which found only limited applications.

That changed in the early 2000s when companies—such as Nebraska-based NatureWorks—leveraged improved lactic acid technologies and partnerships to move into the PLA market. The first PLA products marketed on a large scale were compostable food containers, beverage cups, and composting sacks. Chemical companies went on to develop processes to produce grades of PLA that could withstand high temperatures—as high as 200°C. This opened up new market opportunities for PLA (see figure on facing page).

Today, the global market for PLA totals 240,000 tons a year—accounting for more than 40% of lactic acid demand—and it is expected to grow at a rate of 5% per year through 2020.

New leaves, branches…and trees

Lactic acid has traveled a long way from its original uses. As the traditional market of the 1900s became commoditized, chemical companies found new opportunities in markets that would not have been thought possible a few decades before. The process of this evolution follows the three strategies detailed on pages 57 and 60-61: inward innovation, which adds new leaves to existing branches; outward innovation, which leads to new product branches; and forward innovation, the planting of IP seedlings that spawn new markets.

Commoditization and the tug of war between quality and price are the battleground for inward innovation, and the PLA market is no exception. High-quality lactic acid, defined by its optical purity, is a requirement for companies that produce PLA. While many companies possess lactic acid process technology, perhaps only a handful can produce high-quality, polymer-grade lactic acid at competitive prices. This is the competitive challenge—the inward innovation challenge—facing companies investing in the development of lactic acid-based formulations.

Companies such as Cargill, Galactic, and Corbion Purac have developed new processes designed to increase lactic acid capacity, productivity, and product quality while reducing cost and gypsum byproduct. These include IP in advanced process and purification technologies.

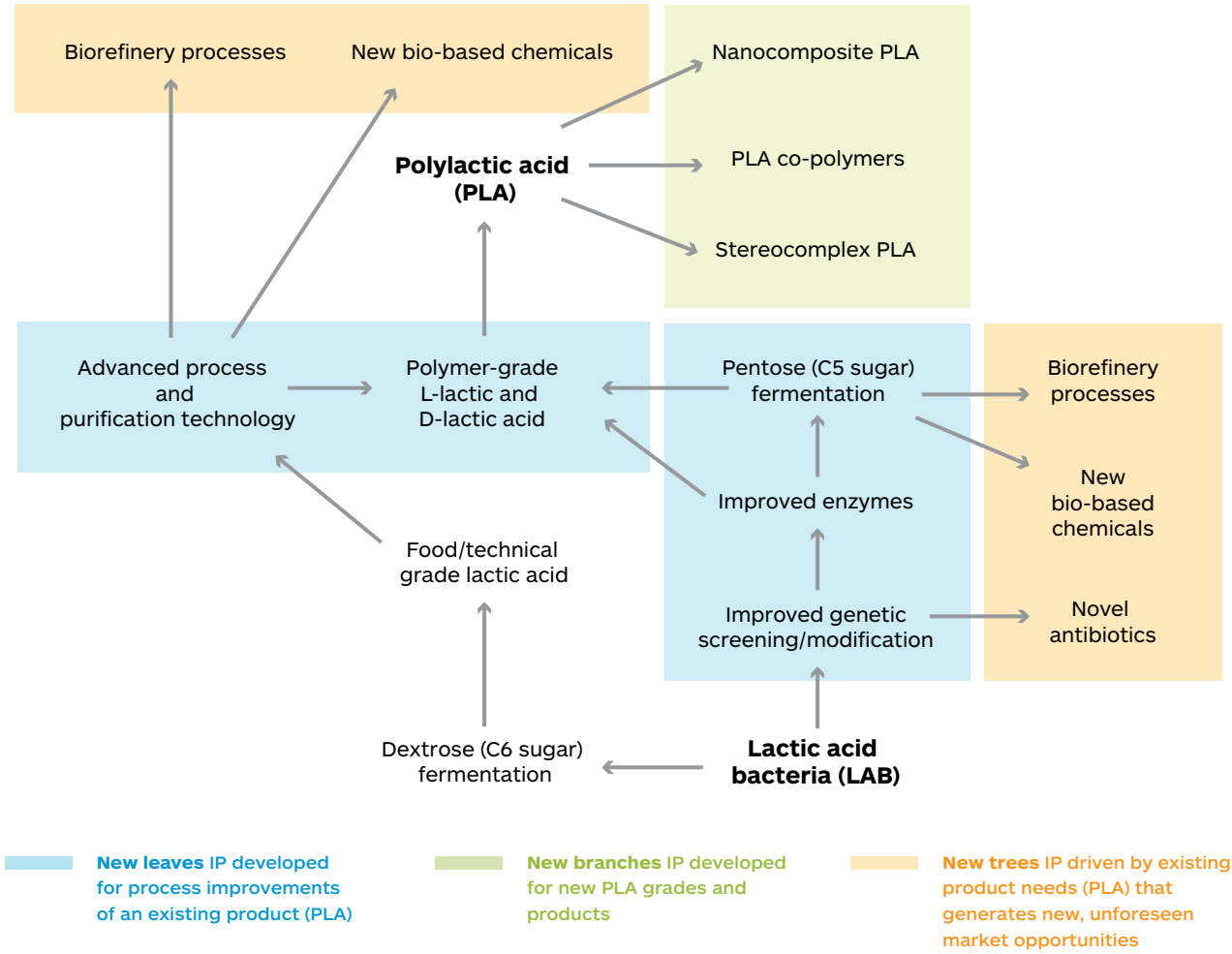
Innovation required to produce high-temperature-grade PLA—an example of outward innovation—went one step further and opened new opportunities in new markets. PLA can be made using two optical forms of lactic acid: L-lactic acid and D-lactic acid. Producing high-purity PLA from each of these and then processing them together produces “stereocomplex” PLA, which has higher heat, chemical, and hydrolysis resistance than standard PLA. PLA can also be formulated as co-polymers, for example by co-processing lactic acid with glycolic acid to make PGLA. Corbion Purac, Teijin, and others are producing these new classes of PLA, which can compete with some existing engineering plastics used in automotive and electronics products, and clothing, and are even used in shale gas extraction.

Another example of outward innovation is PLA being formulated as nanocomposites: plastic compounds containing particles of various materials smaller than 100 nanometers with improved mechanical and electrical properties. Nanocomposites can be used in the production of protective clothing, electronic devices, and tissue engineering for medical applications.

Forward innovation is often based on new IP and patents initiated as an inward innovation to reduce

The polylactic acid branch of the lactic acid patent tree

Lactic acid has been a feedstock to make preservatives for over a century, but the commercialization of PLA, a biodegradable plastic, opened up new feedstock opportunities for lactic acid. In the process, IP developments to refine the quality and reduce the cost of making high-grade lactic acid for PLA have led to unforeseen market opportunities for lactic acid.



Source: IHS

cost or improve quality for existing products, which creates unplanned and unforeseen opportunities that can spawn entirely new markets. An example is IP created to allow fermentation of new biomass feedstocks. Lactic acid is typically produced by the microbial fermentation of dextrose: a six-carbon-atom chain found mainly in food crops such as corn, sugar beets, and sugarcane. However, companies are being pressured to move away from using food crops as a feedstock for lactic acid fermentation.

To address this issue, chemical companies turned to a new feedstock: lignocellulose, a type of dry, woody biomass found in non-edible crops that can be broken down into cellulose, hemicellulose, and lignin. Hemicellulose can, in turn, be processed into a

(Continued on next page)

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five-carbon-atom sugar: pentose, which has a different fermentation pathway to dextrose. But pentose requires new microbial systems, or enzymes, that operate efficiently. While the innovations will, in the long run, improve cost, sustainability, and efficiency important for the commercial production of lactic acid, they also open up new opportunities in new markets.

Better methods to identify and produce the enzymes needed to ferment sugars have led to the discovery of previously unknown bacteria. Understanding these is helpful to producing new antibiotics and consumer products with "healthy bacteria," such as yogurt and probiotic drinks. In addition, the bacteria's enzymatic function can find applications in "biorefineries," which make chemicals and fuels from biomass—a new tree with significant growth potential in its own right.

And so the forest grows.

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new-leaf, same-branch strategy is market topiary designed to keep the light on what will eventually be a fading leaf on an inner branch. Ultimately, the tree will grow from somewhere else and the market won't care about the millions spent on litigation.

Strategy 2: 'New leaf, different branch,' or outward innovation

If the first strategy is about defending old markets, this strategy is about growing outward into new market light to stay ahead of the competition. There are a variety of ways companies can do this, but the most common is to grow or switch to a new branch: for example, the introduction of IP to wirelessly charge mobile phones, which can be traced back to a US patent granted to Nikola Tesla on May 15, 1900.

From observation, only a small percentage of companies are effective at consistently evolving IP into new markets ahead of the competition. The rest are fast followers that enter the market and file incremental patents prompting the early movers to move on again before the market becomes commoditized.

Of course, timing the next move is critical. Understanding where the market is on the life cycle maturation curve—the S-curve—can be helpful, as it often corresponds to the density of patent filings: that is, the more patent applications, the more mature the market (see figure on facing page).

Companies know this and develop IP strategies to stay ahead of the commoditization trap. First movers will harmonize their R&D spending to find the path outward into new light-filled areas, while fast followers track them to ensure they will be the next leaf growing in the new space. The alternative—or complementary—strategy for the market leader is to stay and fight to protect its market position on the branch. This, of course, is the inward-looking new-leaf, same-branch strategy.

Consistently finding and timing the path outward is not easy. For those that do it well—Procter & Gamble, Qualcomm, and Schlumberger, to name three—it has become part of their corporate culture. This includes incentives to file ideas; fast communication paths to legal departments; public recognition of employees for inventiveness; recruitment strategies that include criteria for developing patent portfolios; and providing employees with time to pursue value-added activities outside of their day-to-day responsibilities.

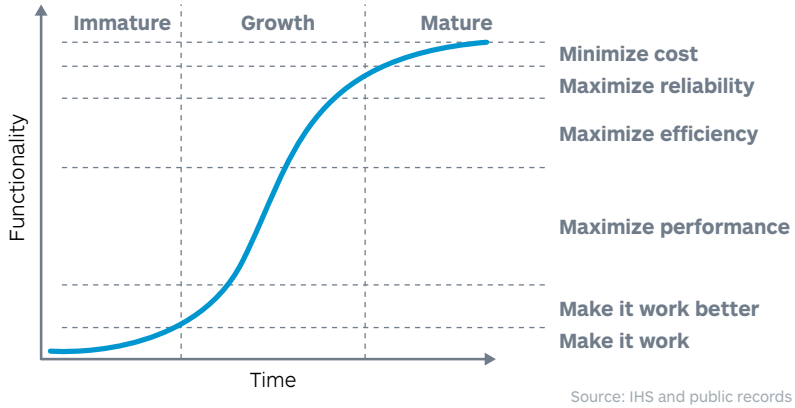
Strategy 3: 'Plant a new tree,' or forward innovation

The list of innovative companies that develop IP that launches a new product classification is the shortest of the three. Edison, Ford, Sony, Toyota, and Apple are iconic examples. While Apple did not invent the smartphone, its IP refined and defined it. Likewise, Toyota built on earlier battery technology to plant the electric vehicle (EV) powertrain seedling in the 1990s. The first leaf was the hybrid Prius, which hit the Japanese market in 1997. Since then, Toyota has filed thousands of patents to protect and grow the EV powertrain tree just as other automakers have entered the market with their own hybrid EVs. Today, the tree has a number of branches, including the plug-in hybrid electric vehicle, mild

As a product matures, so too do the patent challenges

The classic S-curve captures the maturation of a product or process over its lifetime and the changes in how companies manage the product.

The first patent on a tree often has no patent citations within a near timeframe, citing instead journal references or technical literature. As more companies realize the value of the patent, they file according to a strategy of getting ahead, of blocking but not infringing. Progression up the curve leads to congestion until finally the branch nears saturation, no more leaves can grow, and commoditization invites the winner to most efficiently use the market light in the hope of out-competing its nearest rivals. This trajectory of becoming the dominant player in a saturated commodity market morphs into the first strategy of defend and protect.



Source: IHS and public records

hybrids, full hybrids, and hydrogen fuel cell electric vehicles. Combined, these EVs accounted for nearly 3% of vehicle sales worldwide in 2014, according to IHS.

Of course, planting a new tree does not guarantee success. Consider, for example, a display manufacturer that recognized user frustration from relying on touch as the interface for mobile devices. The company launched an R&D effort to develop fingerprintless coatings that could be fused to the glass or added as an aftermarket add-on. However, a disruptive technology that makes touching the screen altogether unnecessary emerged shortly after, and the company's ability to capitalize on its investment is now uncertain.

It all comes down to critical thinking

It is often the case that an incoming technology resolves a constraint that the adopting market had not. The constraint may be one of manufacturing or material properties or something else. It can often be recognized as addressing not the wants the consumer has articulated, but the needs they couldn't.

Of course, hindsight is 20/20 so, looking back, the answer always seems obvious. But why is it not obvious when companies are peering forward? This is the question every executive asks. The decisions made at this level have direct shareholder impact, with percentage points of market share and valuation gained and lost not just on the decision, but on the long-term course for the company set from that point onward.

It could be said that top-tier global companies are better at making these decisions. Indeed, they execute the decisions sufficiently fast to stay on the part of the tree that receives the most market light or plant seeds in the most fertile parts of the forest. But where does this insight come from given that the majority of information is widely available? Indeed, the same advisors and consultants are offering their services to a wide array of companies.

In nearly all cases, the first step—the most important step—is to think critically. This requires companies to be ruthlessly objective when analyzing technology options, the dynamics of the market, and a thousand other factors that often are ignored. The best decisions for forward growth are based on addressing the questions about the unknowns, not the knowns. They deliberately force conventional thinking to be unconventional and, more often than not, aim to disrupt and compete with their own technologies, not just those of their competitors.

By setting a critical-thinking framework with which to drive innovation, companies can embrace the cultural process and grow more efficiently; build sustainable, defensible, and diverse IP; and ultimately create the most value, be they embryonic or iconic.

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Accounting for climate change

Two scenarios of the world's long-term energy outlook project divergent paths for global CO_2 emissions, framing the risks and opportunities for global energy companies.

By Steven Knell

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In 2014 IHS completed a new set of global scenarios that imagines a range of different futures for the world and for energy production and consumption out to 2040. The scenarios are framed around key issues of importance to the energy industry that are explored under a range of different policy and market environments. The result is three unique views of the next 25 years that go beyond a single future and linear forecast. These narratives allow decision-makers to explore and test big questions about the future, enabling the development of robust strategies so their companies can react to and withstand the uncertain twists and turns that lie ahead.

The scenarios are supported by long-term data analysis and modeling developed by a number of energy and automotive research teams that participate in the scenario-building process. As a result, the global energy supply and demand outlooks offer a range of unique insights into the future paths that the energy and automotive sectors and the global economy might take.

Providing a framework for assessing the primary factors shaping carbon dioxide (CO_2) today and over the long term, the scenarios shed light on one of the big questions facing energy markets: how quickly can the world slow the growth of energy-related CO_2 emissions linked to global climate change? They also highlight those areas where public policies and technology trends may lead to new opportunities for alternative investment patterns in energy production and consumption in the future. This article examines the implications of two of the three IHS scenarios: Rivalry and Autonomy.

Rivalry scenario: Local regulations drive policy

Climate-focused policies and measures have proliferated rapidly over the last two decades, with about 500 pieces of legislation now in force around the world. At the same time, strong global economic growth has contributed to an increase in global CO_2 emissions of more than 50% since the early 1990s. The combination of unprecedented regulatory attention, economic development, and persistent increases in emissions is a feature of the IHS planning scenario known as Rivalry, which represents what IHS considers to be the most likely future companies should plan for.

The Rivalry scenario anticipates sustained national and local policy responses that aim to address a range of environmental issues—including CO_2 emissions. While these efforts are expected to have a meaningful impact on controlling greenhouse gas (GHG) emissions, the substance, scope, and mix of targets, mandates, and market-based approaches deployed around the world are not expected to reduce emissions sufficiently to meet stated policy goals.

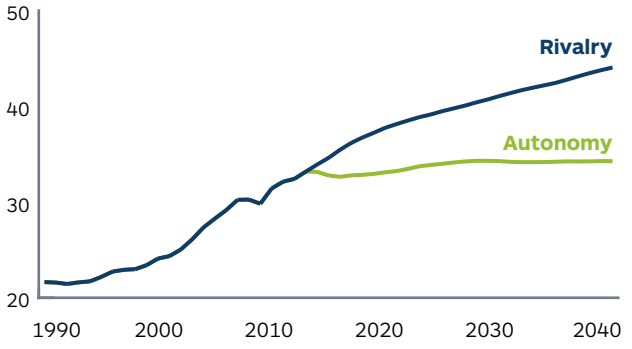
The factors accounting for anticipated increases in CO_2 are many. However, the expected long-term rise in emissions can be captured in two overarching trends of the Rivalry scenario:

- *Economic growth and demographic expansion anchor energy consumption*. The global economy is expected to expand by more than 140% between 2014 and 2040. At the same time, global population will increase from 7.2 billion to 8.9 billion. The world will become wealthier even as population continues to rise, and that wealth points to sustained demand for energy.

- *The momentum of the fossil fuel energy system sets the tone for high emissions intensity.* In 2013 oil, natural gas, and coal accounted for 31%, 21%, and 29% of world primary energy demand, respectively. In 2040, the shares for these fuels are projected to be 28%, 26%, and 24%. Although new technologies and other forms of energy are gradually gaining market share—most notably the acceleration of renewables deployed in the power sector and the rising use of alternative fuels and electric and hybrid cars in the transport sector—their growth is taking place from a relatively small base. Significant cost and technical challenges remain and will take time to overcome, which points to the persistent centrality of the fossil fuel energy system.

Divergent futures for CO_2 emissions

Projections of annual carbon dioxide emissions (2014-2040) based on two divergent economic scenarios for the global energy sector, billions of metric tons (gigatons)



Source: IHS

By 2040, the Rivalry scenario projects global energy-related CO_2 emissions to reach more than 44 billion metric tons, or gigatons, of CO_2 annually (see figure on previous page). That is more than double the 1990 level and represents a 33% increase over the 2013 level, which was approximately 33 gigatons. This CO_2 outlook leaves the world well short of the goal expressed in the 2009 UN Climate Change Conference in Copenhagen of keeping global average temperature increases less than 2 degrees Celsius above preindustrial levels.

According to the latest statements from the Intergovernmental Panel on Climate Change, in order to afford a 66% chance of staying below the two-degree increase, cumulative carbon emissions cannot rise above 1 trillion metric tons. Most estimates suggest that more than half of this cumulative "carbon budget" has already been used up. On this basis, the IHS projection implies the world will cross that threshold as early as the late 2030s.

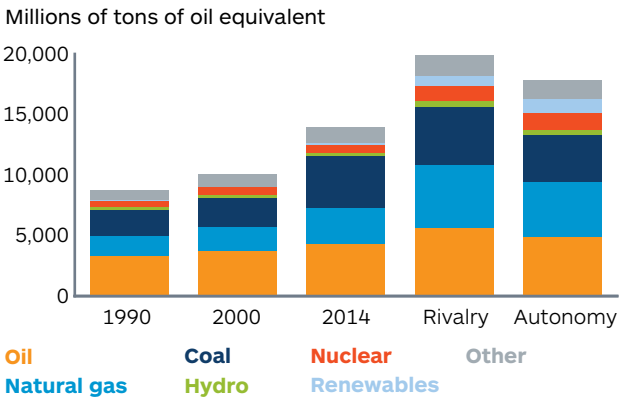
Autonomy scenario: A lower emissions-intensive future

IHS analysis suggests that the type of policies most likely to come to pass in Rivalry will leave a wide range of unrealized potential for emissions reductions across the global economy. The Autonomy scenario, on the other hand, anticipates the realization of a number of these opportunities in energy market segments, including electricity and light-duty vehicle (LDV) transport.

The keys to unlocking that potential are twofold and involve unexpected paths of energy demand, regulation, and supply that are not anticipated in the Rivalry scenario. On the demand side, a combination of generational change and increased urbanization leads to weaker-than-expected demand for vehicles and oil-related fuels, along with stronger-than-expected demand for cleaner energy technologies and environmental policies that, among other things, help to promote energy-sector decarbonization. On the supply side, more-successful-than-expected technology advances in batteries and renewables, as well as expansion of unconventional oil and gas development globally, lead to an expansion of cleaner global energy supplies that edge out oil in the transportation sector and coal in the power sector.

The combination of changing energy consumption patterns and strong local regulatory focus on reducing

Primary power: A lower-carbon world by 2040 under the Autonomy scenario



Source: IHS

conventional pollutants and improving air quality contributes to lower fossil fuel consumption that holds potentially significant benefits for climate change policy objectives in mature and emerging markets alike. In the Autonomy scenario, there are two main trends:

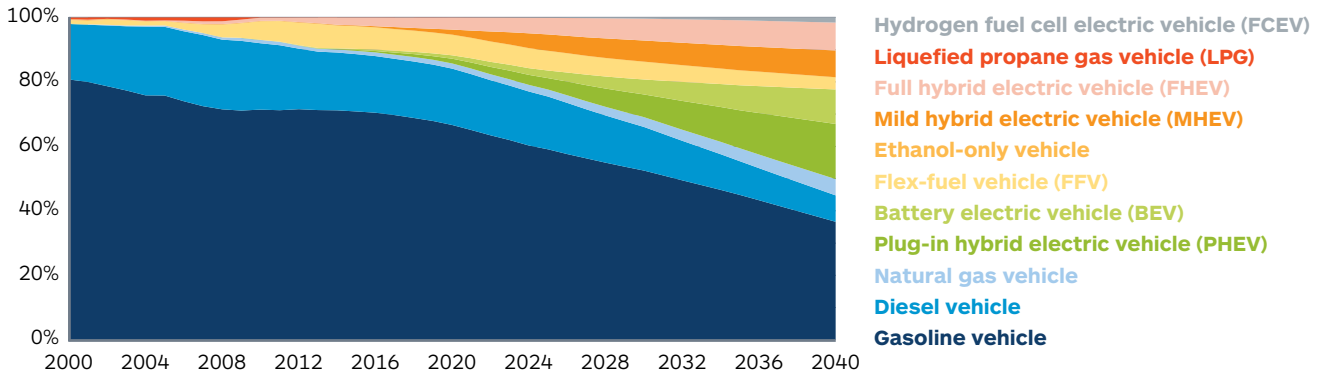
- *Emissions-intensive fuels come under greater policy pressure.* Tighter performance standards for emissions of conventional pollutants and CO_2 in power and transport create disincentives for certain emissions-intensive forms of energy production and consumption. Coal in power and oil in transportation are key targets where tougher policy frameworks are expected to drive a reduction in global primary energy market share by 2040 (see chart above).

- *Accelerated deployment rates for alternatives.* Technology cost declines provide a backdrop unique to the Autonomy scenario that helps drive the accelerated deployment of renewable energy and alternative vehicles, compared to the Rivalry scenario. Autonomy anticipates energy from renewables to more than double by 2040 and total coal consumption to decline, while natural gas grows strongly. Likewise, changes in expected vehicle sales over the next 25 years indicate that by 2040, sales of electric and alternative-fuel LDVs could account for about half of all new vehicle sales globally (see figures on facing page).

Technological innovation is expected to play a central role in slowing the growth of energy-related conventional pollutants and CO_2 in this scenario. Those applications promising lower levels of fossil fuel consumption and associated CO_2 emissions today—including improved battery density and lower-cost

Transportation: Electric and alternative fuel will account for 50% of LDV sales by 2040 under the Autonomy scenario

Global light-duty vehicle (LDV) sales by type of powertrain (percent share)



Source: IHS

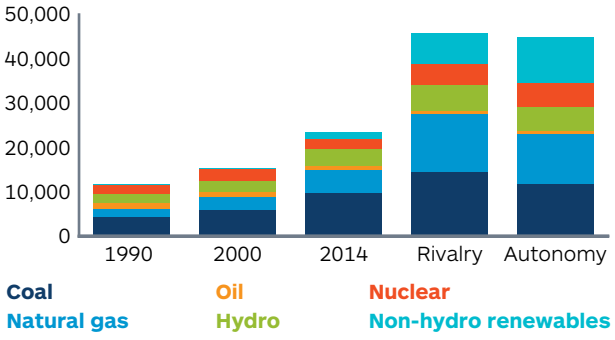
powertrain hybridization, improved electric motor efficiency, light-weighting of vehicles, and advances in materials, product design, and manufacturing—are all expected to accelerate in the Autonomy world.

The improved performance of renewables, both in terms of reliability and cost, and the displacement of coal-fired power generation by natural gas, particularly in China, are key factors that allow for the emissions intensity of the global power sector to continue to decrease over time.

Solar photovoltaics are perhaps the best example. Solar panel costs have declined by more than 50% over the past decade or so, and the Autonomy scenario anticipates another 50% decrease over the next decade. This sharp improvement in competitiveness—the result of advances in manufacturing scale and the greater efficiency of solar cells—means non-hydro renewables will account for almost a quarter of total power generation in 2040 under the Autonomy scenario (see figure below left).

Non-hydro renewables will account for a quarter of power generation in 2040 under the Autonomy scenario

Millions of tons of oil equivalent



Source: IHS

Although the total power generation outputs in Autonomy and Rivalry are very similar, the Autonomy scenario leads to a striking difference in global emissions levels by the end of the forecast period. Under Autonomy, global energy-related CO_2 emissions growth slows dramatically and then plateaus in the second half of the forecast period. By 2040, the Autonomy scenario results in 163 billion tons of cumulative CO_2 savings compared with the Rivalry planning scenario (see figure on page 63). That still puts the 1-trillion-metric-ton carbon budget under pressure, but it offers the international community more time to decarbonize thereafter.

There remains considerable scope for further fossil fuel displacement, particularly in the power and transport sectors. Looking to 2040 and beyond, regardless of the scenario outlook, one can assume the global environment policy agenda will continue to put the fossil fuel energy system under pressure and to push lower-carbon sources forward, which will present a wealth of future challenges and investment opportunities for decision-makers in the energy sector.

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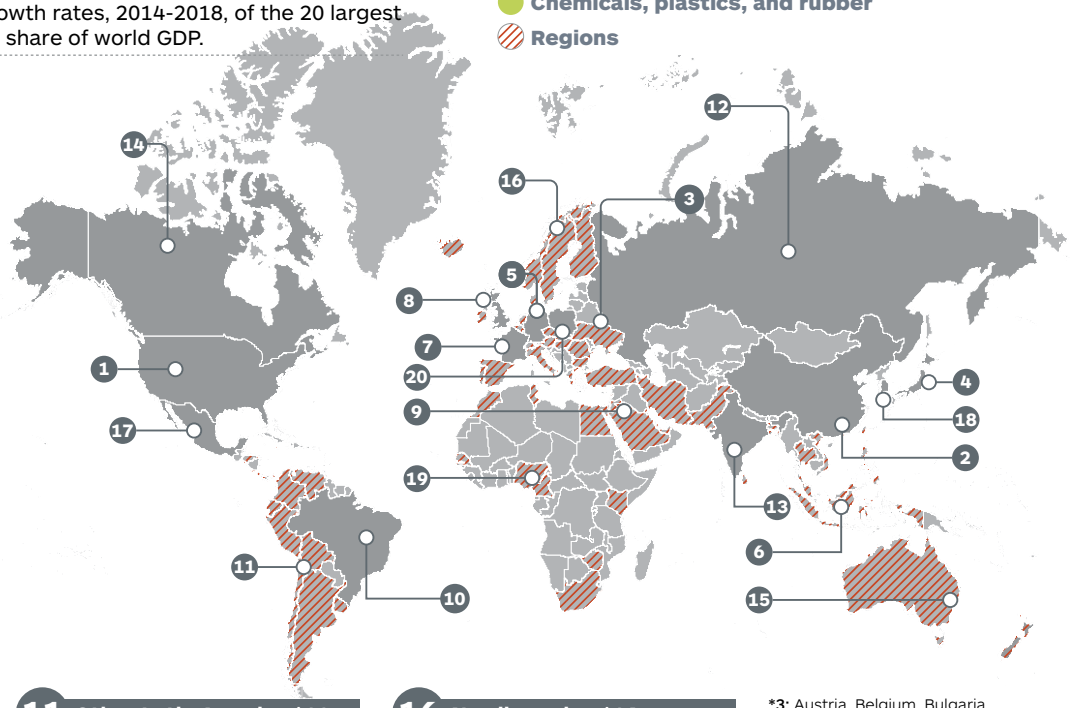
For more information, visit ihs.com/Q21CO2Outlook

Global challenges ahead

IHS has downgraded global growth for 2015 and 2016 as the economies of Brazil, China, Japan, and Russia have slowed in recent months. Global investment spending will outpace GDP growth over the next few years. The Eurozone faces a number of challenges to growth, including restrictive fiscal policies and high public and private debt levels. China's industrial production growth has slowed with the decline in housing markets. The US economy is expected to strengthen gradually, benefiting Mexico and Central American countries. IHS expects output of chemicals, plastics, and rubber to post solid gains over the next few years, with growth above 4% through 2018. All figures are in real US dollars.

WHERE'S THE GROWTH?

Real GDP, capital investment, and chemicals, plastics, and rubber output compounded average annual growth rates, 2014-2018, of the 20 largest countries and regions ranked by share of world GDP.



		GDP	Capital investment	Chemicals, plastics, and rubber
1	USA	2.9	5.0	3.8
2	China	7.3	6.2	7.7
3	Other Europe *3	1.9	2.4	2.0
4	Japan	1.2	1.2	1.4
5	Germany	1.7	2.7	1.4
6	Other Asia-Pacific *6	4.8	5.9	3.8
7	France	1.5	2.0	1.5
8	United Kingdom	2.5	5.1	1.3
9	Middle East *9	4.2	5.3	4.2
10	Brazil	2.9	3.1	3.5
11	Other Latin America *11	3.5	4.3	3.7
12	Russia	1.9	2.8	3.5
13	India	6.9	8.7	6.8
14	Canada	2.6	2.5	1.6
15	Australia/New Zealand	2.8	2.6	1.7
16	Nordic region *16	1.9	2.5	2.0
17	Mexico	3.8	4.0	3.7
18	South Korea	3.6	3.1	4.8
19	Africa *19	5.4	6.5	4.3
20	Poland	3.9	5.1	4.0

***3:** Austria, Belgium, Bulgaria, Czech Republic, Greece, Hungary, Ireland, Italy, Netherlands, Portugal, Romania, Slovak Republic, Spain, Switzerland, Turkey, Ukraine

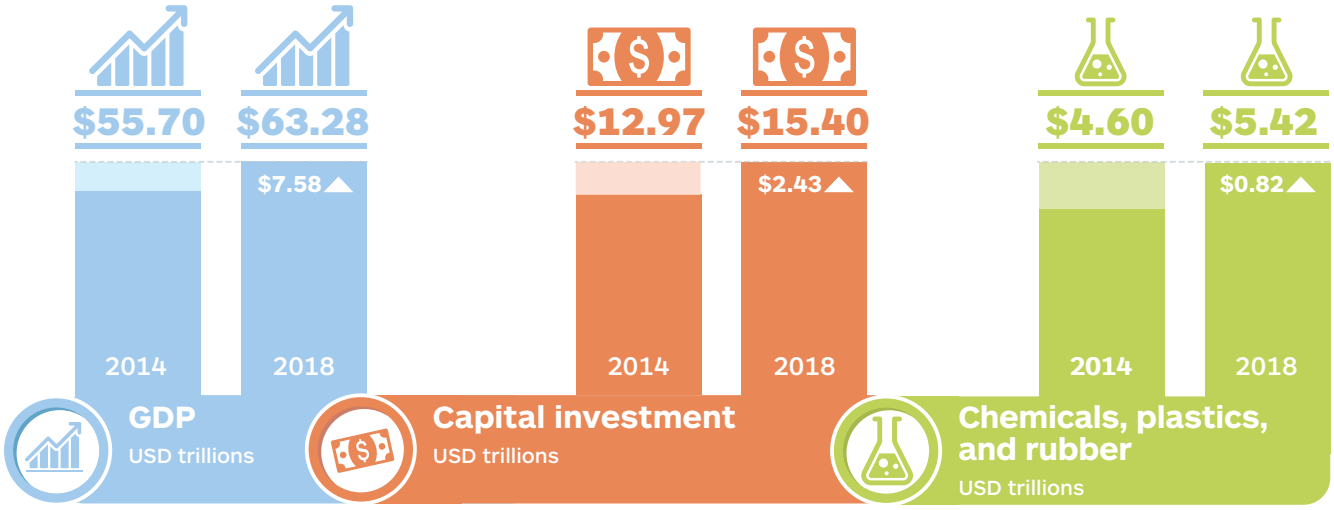
***6:** Bangladesh, Hong Kong, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam

***9:** Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Qatar, Saudi Arabia, United Arab Emirates

***11:** Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Honduras, Jamaica, Panama, Peru, Uruguay, Venezuela

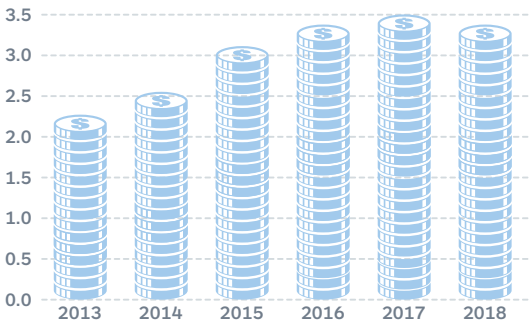
***16:** Denmark, Finland, Iceland, Norway, Sweden

***19:** Cameroon, Kenya, Morocco, Nigeria, Senegal, South Africa, Tunisia, Zimbabwe



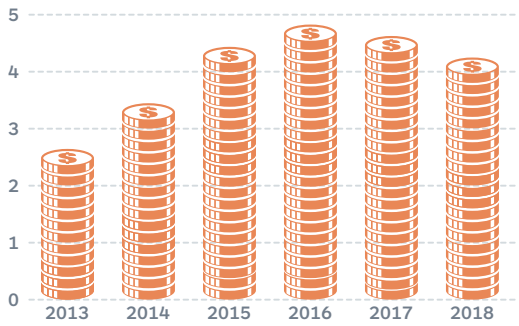
Global GDP growth breaks the 3% barrier

Annual growth rate (%) 2013-2018



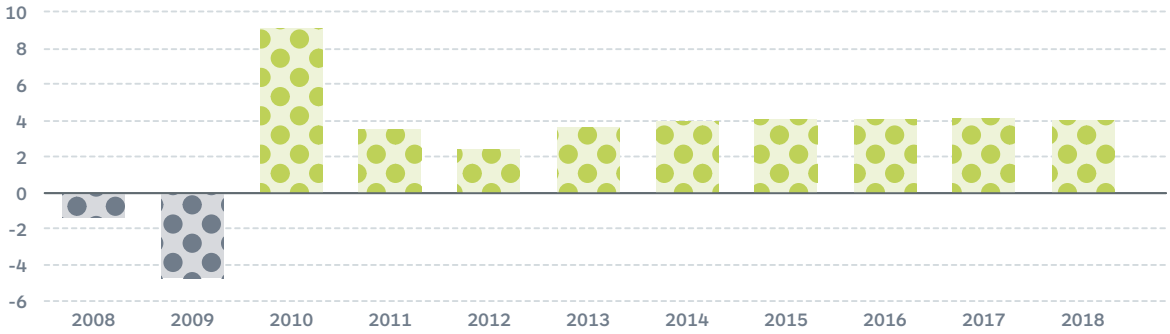
Capital investment growth peaks in 2016

Annual growth rate (%) 2013-2018



Chemicals, plastics, and rubber growth stays above 4% through 2018

Annual growth rate (%) 2008-2018



Source: IHS

50

Number of doctors in Liberia, population 5 million, at the start of the Ebola outbreak

$128 billion

Projected net capital outflows from Russia's private sector in 2014, according to the Central Bank of Russia

$2 million

Daily revenues earned by the Islamic State from the black-market sale of oil from wells in territory under its control as at October 13, 2014

2/3

Proportion of oil in discovered wells worldwide that remains untapped

1.7 million

Number of US manufacturing jobs lost between 2008 and 2013

26x

Number of times higher the price for Stocrin, used to treat HIV, is in New Zealand compared with Romania

44

Percentage of Japan's GDP represented by the cash holdings of the country's private sector firms (US firms hold cash representing 11% of domestic GDP)

50%

Proportion of global light-vehicle sales that will be electric or alternative fuel by 2040 under IHS' Autonomy scenario

21%

Reduction in Western Europe PVC demand since 2008, largely as a result of the construction slowdown

13,297,305,505.09

Estimated tons of global trade via ship, air, and overland in 2014

Source: IHS/Images: Shutterstock

J. Scott Lockhart
Senior Vice President
IHS Operational Excellence & Risk Management

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SPOTLIGHT

20/20 foresight

Hindsight may indeed be 20/20, but world-class organizations would be better served by improving the clarity of their *foresight*—something that requires them to effectively plan for and manage risk in an era of unprecedented global uncertainty. When they can foresee potential downtime, accidents, regulatory violations, and other critical disruptions, companies can more effectively mitigate risks and drive company-wide improvements. Without this level of visibility, ongoing sustainment of revenue, earnings, and shareholder value becomes nearly impossible.

Most companies compile an immense amount of operational data—on everything from asset performance, incidents, compliance obligations, and emissions data to information about material and parts usage, safety performance, and quality conformance. Yet this information is often siloed within companies' operating units and is not gathered using consistent enterprise-wide processes. Subsequently, it is not easily accessible to make strategic, risk-informed decisions, which can have a significant impact on corporate performance.

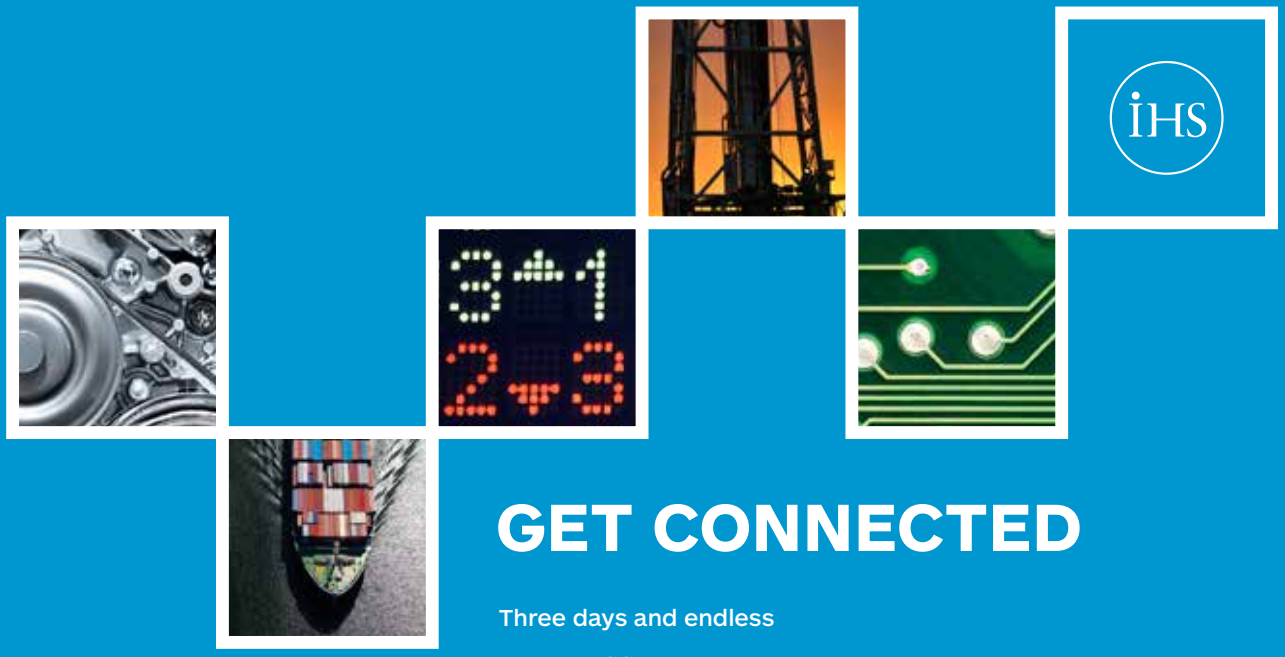
For example, if a gas turbine breaks down at one facility in Chile, predictive indicators, lessons learned, or solutions that emerge from that experience could be quickly deployed to every turbine the company operates, anywhere in the world. This would prevent unexpected downtime from reoccurring, reducing operational expense and driving up the certainty that assets will perform as expected in the future.

As many leading companies have implemented integrated, enterprise-wide management systems to guide their policies and procedures, there is often no standard information technology in use to underpin and support the consistent application of these processes and thus no collection and use of information to support these processes. This leaves no simple way to get the foresight needed to make enterprise decisions.

Companies can sharpen their foresight by leveraging their investment in enterprise information management systems that underpin and enable standardized processes within their enterprise management systems—such as operational excellence management systems. Asset-intensive businesses that require significant levels of operational capital, for example, can utilize these systems to identify and act upon latent risks and opportunities in a powerful way. Through better use of analytics, companies can extract the insight needed to drive sustainable improvements and achieve new levels of performance.

IHS helps organizations pursue operational excellence by bringing their management system to life, underpinning their global operational excellence management system with enterprise software, content, and analytics. Armed with an intimate knowledge of their operations at every level, world-class organizations gain the insight needed to address critical risks and act upon predictive indicators to drive behavioral changes and improve operational performance. Everyone from the CEO to the plant operator shares in the rewards from improved foresight clarity, including better access to capital, enhanced corporate sustainability, and greater long-term shareholder value.

IHS FORUM 2015



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