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Changes challenges and charges

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Changes, challenges and charges

The term “disruption” can have different shades of meaning. We wanted to capture its positive sense, one that evokes a moment of transition that changes the focus of global business models towards more sustainable development—a transformation process that calls upon the energy world to reconcile its production and distribution needs with its commitment to fight climate change. The contours of this “shift” are emerging clearly, as described by Moisés Naim, and its origin is rooted in both technology and geopolitics. From the Chinese economic slowdown to the crisis in the Middle East and the advent of new, more advanced technologies, many things force the energy industry to rethink its modus operandi.



As detailed by Senator Gary Hart, international politics is struggling to keep up with this revolution and risks failing to seize opportunities for development, at the same time that technological research is riding the wave of change. According to Daniel Nocera of Harvard University, progress in solar energy led to discoveries that laid the foundations for a new paradigm for the global energy model. This new paradigm has affected Saudi Arabia which, in the draft of Vision 2030, advances a plan for increasing the mass use of alternative resources, without completely resigning from its role as a key producer of hydrocarbons. Accompanying this “vision,” another major international chapter is being written thousands of miles away: the election of the President of the United States. We wonder whether the new occupant of the White House will continue the strategy for increasing the exploitation and export of hydrocarbons or whether they will rely on a renewables development plan. We will also see how the international community welcomes the U.K.’s exit from the European Union and what repercussions this step will produce for the energy sector. Also overseas, Francisco J. Monaldi describes the difficult times of the major Latin American “energy” nations. Unexpectedly, even China is suffering from development problems as it has experienced a slowdown in the double-digit growth rates of a few years ago and now has to develop an energy transition that lessens unwanted climate effects. Africa, meanwhile, needs stronger growth. The continent is preparing to implement infrastructure projects to expand access to electricity, even in light of forecasts of population growth in the coming decades. Professor Michael Murphy of the London School of Economics explains that an aging and more populous global community will require services and guarantees, including those for energy, that are compatible with environmental protection. The world finds itself at a crossroads, the directions of which lead to many different scenarios. Taking the right turn has never been such a categorical imperative, as the atmosphere has no borders under international law, and the choices of even one of the major international players may affect the future of all.

C O N T E N T S

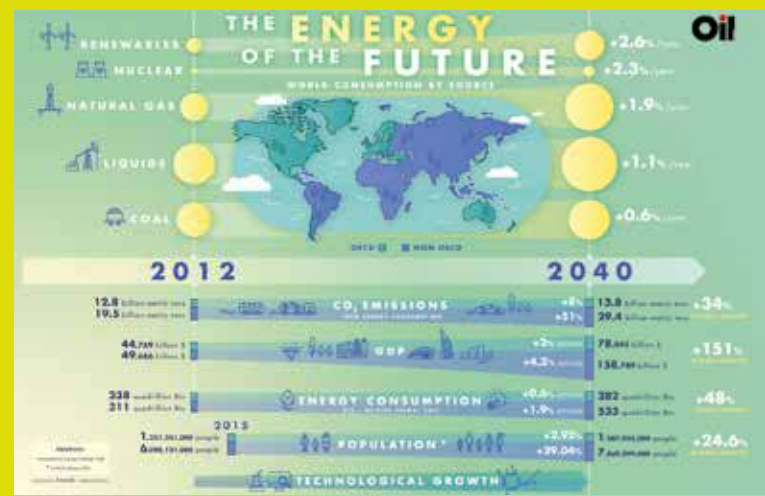
4
**THE SIX POLITICAL
 EVENTS THAT HAVE
 “DISTORTED”
 THE WORLD OF OIL**
 by Moisés Naim



25
**THE AMERICAN
 PERSPECTIVE**



37
**THE SAUDI
 PERSPECTIVE**



infographic
 TOWARDS 2040



72
**CHANGING ROUTE
 IS POSSIBLE**
 by Alessandro Grassani

4 **Disruption**
**THE SIX POLITICAL
 EVENTS THAT HAVE
 “DISTORTED”
 THE WORLD OF OIL**
 by Moisés Naim

8 **Reflections**
**DISRUPTION AND ITS
 OPPORTUNITIES**
 by Gary Hart

12 **Quantitative data**
**DEMOGRAPHY
 AND DISRUPTION
 IN GLOBAL SYSTEMS**
 by Michael Murphy

16 **Technology**
HERE COMES THE SUN
 by Daniel Nocera

20 **Brexit**
**SHORT CIRCUITS ACROSS
 THE ENGLISH CHANNEL**
 by Paul Betts

25 **Energy** **THE NEW
 AMERICAN REVOLUTION**
 by David Koranyi
 and Madison Freeman

28 **Elections**
BLACK, BLUE OR GREEN?
 by Molly Moore

32 **Markets**
**THE AMERICAN
 “COUNTER-REVOLUTION”
 AND THE OIL RECOVERY**
 by Demostenes Floros

37 **Scenarios** **A PLAN
 TO “BREAK FREE”
 FROM OIL**
 by Bassam Fattouh
 and Amrita Sen

42 **Markets**
THE PRICE TRAP
 by Paul Sullivan

46 **Energy** **THE BATTLE
 FOR MARKET
 SHARE**
 by Eric Watkins

50 **Iran**
**BETWEEN EUROPE
 AND THE ASIAN GIANTS**
 by Ellie Geranmayeh

53 **Yousef Baselaib,**
Executive Director of
Sustainable Real Estate
A MODEL
ENVIRONMENTAL CITY
 by Simone Cantarini

56 **Africa** **A VIRTUOUS
 COMMITMENT**
 by Atef Marzouk

61 **China**
**THE DRAGON’S
 SKEPTICISM**
 by Lifan Li

64 **Latin America**
THE TRUE FLYWHEEL
WILL BE A NEW POLICY
 by Francisco J. Monaldi

68 **Arctic** **OIL AND NEW
 SHIPPING LANES**
 by Sebastiano Fusco

72 **Portfolio** **CHANGING
 ROUTE IS POSSIBLE**
 by Alessandro Grassani

74 **Scenarios** **ARE ROBOTS
 THE FUTURE?**
**THE PROSPECTS
 OF ARTIFICIAL
 INTELLIGENCE**
 by Sergio Romano

75 **Centers of gravity**
**THE GEOPOLITICS
 OF ENERGY
 INNOVATION**
 by Nicolò Sartori

76 **Forecast**
**THE INTERNET
 REVOLUTION
 AND THE “SIMPLE
 PROMISES”
 OF TECHNOLOGY**
 by Davide Tabarelli

77 **Society**
**THE TRUMP ENIGMA
 AND THE RESURGENCE
 OF FUNDAMENTALISM**
 by Roberto Di Giovan Paolo

78 **Data** **OBSTACLE
 COURSE FOR
 RECOVERY**
 by Market Scenarios
 and Long-Term Strategic
 Options – Oil
 (SMOS/OIL) – Eni



“When will the world run out of oil?” It’s hard to believe that was once a common question, but analysts of past decades forgot to factor game-changing new technologies into their forecasts. In recent years, the world has discovered much more oil than it has consumed, as hydraulic fracturing, new horizontal drilling techniques, and other factors brought previously inaccessible reserves out of the ground and into the market.

In addition, growth in demand for oil has slowed. A bid by China’s leadership to transition that country’s economy from a model driven by manufacturing and exports to one powered by the spending of Chinese consumers has (predictably) slowed economic growth. Gone are the days of double-digit expansion and China’s voracious appetite for commodities of every description, including oil. This shift is irreversible. China can’t return to the old model without giving back the hard won gains of its middle class and provoking a public backlash. China’s slowdown has hit commodity exporters in Latin America, the Middle East, sub-Saharan Africa, and East and Southeast Asia. From Brazil and Chile to Australia and Malaysia to South Africa and Russia, governments and economies are feeling pain as China’s slowdown deepens. Add uncertainty over Europe’s future with the beginning of negotiations over Brexit, the risk of a return of the migrant crisis as the EU’s deal with Turkey begins to unravel, plus the continued uneven recovery in the United States, and it’s difficult to see where a future surge of oil demand might originate. As for the supply picture, in the past, major oil producers, Saudi Arabia, first among them, could quickly and easily rebalance markets by increasing or cutting

The New Era of low cost crude

production. Following Saddam Hussein’s 1990 invasion of Kuwait, prices spiked, but the Saudis cooled the market by adding new supply; after the collapse in prices following the onset of the 2008 financial crisis, the Saudis slashed output to ease the pain. Things are different now. The resilience of smaller U.S. companies at the forefront of the fracking revolution and the relative speed at which they can ramp up production in response to

The author

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higher prices ensure that the Saudis can’t make a lasting difference in oil prices. If the Saudis cut production, the price drifts higher, more U.S. fracking comes back on line, and the added supply brings the price back down. The net effect is a Saudi loss of market share and the realization that, after peaks at \$147 per barrel in 2008 and \$115 in 2014, oil prices will not again approach \$100 for the foreseeable future. There are four implications of note. First, state-owned oil giants are in big trouble because they are not sufficiently agile and resilient to thrive in a market where production is now more price-sensitive than ever. Inefficiency has never been more expensive. Second, the Saudis will become even more anxious in coming years because they can’t cut production to reach the oil price needed to provide crucial government revenue. Bitter rival Iran, now free of sanctions, is rapidly increasing

production and growing market-share at Saudi expense. Adding to this anxiety is the specter of generational change in Saudi leadership following the eventual death of King Salman and the accompanying doubts that his son Mohammed bin Salman can lead an effort to bring the kingdom and its economy into the 21st century. Third, lower oil prices leave the Russian economy on an unsustainable course. Vladimir Putin remains remarkably popular, and his government sits atop substantial financial reserves. But over the longer term, Russia will face the same pressure to modernize and diversify its energy-export-dependent economy just as the Saudis and many others do. However, unlike the Saudis, the Russians haven’t yet accepted that they have a serious problem. Finally, there is one oil-producing nation already on the brink of disaster. Venezuela imports virtually everything except crude oil, and shortages of electricity, water, staple foods, and other necessities have the country on the verge of open conflict. Those within the Chavista movement may soon sacrifice President Nicolas Maduro to preserve their own grip on power. But only a much higher oil price can buy the regime a lot more time, and that’s not on the horizon. We live in a moment of seemingly constant change. Yet, all of us, oil producers and consumers, must prepare for a world in which crude oil trades at a lower price, the implications of which will only become more important.

Disruption/When politics is more disruptive than technological innovations

The political events that have “distorted” the world of oil

From climate change to the crises in the Middle East, from the slowdown of the Chinese economy to the Russian sanctions and the collapse of the South American energy giants: the factors that have changed the global energy scenario in recent years

MOISÉS NAIM

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Disruption, mostly due to the advent of new technologies that make old business models uncompetitive and eventually obsolete, has become a fashionable concept. Established companies fear it and start-ups hope to create it. We know the iconic examples of disruption: Amazon practically wiped out bookstores, travel agencies and newspapers have been “dis-intermediated” and Uber and Airbnb are upending the business of taxis and hotels. No industry has been spared, and the energy sector is no exception. Hydraulic fracturing and other technologies that have deeply altered the way in which hydrocarbons are produced and advanced the industry’s technological frontier have changed not merely the oil and gas business but altered longstanding geopolitical arrangements. Yet, notwithstanding the indubitable impact of new technologies, another source of disruption well known to oil and gas companies continues to be a major force in shaping the world of energy: politics. In fact, the attention to technological disruption has distracted us from the

fact that politics continues to be the most disruptive force of all in the oil and gas markets.

A brief intellectual history of disruption

The pattern whereby an entire industry can be disrupted was first identified by the German Marxist sociologist Werner Sombart in his 1913 work *War and Capitalism*. The idea was later refined by Joseph Schumpeter in his 1942 book: *Capitalism, Socialism and Democracy*. Schumpeter famously called it “creative destruction” and said that it was “an essential fact about capitalism,” basing his ideas on Marx’s early assertion about the self-destructive tendencies of capitalism. He characterized it rather dramatically as “a process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.” Half a century later, Clayton Christensen, a Harvard Business School Professor, extended this idea by de-

scribing in 1995 what he called “disruptive innovations”: new technologies and business strategies that create a different product, one that often displaces the dominant player in that market and at times even creates an entirely new market. iPad is, of course, the paradigmatic example of this latter phenomenon. Christensen’s concept of disruptive innovation was validated by a flurry of new technologies and business models—often related to the Internet—that in turn spawned a wave of new companies that quickly became market leaders. Searching for the “disruptive innovation” that would drastically alter the old ways of doing business in a given sector became the obsession of inventors, entrepreneurs, investors and analysts. Existing companies became alert to threats represented by the irruption of a new way of doing business that would wreak havoc in their traditional markets. As noted above, in the oil and gas industry, hydraulic fracturing and related technologies have created new ways of producing hydrocarbons, in

the process bringing new companies and new financial models to life, and unleashing enormous and unprecedented geopolitical shifts, such as the dramatic emergence of the United States as one of the three main oil and gas producers (with the potential to become a major exporter). In addition to hydro fracking, solar panels and batteries, wind turbines, biomass gasification and the promise of tidal energy, are only a few of the technological innovations changing the face of the energy industry across the planet.

But focusing only on technologically induced disruption obscures the fact that politics can be as disruptive to an industry as a new technology. Although the term "disruption" often brings to mind the dramatic changes brought about by technological innovation, most commonly related to information technologies, computing and the internet, the reality is—at least in the world of energy—that political changes are having as great an impact as new technologies—if not more.

The oil industry has a long experience with the impact of politics on its operations and profitability. Recent trends confirm this historical pattern. Here are six examples of recent politically induced disruption that illustrate the importance of non-technological factors in defining winners and losers in energy markets.



1 THE POLITICS OF CONTAINING GLOBAL WARMING

It has taken a while but now there is close to a scientific consensus about the link between fossil fuel consumption and global warming. This scientific consensus has led to a political consensus about the need to minimize the use of such fuels if the planet is going to avoid major climate change. The political decision reached in Paris by 150 nations in November 2015 to limit global temperature increase to well below 2 degrees Celsius, while urging efforts to limit the increase to 1.5 degrees, established binding commitments by all parties to make "nationally determined contributions" (NDCs) and will have enormous consequences for the energy industry. The Paris agreement represents the biggest game changer in the global pattern of energy consumption, which has been based for more than 100 years on coal and fossil hydrocarbons. Direct actions resulting from this decision

include a \$19 billion pledge made by developed countries to support developing nation efforts to promote renewable energy and the creation of a 120 nation International Solar Alliance, led by France and India, to support solar energy deployment in their countries. Non-governmental organizations, cities and private investors also became involved in this major initiative. Bill Gates and ten other investors have launched the Breakthrough Energy Coalition to steer private capital into clean energy projects. At a side summit in Paris, the Compact of Mayors, hosted by Paris Mayor Anne Hidalgo and former New York Mayor Mike Bloomberg, has committed more than 360 cities around the world to deliver over half of the world's potential urban emission reductions by 2020. These are political decisions that will drive immense change in the industry and spur the creation and growth of new energy-related businesses.



2 THE U.S. ENERGY POLICY

The dramatic increase in oil and gas production in the United States, mostly the result of the intensive use of hydro fracking, has triggered important politically determined changes in energy policy. Perhaps the most important has been the lifting, in November 2015, of the prohibition to export crude oil, which had been in place since 1973. Such a major political decision comes at a time when U.S. domestic refineries are reaching their maximum levels of shale oil processing capacity, and oil storage in the U.S. is at an historical high, making crude oil exports a logical move. The decision has opened the door for significant changes in the global role of the U.S. as a net hydrocarbons exporter. One example is its impact in Europe, which can now reduce its dependence on Russian gas. Lifting the ban on U.S. oil exports also provides Washington with a formidable geopolitical weapon in its relations with oil producing countries.



3 CHINA'S ECONOMIC SLOWDOWN

The impact of China's level of economic activity on global energy demand (and prices) is well known. An economic downturn in China means lower prices for all the commodities that the Asian giant voraciously imports and oil is no exception. The current lower rate of growth of China's economy can be dismissed as just a transitional phase of a normal economic cycle. That means that after decades of double-digit growth, it is only normal that a period of slower growth ensues. But the concern is that China's economy may not just be slowing down temporarily but has instead entered a new and prolonged period of meager growth. The experts who hold this less sanguine view of the Chinese economy argue that there is ample evidence pointing to the fact that a major structural change is underway. Last year, China's growth was the weakest of the last 25 years, accompanied by a collapse of the stock market and a significant devaluation. In January of 2016, some \$110 billion left the country, while over \$600 billion of capital flight took place during 2015. The most troubling sign, however, is the skyrocketing growth of the national debt, which has tripled since 2007. In response, the government has stressed its intention to move the economy away from its reliance on exports as a source of growth to the expansion of the domestic market and from massive infrastructure investments and industrial development to the stimulus of a larger and stronger service sector. All these are political decisions that will profoundly change the way China produces and consumes energy.



5 RUSSIA'S EXPANSIONISM AND SANCTIONS

Russia's 2014 annexation of Crimea triggered economic sanctions by the European Union and the United States. Some of these sanctions directly affect the Russian energy sector and its ability to continue to be the foremost

supplier of natural gas to Europe. The sanctions include the freezing of exports to Russia of energy related equipment and technology and the banning of the supply to Russian oil and gas companies of services like drilling, well testing and completion services. The implications are as enormous as the surprises. Many observers predicted that the international coalition that supported the sanctions would quickly fragment, that the sanctions would be watered down or that they would be short-lived and ineffectual. None of these predictions has come to pass. Instead, the Kremlin's decision to annex Crimea and destabilize Ukraine has resulted in major upheavals in Russia's oil and gas industry and an unexpected opening for U.S. gas exporters to European markets.

4 THE CRISES IN THE MIDDLE EAST

Bloomberg reports that "about 2.6 million barrels a day are being kept from the market by conflict and sanctions in the region, more than five times the average from 2000 to 2010." The IEA energy outlook for 2016 reports oil production disruptions averaging 3.2 million barrels per day over the last two years, mostly due to political instability in Iraq, Libya, South Sudan and Syria. This significant supply imbalance has been partially compensated by new Iranian exports, which have doubled since last year, reaching 2.1 million barrels per day in May. Such an increase is the result of the lifting of sanctions against Iran by western powers, following the nuclear deal reached in July 2015. This decision has disrupted the global oil supply and has contributed to fragment and weaken OPEC, leading one of Vladimir Putin's main collaborators, Igor Sechin, to say that "OPEC has practically stopped existing as a



united organization." And this of course is just one example. Libya, Syria, Egypt and the Eastern Mediterranean are all hotspots rife with instability and hydrocarbons. In the Middle East politics far outweighs technology in defining its weight in the world of energy.



6 THE IMPLOSION OF VENEZUELA AND BRAZIL

Mismanagement, lack of investment and massive corruption in Venezuela's state oil company, Petroleos de Venezuela, and corruption scandals in Brazil's state oil company, Petrobras, are causing severe disruption in the production and development plans of these two oil giants. Petrobras is now afflicted by the largest debt among all major oil companies and its 5 year investment plan to 2020 is down by 25 percent, while its stock has lost 80 percent of its value in the last two years. In spite of its large oil reserves, Venezuela's production and exports have declined significantly, relegating the country to playing a minor role in the global energy sector. In both cases, technology had nothing to do with their downfall. It was all about politics. It is common for corporate leaders of oil and gas companies to stress that their companies are as technological as those of any other industry—if not more so. In fact, the investments in research and development of the large oil companies are staggering and the list of successful innovations that they have brought to the markets is equally impressive. There is no denying that technological innovation is an integral part of this industry. But it is equally true that few other industries are as directly impacted by politics as oil companies. Yes, technology can disrupt this industry and in the past it has done so, but not as much nor as often as politics.



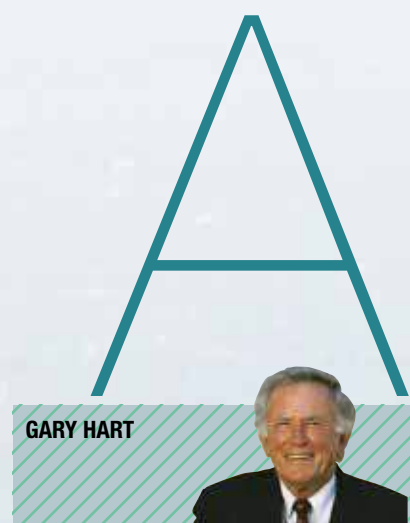
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Reflections/Past route changes and the potential for future routes

Disruption and its opportunities



New governance systems may reduce “disruptions” and provide a higher level of stability. The key lies in anticipating rather than reacting. Preparation will be essential if the world wishes to avoid significant upheaval in the future



GARY HART

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Although it's a blunt word, disruption nevertheless characterizes the age in which we live. Old formulas are dissolving. Traditional systems are disintegrating. Established orders are fragmenting. Dependable alliances are sundering. All of this is synonymous with disruption. We know what revolutions are. Like traditional wars, they have a beginning and an end. But the disruptive age of the early 21st century had no official beginning, and we do not know when and how it will end.

Arguably, this age of disruption and revolution, much of it occurring below the visible surface like tectonic plate shifts, began in 1973-74 with the OPEC oil embargo. Then America's defeat in Vietnam. Domestically in the United States, there was the civil rights movement, the women's equality movement, the dawn of the age of environmentalism, and widespread shedding of traditional social norms. Variations of these cultural

shifts were experienced in much of the West. But the world also was experiencing the disintegration of national borders. Economically, this came to be called globalization. Socially, it was the beginning of mass south-north migrations. The dissolution of the Soviet Union then led to the end of the Cold War and the end of the bipolar world divided between democracy and communism. On top of all this was the information revolution. Some have argued that the fax machine played a central role in the collapse of the Soviet Union because authoritarian governments demand control of information. When information is widely shared, centralized political systems lose authority. Economically, the explosion of information technologies, especially in the United States, signaled the shift of our economic base from traditional manufacturing to the silicon chip and all the technologies that grew from it.

As the geographic center of economic power in the United States was shifting from Detroit and Pittsburgh to Silicon Valley in California, Asia was awakening to dominate the production of mass-market consumer goods and low value technologies. Trade barriers and protectionism could not stem the tide of container ships. On they came with automobiles, television sets, textiles, shoes, appliances, and an endless stream of consumer products.

When policy is the latecomer

A survey of public policy in the United States from the mid-1970s until today reveals a pattern of delay in responding to the forces of disruption. A few younger U.S. political leaders urged economic policies, including education reforms, a focus on laboratories, science, and technology, and job retraining for older workers, to ease the transition from an industrial to an information-based



economy. The call for these initiatives was not heeded. Likewise, during the Mikhail Gorbachev years in the Soviet Union, a few American elected officials urged new thinking about America's role in a post-Cold War era. However, traditional defense and foreign policies, often fostered by Cold Warriors, prevailed, as some came to miss the certainty of the bipolar world and to look for opportunities to recreate it. Where the military and U.S. national security were concerned, efforts to institute serious military reforms in anticipation of the rise of unconventional conflicts and irregular warfare, as nation-state borders and sovereignty eroded, met with resistance and traditional thinking. Even in a nation such as the United States, which prides itself on innovation, leaving behind traditional policies to address disruptive events meets with resistance. The status quo takes strong roots in the minds of conventional thinkers committed to preservation of things as they are. Machiavelli observed "the incredulity of mankind who do not believe in anything new until they have had actual experience of it." And the American Ralph Waldo Emerson wrote of "gravity, custom, and fear" making experimentation and innovation difficult to bring about. All these disruptions contributed to the beginning of erosion of nation-states, the basic global political building blocks since the Peace of Westphalia in 1648. As finance and

economics became ubiquitous and outside the control of national financial ministries, so political sovereignty began to weaken. The nation-state demands a monopoly on violence, but this monopoly crumbled as disaffected peoples shifted their loyalties from states to religious fundamentalism, ethnic nationalism and even tribes, clans and gangs. Given the declining ability of nation-states, including the powerful United States on 9/11, to provide security for their citizens, a vast new international industry of private security for individuals and communities arose virtually overnight. New mafias arose out of the Soviet collapse. Drug cartels emerged as substitutes for state authority in parts of Central America. Cold War weaponry became available to stateless nations. The rise of terrorism as a form of warfare seems almost inevitable. Old 20th century ideologies of National Socialism and communism gave way to religious fundamentalism and in parts of the Muslim world became a central organizing principle, especially for masses of unemployed youths. Not all disruption is immediately political or economic. This new century brings with it the postponed costs of the industrial age. Mankind is altering the very climate upon which its well-being depends. We are depositing carbon in our biosphere faster than it can be absorbed, and we have been doing so for some time. There seems insufficient political will, par-

ticularly in the developed world, to substantially alter our consumption patterns. On top of this, the developing world seeks to catch up and requires more carbon combustion to do so. Serious climate scientists predict rising sea levels across the globe even as desertification brings drought and famine inland. We have dodged pandemic bullets with HIV and the Ebola virus, but modern air travel makes it virtually inevitable that new viral outbreaks will occur and spread faster than modern medicine's ability to contain and quarantine them. And few, if any nations, including the United States, have the personnel and equipment, including inoculations, on hand to deal with unknown viral mutations. Scientists now say that we are nearing the threshold of an age of synthetic biology when viruses unknown in nature can be manufactured in small hidden laboratories and dispersed by individuals and groups of ill-will among the healthy populations of their enemies. The new information age carried with it magical transformations. Critical infrastructures—communications, transportation, financial, and energy systems—are now all operated by computers. But we now know that those same magical computerized operating systems are vulnerable to state and non-state hackers and disrupters. The critical systems upon which the developed world depends are now more efficient, but also more vulnerable, to the new threat of cyber warfare. It is difficult

to imagine what might happen if interlocked international banking systems or entire air traffic control systems were suddenly disrupted or shut down. This surface sketch of the revolutions—disruptions if you will—makes the future seem grim.

Revolutions: What improvements they have brought

A fair accounting, however, must also note the rising standard of living, including in much of the developing world, across the globe. Science and technology are bringing new devices such as cell phones to multitudes, and they make masses of people healthier and more able than ever before to participate in local market economies. Education and health standards are on the rise, and birth rates in many large nations are settling into more sustainable patterns. New sustainable sources of energy, wind and solar in particular, are increasingly available at the community level. Major oil producing nations, including significantly Saudi Arabia, see the solar era arriving more quickly than they would have believed even a few years ago, and experiments with micro-geothermal energy sources are occurring in parts of the world. Considered cosmically, it is possible to view our age of disruption as a race, a race between the destructive forces unleashed in the past three of four decades and the constructive human inventive genius

capable of avoiding natural or man-made disasters. We have science, technology, imagination, and invention on our side, but we do not have unlimited time. We are lacking in statecraft, in moral leadership, and in our appreciation for our common humanity. To transcend these disruptions, we must rethink systems of governance. National and international declarations of independence, of human rights, and of democratic freedoms are the building blocks. But these principles must now be put to the service of finding new ways of governing ourselves and addressing our common and universal needs. For example, we need now to think of the world as a Global Commons, a virtual place created out of mankind's universal desire for economic and physical security. No single nation or existing treaty organization can stop global warming. No regional alliance alone can stop a viral pandemic. No democratic coalition can stamp out extremism and terrorism.

These are threats requiring wholehearted participation of all nations, ethnic groups, religions, and tribes. The Global Commons approach to the challenges of 21st century disruption is based on one central principle: all humans have more interests in common than they have differences. Those interests transcend race, ethnicity, historic identities, political ideologies, geography, and traditional cultures. In the arena of

international security, the core of a Global Commons coalition would be composed of advanced democracies mutually committed to collective security, suppression of terrorism, and elimination of criminal syndicates. Other nations committed to the rule of law and protection of human rights would be welcome under the Global Commons security umbrella. The advantages of joining the coalition would outweigh outmoded notions of sovereignty, and only renegade nations such as North Korea would remain alone and isolated. Where national sovereignty is concerned, it became quickly apparent to North American Treaty Organizations (NATO) nations at the dawn of the Cold War that they could participate fully in a collective security alliance without sacrificing national authority and sovereignty. Globalization, information, eroding borders, and mass migrations represent threats to the old order, but they also represent opportunities for common understanding. Most needed now are statesmanship, moral authority, and leaders with courage, integrity, and vision.

The strategy is to anticipate revolutions

In our complex world, there will never be absolute stability. But new systems of governance can reduce disruptions and achieve a greater degree of stability than we are experiencing today. The key is anticipation rather

than reaction. Too often in the early 21st century, even the most advanced nations have waited for a disruptive event to occur and then responded with whatever resources might be at hand. Events are happening faster, however. Warning times are shrinking as are reaction times. Delay and the search for remedies have become a luxury. Anticipation and preparation have now become a necessity if the world is to avoid being victimized by more disruptions. Years must pass before we or future generations can adequately assess the multiple epic transformations we are now experiencing. A century ago, Joseph Schumpeter welcomed the "gales of creative destruction" in economic transformation. Out of it, he believed, new and sometimes even better economic opportunities and economic systems might arise. This is the attitude we must take about our age of disruption. We may not welcome gales of creative disruption, but they have come to visit us anyway. If we are able to disenthrall ourselves from past policies and programs, while maintaining our commitment to timeless principles, and use our collective imaginations to invent new systems and policies, the 21st century might yet emerge as one of the most enlightened eras in human history. Disruptions must be turned to our advantage. We have no other choice.

Disgregation

- 1. THE OIL EMBARGO** The 1973 energy crisis was caused by the suspension of the flow of oil supplies from the OPEC member nations, due to the Yom Kippur War.
- 2. DISSOLUTION OF THE SOVIET UNION** This decreed the end of the Cold War and the end of the bipolar world divided between democracy and communism. Since the Soviet collapse, new mafias have emerged.
- 3. GLOBALIZATION** The world has experienced the disintegration of national boundaries. In economic terms, this phenomenon has marked the beginning of mass migration in the south-north direction.
- 4. INTERNET** Currently, the critical systems on which developing countries depend are certainly more efficient, but also more vulnerable to the new threat of cyberwar.
- 5. SEPTEMBER 11** Governments' inability to protect their populations adequately has given rise to a large international private security industry.
- 6. CLIMATE CHANGE** Because carbon is being deposited in the biosphere at a greater rate than can be absorbed, we're seeing sea levels rise and draught and famine increasing.

Growth

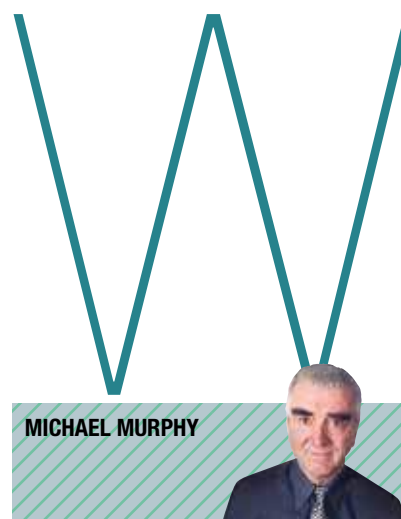
- 1. EDUCATION STANDARDS** According to current trends, China and India will, by 2020, account for over 40 percent of young people with a university diploma. However, only one quarter of young people in the European Union will have a degree (OCSE data).
- 2. HEALTH** Sciences makes mass populations healthier and more capable of participating in local market economies.
- 3. THE COMMUNICATION REVOLUTION** Science and technology are introducing new devices, such as cell phones, to multitudes of people, making them healthier and more capable of participating in local market economies.
- 4. SUSTAINABLE ENERGY** New sustainable energy sources, especially wind and solar power, are available to an increasing extent at the community level. The main oil producing nations are witnessing the approaching era of solar power.



Quantitative data/The big changes of population

Demography and disruption in global systems

Changes in demographic size and structure have the potential to disrupt global stability on both national and international levels, with significant environmental and political repercussions



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World population size is currently estimated as 7.4 billion people. It is growing by about one billion every 12 years, and it is expected to double from 4 to 8 billion between 1974 and 2023 (United Nations projections). It only reached one billion in about 1804 and took a further 119 years to reach two billion. Recent increases have been unprecedented and have raised concerns about their effect on the sustainability of social, economic and environmental systems. Changes in population size and structure have the potential to disrupt global stability from the individual level, such as the impact on intergenerational relations within families, to national fiscal and to global environmental systems. There are also political and strategic implications. Even if population growth is not the prime driver, larger population size is likely to magnify challenges arising from other underlying causes, with varying impacts in different parts of the world.

Global population change

Global population size and structure can change only through births and deaths. Around 1950, life expectancy at birth was 47 years; by 2015 this had increased to 71 years. At present, life expectancy is increasing at about three years every decade, and this is likely to continue to increase in the foreseeable future. A woman would have five children on average with the fertility rates of 1950, but that figure had been halved by 2015. Future de-

clines are likely to be less substantial, with a value of about two children per woman expected by 2100. Lower fertility is associated with development, both because couples are increasingly able to decide on their preferred number of children, and because lower infant and child mortality means they do not require so many births to reach that goal. This demographic transition represents a remarkable achievement and major global success but have also been responsible for the rapid growth in global population size noted above.

Regional differences

Global population growth has been generally smooth, increasing to a maximum annual rate of 0.9 percent around 1965, before falling back to 0.5 percent currently, and it is expected to decline towards zero over this century. However, these figures mask considerable differences between different parts of the World, differences that can potentially lead to major tensions. Growth rates have been lowest in the most developed regions. Initially, growth rates were higher in all parts of the rest of the World, but recently growth rates in middle-income countries have tended to converge towards those of the more developed countries (in Europe, North America, Japan and Australasia), with high growth being particularly concentrated in the least developed regions, primarily sub-Saharan Africa together with a small



number of other countries such as Afghanistan. In the middle of the 20th century, the population of Africa was less than half the size of Europe (see graph at page 14). By 2025, it is expected to be twice that of Europe, and by 2100 there are expected to be as many people aged 15 to 24 in Africa as the total European population. The share of the world's population in the more developed regions was 32 percent in 1950, 17 percent in 2015 and is likely to fall to 13 percent in 2050, when numbers would be in absolute decline, as is already the case for countries such as Japan. In contrast, the populations of the least develop-

ment countries are likely to account for 20 percent of the global population in 2050, compared to just 8 percent in 1950. The impact of a variable on the global system may be given by the equation $I = P \cdot A \cdot T$, where impact, I , depends on population size (P), affluence (A), and technology (T). Of these three variables, population is by far the most predictable, for example, the 95 percent confidence interval for world population size in 2050 is between 9.3 and 10.2 billion people based on United Nations probabilistic population projections that have been generally accurate at the global level (although less so at the national

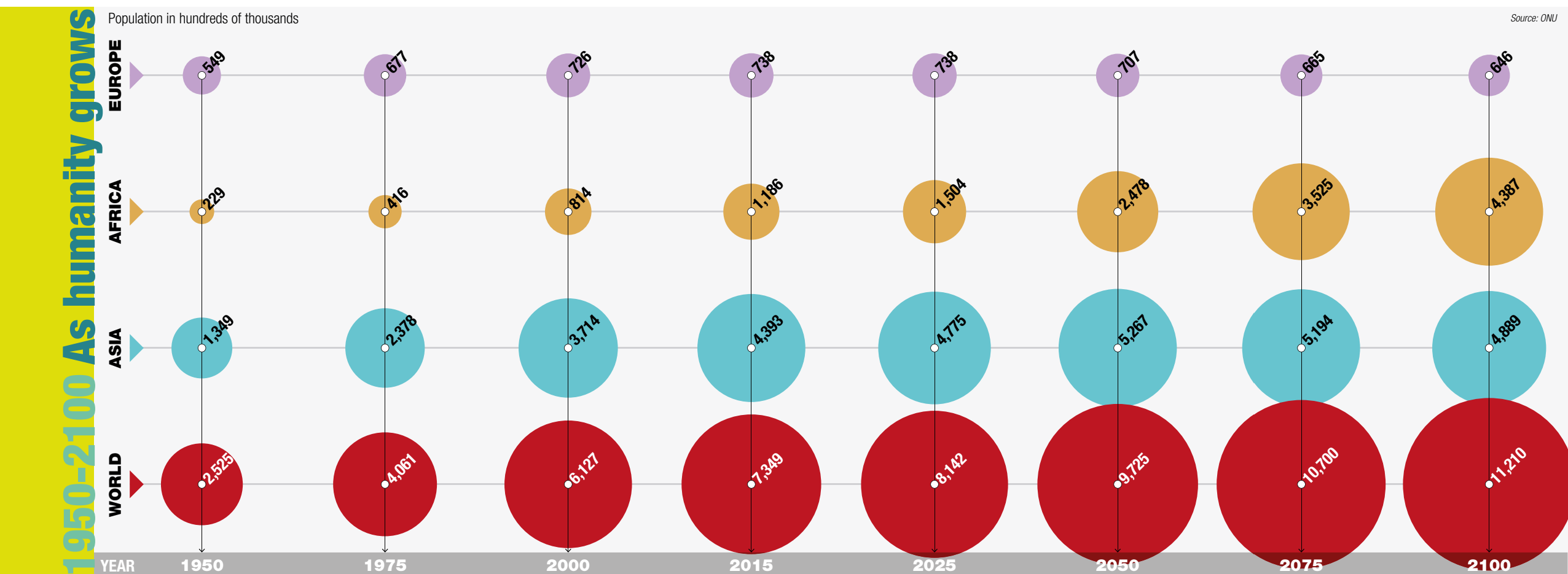
level). Affluent nations use more resources for a given population size even allowing for the fact that they can deploy technologies that may mitigate environmental and other impacts. For example, average CO_2 emissions per person in the least developed countries is only 3 percent of the value of a person living in an OECD country, or 4 percent of a person living in China in 2011 (World Bank). This suggests that emissions would rise at a lower rate than population growth, which is concentrated in countries with relatively low emissions. However, since less affluent nations want to become rich-

er, additional resources will be required, a need reinforced by population growth. Growing populations place particular pressure on resources such as water for domestic use, industrial expansion and for irrigation to meet additional global food needs.

Population structure

In the second half of the 20th century, the proportion of children—those aged under 15—fell from about 27 percent to 17 percent of the total population in the more developed regions, largely due to sharp drops in fertility (see graph at page 15). Other regions showed an initial pro-

nounced increase due to higher fertility and improvements in infant and child mortality in the immediate post-war period. After that, they started to decline, although the year when the proportion of children falls below 25 percent is likely to be delayed for 50 to 100 years. The proportion of the population ages 15 to 64, conventionally defined as working age, has been higher in more developed regions, but middle-income countries are now catching up. A reduction in fertility leads to a one-off increase in the proportion of young adults since the succeeding generations will be smaller. This “demo-



graphic dividend” increases the proportion of the population that is economically active, and that “dividend” helped development in East and South-East Asia in the 1980s. A similar trend is expected in the least developed countries, but the benefits will only accrue if there are sufficient jobs available, since a large numbers of disaffected, unemployed youth may have a negative rather than positive impact on development.

The proportions of older people, those aged 65 and over, are increasing everywhere or are very likely to do so in future, but with a substantial lag in the least developed countries, where there is little indication of population aging to date (see graph at page 15). However, middle-income countries are starting to age and at a faster rate than was the case for more developed regions. The proportions of older people, those aged 65 and over, are increasing in more developed regions, although the post-war baby boom of the 1950s and 1960s led to an increase in births, which tended to offset population aging in those periods. However, in more recent decades, fertility has dropped substantially in most parts of the World. In some European countries such as Spain, Italy and Greece, the fertility level is below 1.4 children per woman, a level which if continued in the absence of migration would mean that each generation would be succeeded by a generation only about two thirds its current size. The impact of fertility decline on population aging has been reinforced

by improving longevity. The potential dependency ratio, the number of potential workers defined as those aged 20-64 for each person aged 65 or over, was 7.5 in the most developed countries in 1950, but half that number in 2015, and it is likely to be about two by 2050. Potential support values in medium-income countries have also fallen sharply but are about double those of the most developed countries at each corresponding year. Aging requires additional resources to be transferred from workers to non-workers. While the proportion of child dependents has fallen, resource needs for older people are increasing substantially. These resources include pensions and healthcare, mainly from the formal sector, and personal care from the informal sector, especially close family members. Within the older population, the “old old,” those aged 80 and over, form an increasing fraction. These groups are much heavier users of health and social care services and thereby add pressure to the budgets of these sectors. Changing population structures and wider social and economic trends put pressure on both sectors. Lower fertility and changing economic and social systems that require high geographic mobility mean that younger relatives may no longer live close to their parents. Traditionally, women are particularly likely to provide personal care, but more people are childless, younger women are increasingly less likely to marry and women with formal labor market responsibilities may be less

willing or able to provide care for parents-in-law. These aging trends are inexorable and highly predictable, and the British Office for Budget Responsibility identified the costs of population aging as the largest single challenge to the sustainability of the United Kingdom’s fiscal system. Policy responses to population aging in high-income countries have been muted in part because they are frequently politically unpopular. These policy responses can include less generous pension arrangements and, in particular, extension of working lives for current workers who had expected to retire from the labor force at ages similar to their predecessors. In less developed countries, reductions in mortality in the 1950s tended to keep populations younger, since improvements were concentrated among infants and children. Highly effective public health interventions such as vaccinations and the treatment of communicable diseases were relatively straightforward to implement.

Reduction in fertility and increase of the older population

Reduction in fertility means that the number of young people is reduced, thereby increasing the proportion of the older population. Mortality improvement is increasingly concentrated at older ages, so the number of older people increasing rapidly. This trend reflects success in controlling both unwanted fertility and mortality. However, the sharper the decline in fertility and mortality, the more

rapid the increase in population aging. As a consequence, the challenges associated with population aging are more substantial in medium-income countries where pension and health-care schemes are less developed. The implications of decisions at a particular time can directly affect population trends for up to a century or more in the future, with indirect effects taking even longer. This is well illustrated by China, a country that experienced a number of important changes, and is the largest country in the world and thus has the greatest impact on overall global values. After the Communist revolution in 1948, the government took the view that people were the nation’s greatest asset and that population growth should be encouraged by increasing fertility. Therefore, in the 1950s and 1960s, the fertility rate was about six children per woman, although the effect on population growth was offset to some extent by the catastrophic Great Leap Forward of the 1960s that led to the death of about 45 million Chinese people (estimates vary). The government reversed its pro-natal policy in 1980, introducing a “one-child family” policy to restrict population growth, and fertility fell to 2.5 children per woman. The Chinese government was efficient in achieving its objectives by mobilizing all levels of society, sometimes using questionable methods. At the same time, life expectancy at birth had increased by 20 years in the previous two decades, leading to a substantial demographic dividend and one of the

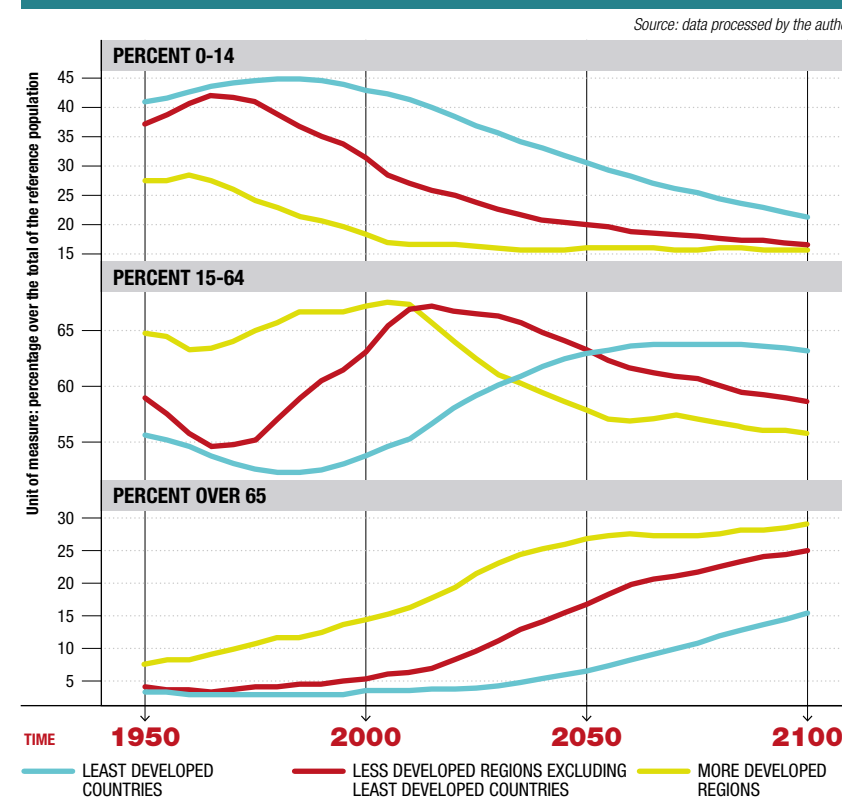
most rapid examples of population aging ever experienced at that time. While there are currently about seven people aged 29 to 64 for each person aged 65 or over in China, compared with 3.5 in Europe, both are expected to have a value of two by 2050. More recently, the Chinese government has recognized there are a range of problems associated with low fertility societies. In a true one child society, no one has a brother, sister, aunt or uncle. With greater longevity, a one-two-four system becomes established, with each child having two parents and four living grandparents, but no other relatives. However, low fertility in China is not simply a consequence of government pressure. It appears that Chinese parents have adapted to low fertility, which has become institutionalized, so that even though restrictions are relaxed, they are reluctant to return to earlier patterns. In one of the most developed parts of China, Shanghai region, with a population of 30 million people, women have an average of 0.7 children, about half the level of low fertility parts the World such as Southern Europe. China’s experience emphasizes that demographic changes, planned or unplanned, will have very long-term effects. China’s current challenges with population aging arise in part from the pro-natalist policies of the 1950s and 1960s (large numbers of people currently entering older age groups) and the 1980s and 1990s (deficit of working age people). These trends are compounded by the experience of mor-

talidity and migration over the period. China was enormously successful in reducing mortality. Between the 1950s and 2015, life expectancy at birth increased by around 43 years, whereas its neighbor Russia increased life expectancy by only 11 years in the same period. International migration has not been a major factor in Chinese population trends, but China experienced the largest level of migration in human history. It is estimated that about 150 million people, mainly young adults, moved from rural areas to expanding economic areas around the coast starting in the early 1980s. This left older people in rural areas, sometimes without the family that was their main source of support, and, in any case, over time there are increasingly fewer young people to provide support. China is an extreme case, but similar trends of high fertility in the early post World War II period were followed by historically very low levels in the later 20th century. These trends were also combined with improved longevity and more long-distance migration in high-income countries as well, leading to similar but possibly less extreme consequences.

Strategic issues

Population pressure has always been a potential cause of conflict, with expanding populations attempting to acquire additional resources (sometimes by appropriation of goods or land rather than by colonization). High population growth means more troops were available, and a higher proportion of young men in a population is itself a factor associated with violence and conflict both internally and externally. Countries with a perceived population deficit may advocate pro-natalism such as France did following its defeat in the Franco-Prussian war, a result of fear of German expansionism following France’s defeat. More recently both Turkey and Iran have adopted pro-natalist policies in a region of considerable instability. India is likely to overtake China as the World’s largest country around 2025, near the time China’s population is expected to start declining in absolute terms. India already has 30 percent more men than China aged 20 to 24, the group likely to be in military forces. A rapidly expanding population has both a greater incentive and greater ability to appropriate resources by force, and that may in turn encourage neighboring countries to invest in more sophisticated arms as a response to a perceived or actual threat. Similar points hold not only for conflict between states but also for internal conflicts which form an increasing fraction of violence throughout the World. These challenges are

POPULATION BY AGE AND BY DEVELOPMENT OF COUNTRIES



In more developed areas, the percentage of children under the age of 15 years has dropped from 27 to 17% of the total population, for reasons related to the significant decline in fertility.

compounded when young men form a large fraction of population, especially if they do not feel that they share improved conditions. Population pressures are particularly likely to exacerbate tensions in areas like the Middle East and Africa where they can place increased demand on scarce resources such as water.

International migration

International migration has become an increasing focus of the political and social agenda in recent years. From a global perspective, the numbers involved are not large; only about 3 percent of the World’s population are international migrants. However, migration is particularly unpopular in European countries. A recent poll for the International Organization for Migration found 7.5 percent of Europeans in favor of increased migration and 52 percent in favor of reduced migration, and this was the period before large-scale flows of migrants, many from Syria, Iraq and Afghanistan in 2015. Migration is also a source of tension in other parts of World, such as South Africa, and it has substantial potential to cause disruption. Remittances may help to develop the local economy in sending countries, but they may lead to a loss of skilled personnel. Remittances may also exacerbate inequalities and be used for consumption rather than investment. For receiving countries, while employers may welcome sources of flexible, cheap and motivated labor, native

workers may see competition for employment reducing their chances and conditions. Migrants are likely to benefit from migration, but disappointment is possible if they find that they do not quickly obtain the expected benefits of movement, and/or experience problems integrating to the new culture.

A lack of organizational structure

This brief summary has not been able to include closely related population issues such as urbanization that will often reinforce the potentially disruptive impact of demographic change. In addition, there are a number of potentially important areas that are very uncertain, those including large-scale population displacements due to conflict and/or the impact of climate change. Attention has concentrated on changes that are very likely to occur. For example, everyone who reaches age 65 in the next year is already alive, but it is also clear that planning for these trends has been lacking. It is tempting for governments to delay unpopular measures such as increasing pension ages, or for international funding to switch priorities from areas with major long-term benefits such as family planning to areas of contemporary concern such as reproductive rights or HIV/AIDS. However, population trends will continue to have a major effect on global sustainability.

Technology/Future directions from production to storage

Here comes the sun

Scientists have launched a revolutionary low-carbon process based on solar power. Emerging economies may lead the way in creating the infrastructure to use it effectively



DANIEL NOCERA

He is the Patterson Rockwood Professor of Energy at Harvard. He created the artificial and bionic leaves, which together perform an artificial photosynthesis that is ten times more efficient than natural photosynthesis. His company Sun Catalytix is now commercializing his energy storage technologies.

The year was 1898 when civic planners and engineers gathered in New York City to discuss the greatest problem confronting society: horse manure. At the cusp of the industrial revolution, the population was expanding, horse buggies were the preferred mode of transportation and horse manure was accruing in the cities. Extrapolation of the transportation needs of the growing population yielded an alarming conclusion. As Eric Morris writes in *ACCESS* (no. 30 Spring 2007) "The situation seemed dire" with estimates "that by 1950 every street in London would be buried nine feet deep in horse manure" and in New York City "horse droppings would rise to Manhattan's third-story windows." Conference attendees were "stumped by the crisis" and accordingly decided to dissolve their ten-day conference after three days because "the urban planning conference declared its work fruitless." I doubt most readers have ever heard

about the "horse manure crisis" because science and engineering was developing a number of technological "disruptions" that were to change the course of our society. By 1846, the Canadian geologist Abraham Gesner had discovered a distillation process that refined kerosene from coal, and by 1856 the first oil refineries had been constructed. At the same time, numerous engineers were investigating engines that could be fueled by hydrocarbons, and in 1885 Karl Benz developed the Benz Patent Motorwagen in Mannheim Germany, a vehicle acknowledged to be the first practical automobile powered by an internal combustion engine. Thus by 1898, when the civic planners and engineers from around the globe met in New York City, they didn't realize that science and engineering had already been set on a path of "disruption" a decade earlier, disruption that would avoid the impending societal crisis of horse manure.

The role of science and technology in our future

The parallels between the 1898 horse manure crisis and today's discussion of the energy crisis are uncanny. Today, a growing world population, especially in the developing world, is fueling an accelerated demand for energy. The global population is expected to increase from the current 7.3 billion to 9.7 billion by 2050, and in addition to these 2.5 billion new inhabitants of the planet, 3 billion people in the emerging world seek a rising standard of living. Because energy consumption scales directly with a country's gross domestic product, their energy use will only increase dramatically as they modernize. Extrapolating the energy demand attendant to this growth in population and the increase in the aspirations and needs of billions of people in emerging economies, the rate of worldwide energy consumption is predicted to double by mid-

century and triple by the end of the century. If energy need is met with our current energy infrastructure, the atmospheric carbon dioxide concentration will likely double and even triple within the 21st century. Not unlike the 1898 horse manure conference, considerable anxiety surrounds a decision to maintain an energy path based on carbon, a path that will result in burying ourselves, this time not in horse manure, but in CO₂. While the consequences of this increase cannot be predicted precisely, what is certain is that we are disturbing the planet on a scale never experienced before. The situation seems dire. But it is not widely realized that once again, science and engineering have initiated a course of "disruption" to mitigate the impending societal crisis due to carbon. The scientific research community has set its sight on a solar-based renewable energy supply for the global future. The last decade of solar en-

ergy research and technology has delivered astounding discoveries that sets the stage for a paradigm shift in our global energy infrastructure. Shifts have occurred along two lines: generation and storage. With regard to the former, new photovoltaic materials and processing techniques have led to unprecedented efficiencies for the generation of electricity from sunlight. Who could have imagined less than a decade ago that a solar photovoltaic material operating at efficiencies in excess of 20 percent could be prepared by simple precipitation of a semiconductor material from solution? This is indeed the case for perovskite solar cells that combine organic and inorganic compositions. Their high efficiency is stunning in view of how cheap they are to produce and how simple they are to manufacture, although they are not without challenges for implementation (the high-efficiency materials are moisture

ENERGY AND ART

The installation "Greeting to the sun" by Nikola Basic in Zadar, Dalmatia (Croatia).

22 countries

had enough capacity at end-2015 to meet more than 1% of their electricity demand

50 GW

of solar energy added in 2015, at global level (REN21)

227 GW

of global Solar PV energy capacity in 2015 (REN21)

3.8 million

estimated direct and indirect jobs in solar energy sector (PV and Heating/Cooking)

Source: REN21

sensitive and rely on lead, a heavy metal). An especially impactful advance in solar generation will be roll-to-roll manufacturing on flexible substrates. Even here significant advances have been made in recent years with amorphous silicon (a-Si) and with the potential offered by materials that combine elements from the periodic table in the Groups of III and V (commonly called "three-five" photovoltaics). Nonetheless, it is fair to say that none of these advances are essential, as none of these scientific advances have been as disruptive as the sea change in manufacturing. Owing to a significant Chinese commitment to the production of crystalline silicon (c-Si), prices are in the mid-dollar per watt range for a solar module. Accordingly, there has not been much need for discovery in solar generation, as c-Si (which has also had reported efficiencies of 25.6 percent) is already cheap enough for the widespread implementation of solar power. But that has not yet happened, and the question is why. The simple answer, in view of the Chinese commitment to c-Si production, is that it is not a generation issue but rather one of storage. Once solar energy is stored, it becomes a useful commodity. Accordingly, energy storage is the single most critical challenge to the widespread implementation of renewable energy.

The real challenge: energy storage

Renewable energy storage assumes different targets depending on whether it is for transportation, and, if not, whether energy distribution is centralized over a grid as is the case for mature markets, or decentralized, as is more possible in emerging markets. Energy storage in the trans-

portation sector has been driven by lithium-ion (Li-ion) batteries, though there has been some innovation in battery materials with the Li-ion paired with oxides of cobalt, manganese or nickel (and combinations of these metals) or as a titanate or iron phosphate. The disruption in Li-ion has come in a commitment to large scale manufacturing, which is having a major impact in driving the explosive growth of the electric vehicle market. Often the promise of Li-ion batteries in the electric vehicle (EV) sector is applied to large-scale stationary (grid) applications, which require much lower price points than those of the transportation sector. "Learning curve" extrapolations applied to Li-ion often make it appear

AN ENERGY TREE

The process for storing and exploiting solar energy in the form of zero-emission fuel requires the recombination of hydrogen and oxygen to create electricity through batteries and fuel (Bristol's Energy Tree in the picture).



to be a viable option for large-scale storage technology. However, such extrapolations are likely to be overestimates as there will be materials limitations (not just in lithium but the other metal oxides as well) at large scale. A better situated technology for grid storage are redox flow batteries (RFBs), which effectively are rechargeable “fuel cells” in which a dissolved electroactive species flows through an electrochemical cell that reversibly converts chemical energy directly to electricity. The RFB is a powerful technology option because energy density and power density are separated, and hence a versatile storage technology for the grid operator. Price points for redox flow batteries are well below Li-ion batteries, and some RFBs have been acquired by large engineering companies for commercial scale-up to megawatt (MW) storage capacities. At the same time, RFBs are also a viable option for energy storage on microgrids in emerg-

ing energy markets. It is important to realize that RFBs have much lower current and energy densities than Li-ion—hence RFBs are confined to large-scale stationary energy storage whereas Li-ion are ideal for the transportation sector. Batteries are not well suited for the terrawatts-equivalent of energy storage needed by mid-century because of their limited energy densities. In a battery, the electrons must reside on atoms, and thus the stored energy is limited by the physical density of materials. With lithium as one of the lightest elements in the periodic table, and hence with one of the lowest physical densities, stored energy in the form of electrons within batteries has already approached a ceiling. Society has intrinsically understood this limitation. Although batteries were known since the turn of the 18th century, hydrocarbon-based fuels were immediately adopted in the 20th century to power industrialization. The energy

density of a liquid fuel is 50-100 times greater than that of a battery, and consequently the future of energy storage will not change as the large scale storage of energy storage will necessarily be in the form of chemical fuels. Discovery during the last decade has set off on a path of disruption to convert a fossil fuels industry to a solar fuels industry.

The sun: A source of carbon-neutral energy

The simplest process to store solar energy in the form of a carbon-neutral fuel is to use the sun to split water into hydrogen and oxygen. Recombining the hydrogen and oxygen converts the stored solar energy back in a useful form (electricity through fuel cells) when and where it is needed. In this renewable fuels cycle, no carbon dioxide is produced and there is no loss of water since it is the product of hydrogen and oxygen recombination. In less than a decade, re-

markable advances have been made in this area of renewable energy. Catalysts have been created from earth abundant elements to perform the water splitting reaction under simply engineered (and thus inexpensive) conditions. When integrated directly with silicon (i.e., the artificial leaf) or indirectly by wiring to a silicon photovoltaic, solar-to hydrogen efficiencies of greater than 10 percent have been achieved, with 15 percent efficiencies on the horizon. The challenge of using hydrogen as a fuel is the lack of a widespread infrastructure for its use. In this regard, the rise in popularity of natural gas may well be a driver for a hydrogen infrastructure, as hydrogen can be generated by combining natural gas with water in a process called reforming. As natural gas becomes more prevalent, the price of a gas gallon equivalent of hydrogen is approaching \$1.50 USD, and point-of-use hydrogen becomes feasible with on-site

reforming as yet to be achieved in a cost-effective way, thus alleviating the need for a hydrogen distribution infrastructure. It is to be noted that, in the reforming process of natural gas with water, carbon dioxide is produced in addition to hydrogen. Thus, it is a short jump to solar-driven water splitting as the carbon neutral version of methane reforming to produce hydrogen. Natural photosynthesis confronts the same challenges society does in storing hydrogen. Photosynthesis also uses the sun to split water to hydrogen and oxygen. To circumvent the hydrogen storage challenge, it combines the hydrogen from water splitting with carbon dioxide to produce carbohydrate or some other form of biomass. On an electron equivalency basis, the production of the carbohydrate stores only less than 1 percent more energy than water splitting. Thus, the solar energy storage in photosynthesis is achieved

by water splitting; the carbohydrate is nature's method of storing the hydrogen released from the water splitting reaction. Even here, advances in science have been astounding. Using the tool of synthetic biology, organisms have been engineered to breathe in the hydrogen from water splitting and then combine it with carbon dioxide to produce biomass in excess of 10% solar-to-fuels efficiencies. Realizing that the best growing crops achieves a biomass efficiency of 1 percent reveals the extraordinary accomplishment of science in the last decade. Even more striking, the organisms have been further engineered to bypass biomass and directly synthesize liquid fuels at 5 to 7 percent efficiency. Thus, science has shown that we, as a society, can far surpass the solar energy process of nature that drives our planet.

We need a change in our energy model

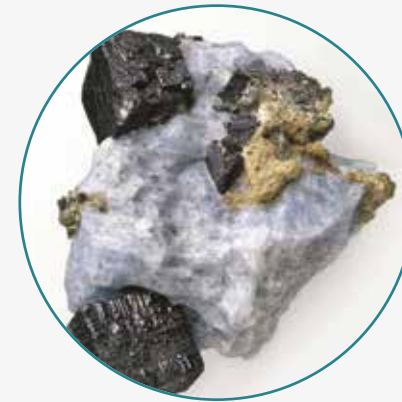
A ledger of science and technology advances in just the last decade demonstrates that we can generate solar energy in a cost effective manner with silicon. Batteries can store renewable energy and meet our transportation and grid-based electricity needs. The sun can be stored in the form of the chemical fuels of hydrogen, biomass and liquid fuels, and at efficiencies that put society on a genuine path forward to a restructuring of a fuels industry based on fossil-fuels to one based on solar energy. The disruption delivered by science and technology for historic change to the global energy infrastructure now exists. So why isn't it being adopted? In short, the last century has seen a massive investment in an energy infrastructure that has been paid off. Thus, there is no discovery that can supplant this energy infrastructure in mature markets. This is where emerging economies offer hope for leading global society to a new energy infrastructure. In the absence of massive investment, it will be easier for emerging economies to leap frog the established energy infrastructure and adopt new renewable energy innovations and technologies. In either case, in emerging or mature energy markets, there must be a societal imperative for changing our energy infrastructure that extends beyond near term costs. Unfortunately, the price of burying ourselves in carbon dioxide is not in society's current equation for change. When it does become part of the equation, science and technology will be ready with the enabling and disruptive paradigm shift to deliver the Sun to the people of our planet as their direct energy supply.



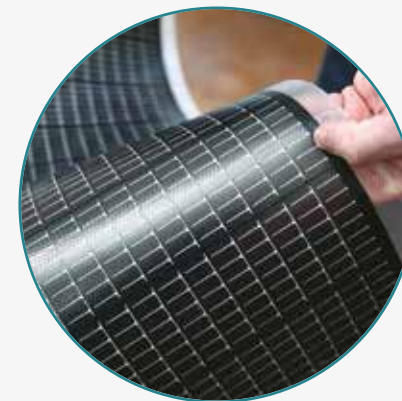
The latest frontier

**LI-ION**

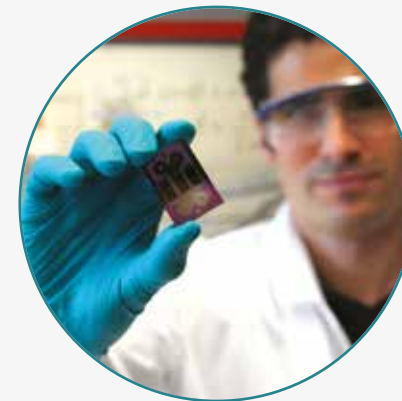
This rechargeable battery known as a lithium ion battery (sometimes abbreviated to Li-Ion) is commonly used in consumer electronics. It is currently one of the most common types of batteries for laptops and cell phones, as well as for some electric cars, with one of the best power/weight ratios, no memory effect and a slow loss of charge when not in use.

**PEROVSKITE**

Its name was coined by Gustav Rose in 1840 in honor of the Minister of the Russian Imperial Court, Lev Perovski, a great collector of minerals. It refers to the opaque, cube-shaped crystals found by Rose in 1839 in the Ural Mountains. The material has a particular crystalline structure, composed of a double oxide of Ca and Ti (CaTiO₃). What stands out is its characteristic feature of being an excellent conductor, which makes it usable in new technologies.

**AMORPHOUS SILICON**

Known by its abbreviated name as “a-Si”, this is the non-crystalline, allotropic form of silicon. Amorphous silicon photovoltaic technology with the lowest environmental impact is currently in the production phase. The specific production process, in which limited amounts of silicon are used, means that in approximately 2 years, each unit will have produced an amount of electricity equal to that used to produce it.

**REDOX FLOW BATTERIES**

This is one of the most promising technologies for network storage. They are rechargeable “fuel cells” in which an electroactive solution passes through an electrochemical cell which reversibly converts the chemical energy into electricity. RFBs provide a versatile storage technology for network operators.

**REFORMING OF NATURAL GAS**

This is a process by which hydrogen can be generated by combining natural gas with water. It is a small step towards separating water by resorting to the sun, as an emission-free version of the reforming process with methane used to produce hydrogen.



THE NEW LADY

On July 13, Queen Elizabeth II of England welcomed Theresa May at Buckingham Palace to formalize her appointment as Prime Minister.

has become Foreign Secretary. She has underlined her commitment to Brexit, and some of her cabinet members suggested the government was planning to trigger Article 50 early in the New Year after extensive consultations with European governments. Mrs. May has already had quite positive talks with Germany's Angela Merkel and somewhat frosty ones with France's Francois Holland. Mr. Johnson has so far shown some unexpected diplomatic skills and avoided the polemics for which he is well known. After all, he is only too pleased to have been given such a big role in the new government after being betrayed by his closest Brexit ally, former Justice Minister Michael Gove, during the leadership contest that followed Mr. Cameron's resignation. He now has a strong platform from which to launch his own bid to become Prime Minister in the future.

An internal party showdown

The tensions and divisions within the Conservative Party have shown in broad daylight how the Brexit referendum was, at the end of the day, an internal party showdown. The sad thing is that such a crucial issue as Europe and the U.K.'s membership of the E.U. boiled down to a dirty internal political squabble in the Conservative Party as well as in the Labour Party, which was supposed to have backed Mr. Cameron's bid to remain in the E.U. But the controversial Labour leader Jeremy Corbyn made it clear he was extremely reluctant to back Mr. Cameron and did little to fire the Labour Party base to vote to remain. Indeed, the leadership contests in both the governing Conservative and the opposition Labour Party have been widely compared to a political soap opera that has the makings of a big budget sequel to the blockbuster "House of Cards" television series. In fact, there are two — the first set in London and the successful American adaptation in Washington D.C. These are all gripping stories of personal political ambition and betrayal that have been played out for real in the fallout of the unexpected Brexit vote. Although Theresa May ultimately won the Conservative leadership contest with an overwhelming majority and is generally considered as "a safe pair of hands" with considerable political experience, she will still need to navigate difficult waters both within her own party and country and with Europe. The Brexit hardliners are frustrated that the new Prime Minister is not an out and out pro-Brexit supporter, and those left out of her cabinet will watch and wait for her to trip up. As for the Labour Party, the situation is a complete shambles, and that is no exaggeration. The vast major-

Brexit/The repercussions of Great Britain's "divorce"

Short circuits across the English Channel

The effect on the energy sector is still coming into focus. The fate of the U.K.'s participation in the Energy Union project and the liberalization of the E.U. energy market will be crucial

PAUL BETTS



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he dust still needs to settle—and this could take many more months, perhaps years—before it will be possible to assess the full impact of Britain's decision to leave the European Union on the U.K. economy and its all important energy sector. One thing is certain: The future will depend on the skill of the new Conservative government led by Prime Minister Theresa May to negotiate an acceptable arrangement with the rest of the European Union after a short but particularly bitter leadership contest that has left deep scars inside the party. The ongoing turmoil in the opposition Labor Party also risks unsettling the situation further, as does the attitude of Scotland, which wants to remain in the E.U. and may seek a new referendum to split from the UK. Will many of the "Leave" voters start having second thoughts

should the U.K. economy come under increasing pressure with the possibility of falling into recession? So far, the stock market and the economy have resisted quite well although the pound has inevitably suffered a sharp decline against the dollar and the Euro. Mrs. May does not seem in any great hurry to invoke Article 50 of the Lisbon treaty that would trigger the two year process for Britain's exit out of the E.U. As Home Secretary (the equivalent of Interior Minister in E.U. countries), she had backed former prime Minister David Cameron's unsuccessful campaign to remain in the EU. But she has always been tepid about the EU. She has also appointed in her government a number of pro-Brexit influential Conservative members, not least one of the leaders of the Brexit campaign, former London Mayor Boris Johnson, who

Energy: What changes now?

Increase in domestic energy bills

Collapse in energy security
if access to the domestic energy market is lost

£500 million in 2030
the demand for higher returns by investors

£20 billion per year
over the next five years represents the increase in investment infrastructure

The “green” challenge
collapse of the constraint of producing 30% of electricity from renewable sources

Nuclear advancement
re-launch of projects such as controversial Hinkley Point C nuclear power station

More difficult access to loans
from the European Investment Bank and the EU Fund

Research at risk
due to difficulties in funding research programs and collaboration in Pan-European projects

Investment risk
on the part of companies, which could postpone or cancel project

The English Channel
agreements on the freedom of movement under threat

Labor costs
increase in costs for European oil companies that employ British workers

Decline in the supply of labor
bureaucratic limitations would hinder the oil and gas industry's access to skilled workers

ity of Labor Members of Parliament as well as the shadow cabinet want the current party leader Jeremy Corbyn to resign after his feeble support to stay in the E.U. in the recent referendum. He has lost a vote of confidence from his own parliamentary members, but under the arcane rules of the Labour Party, he has resisted resigning and suggested he would soldier on. All this goes to show how deeply divided are the Labour Party and the Conservative Party, for all the current efforts to rebuild party unity, England and the United Kingdom as a whole. After the initial knee-jerk reaction following the largely unexpected victory of the “Leave” camp, the financial markets have recovered some composure and the Bank of England has so far resisted making an immediate interest rate cut. The mood, however, remains nervous and volatile. This is all principally due to the uncertainty created by the U.K.'s decision to leave the E.U. that in turn risks spreading more economic instability, and undoubtedly weakens the U.K.'s negotiating position and, at least in the short term, discourages investment. In short, the referendum and its outcome have introduced a severe source of new turbulence and confusion to both the U.K. and E.U. economies, not least in the energy sector.

An unclear effect on the energy sector

The precise impact on the energy sector is unclear at this stage. However, as the legal firm Herbert Smith Freehills put it in a recent note: “One certainty is that in the immediate future we are very unlikely to see any major changes to the current systems and regulations. The exit will take a significant amount of time to negotiate and plan, and the E.U. and the U.K. will have to decide how access to each other's energy markets would continue, if at all.” The key issue is whether the U.K. will be able to retain its access in the single market without having to comply fully with the obligation of freedom of movement for E.U. citizens. Migration was from the very start one of the main issues of the referendum, and whatever government is formed in London this autumn, migration will remain at the top of the agenda of negotiations with the E.U. That does not mean, as Mrs. May has suggested, that the new government will invoke Article 50 of the Lisbon Treaty straight away. All the signs are that the new Prime Minister will try to delay this until the end of the year to test the negotiating climate and assess the economic environment. At present the other E.U. countries are suggesting that the U.K. would be given no favors - “no cherry picking” Mrs Merkel told

Mrs May - and if it wants continued access to the single market, it will have to comply with the quid pro quo of freedom of movement, capital, goods and services. This would apply in a Norwegian style solution with the U.K. remaining part of the European Economic Area. However, negotiating positions can evolve, especially as many other E.U. countries have similar worries and domestic pressures over controlling migrant flows that could lead to a broad reassessment of E.U. migration policies. These might help open the way towards a compromise with the U.K. which would be able to adopt what some commentators are already calling a “soft Brexite” or “Brexite lite” option—the U.K. would be allowed a certain control on migration through, say, a quota system, to allow its continued participation in the single market. These are very early days, but ideas are already being floated about. They have important implications for the U.K. and E.U. energy sector because they will ultimately determine the U.K.'s continued participation (or not) in the Energy Union project and its participation in the liberalization of the European energy market. Britain has a number of electricity and gas inter connectors with continental Europe and is currently developing more. This amount would make up about 60 percent of all planned infrastructure spending in the UK.” Indeed, Brexit is likely to make the U.K.'s challenge to build a clean, secure, affordable energy system even harder. In a Brexit scenario, Britain would no longer be bound by the E.U. requirement to produce about 30 percent of its electricity from renewable sources. It would also give the U.K. greater freedom to pursue nuclear projects such as the controversial £18bn Hinkley Point C nuclear power station led by the French state controlled utility EDF. After the referendum, French political leaders confirmed they continued to support this project that is important for both countries. The plant would provide low carbon electricity to meet 7 percent of the U.K.'s total needs from 2025 onwards while it would help support France's nuclear industry that has faced increasingly difficult times of late and is in the midst of significant restructuring. But Brexit is also likely to make it harder for the U.K. energy sector to secure loans from the European Investment Bank and the European Fund for Strategic Investment to help fund much needed new energy infrastructure investments. The scientific community is also concerned about the implications of Britain leaving the E.U. on funding research programs and U.K. collaboration in pan-European projects. Professor

Impacts on utility bills, green energy and nuclear projects

The U.K. National Grid has also already warned that domestic energy bills would rise and energy security would fall if the U.K. does not retain access to the Internal Energy Market (IEM) when it negotiates Brexit. In a statement after the referendum vote, the company said: “It is vital the U.K. retains access to the IEM which provides stability for energy companies and helps keep household bills down. U.K. energy security depends on gas and electricity from the IEM and it is essential therefore that we take no risks with that. The issue of energy needs to be treated with the highest importance by the government as the negotiations on Britain's exit begin.” According to an analysis from the Vivid Economics research group, the cost of reduced collaboration with Europe would be significant. “The potential impact from the IEM could be up to £500m a year by the early 2020s, “the group's analysts said, adding that further costs would come from investors demanding



CHANNEL AT RISK

One of the biggest concerns of oil and gas multinationals is the possible loss of the relevant agreements to freedom of movement through the Channel between the E.U. and the U.K. (Pictured cargo business in the Channel).

higher returns as the risks of new projects rise. With dirty aging power plants closing down, the U.K. now needs to invest about £20bn a year over the next five years, says the National Infrastructure Commission. This amount would make up about 60 percent of all planned infrastructure spending in the UK.” Indeed, Brexit is likely to make the U.K.'s challenge to build a clean, secure, affordable energy system even harder. In a Brexit scenario, Britain would no longer be bound by the E.U. requirement to produce about 30 percent of its electricity from renewable sources. It would also give the U.K. greater freedom to pursue nuclear projects such as the controversial £18bn Hinkley Point C nuclear power station led by the French state controlled utility EDF. After the referendum, French political leaders confirmed they continued to support this project that is important for both countries. The plant would provide low carbon electricity to meet 7 percent of the U.K.'s total needs from 2025 onwards while it would help support France's nuclear industry that has faced increasingly difficult times of late and is in the midst of significant restructuring. But Brexit is also likely to make it harder for the U.K. energy sector to secure loans from the European Investment Bank and the European Fund for Strategic Investment to help fund much needed new energy infrastructure investments. The scientific community is also concerned about the implications of Britain leaving the E.U. on funding research programs and U.K. collaboration in pan-European projects. Professor

Steve Cowley, the head of the U.K. Atomic Energy Authority, told the BBC that researchers were afraid that annual European Commission funding would be withdrawn. This also risks affecting the oil and gas industry that has benefitted from working closely with research institutions in both the U.K. and the EU. This cooperation has allowed companies in the North Sea to maintain their competitiveness over the years and become leaders in the field of new offshore technologies. Compared to the power utilities, the oil and gas industry appears to be in a better position to weather the Brexit storm, according to industry analysts and executives. Nonetheless, the question of a possible second Scottish independence referendum is creating more uncertainty for the oil sector and could induce companies to delay or cancel projects until the full outcome of Britain's exit negotiations are known. But one big worry of the multinational oil and gas companies is the possible loss of cross-Channel freedom of movement arrangements between the E.U. and the UK. Many U.K. workers employed by European oil companies work in E.U. countries and vice-versa. Non E.U. status for these workers could increase bureaucracy and hence costs to employers. Shell has underlined this issue, warning that trade barriers and movement restrictions would negatively impact its U.K. operations. Such restrictions would also undoubtedly affect the U.K.'s ability to attract highly skilled oil and gas workers to its shores. This would represent a further blow to the mature

U.K. North Sea industry that has already lost 8000 jobs since 2014 as a result of the oil price slump and has, as a result, seen a sharp rise in labor tensions and strike action.

The future, looking also at the U.S.

Mrs. May and her new government have so far adopted a cautious, constructive and pragmatic stance to its commitment to take Britain out of the E.U. The question is whether the new government will be able to maintain this approach in the face of the inevitable political and economic turbulence ahead. Mrs. May will hope her opposite numbers in the E.U. also adopt a constructive and pragmatic approach to exit negotiations when they eventually start after the U.K. invokes Article 50 of the Lisbon Treaty. At the end of the day, it is in both the U.K.'s and the E.U.'s long term interest to come to an acceptable arrangement, however long that might take. The outcome of the forthcoming U.S. Presidential election could make the need for such an arrangement all the greater.



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the AMERICAN PERSPECTIVE

The ups and downs of the shale revolution, the rise of cheap natural gas, the sharp decline in coal use, the rise of more restrictive environmental regulations: America has witnessed dramatic changes over the last ten years in the realm of energy, and it could see yet more significant transformations after November's presidential elections. Analysis, forecasts and comments from

- David Koranyi and Madison Freeman
- Molly Moore
- Demosthenes Floros

Energy/Radical changes and future scenarios

The New American Revolution

In the U.S., coal and oil have given way to natural gas, wind and solar energy. Further transformation awaits, though the pace of change will depend on who prevails in the 2016 presidential election



DAVID KORANYI AND MADISON FREEMAN

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Madison Freeman is a research assistant with the Eurasian Energy Futures Initiative. She is studying International Studies and Economics at the American University. Her specific interests include Kurdish issues, Turkish politics, and the intersection of energy security with political stability.

During the past decade, the energy sector of the United States changed dramatically. The period saw a fundamental altering of energy consumption and production and export and import patterns, as well as revolutionary developments in energy technologies. This transformation of energy markets and technologies is likely to continue and accelerate in the coming decade, though the pace with which it will happen is uncertain. Policy changes that might emanate from the 2016 presidential and congressional elections represent the most important unknown. This article provides a brief and incomplete overview of changes during the last decade and looks ahead to the next.

Shifts in fossil fuel consumption

Fossil fuel consumption and production patterns have changed quite dramatically since 2005. Coal and oil have declined in favor of natural gas. Coal, once the backbone of America's energy mix, has witnessed a massive decline in its role in electricity generation from its peak in the late 1980s, a decline that accelerated beginning in the mid-2000s. Generation from coal sources made up only 33 percent of electricity production in 2015, down from 50.5 percent in 2005. This change was especially pushed forward by the availability of cheap natural gas, more affordable renewable power, and by stricter environmental regulations. Coal production has declined to its lowest point in 35 years and is forecast to decline by a further 10 percent this year and 12 percent in 2017. Coal consumption has declined even more dra-

matically, falling 13 percent in 2015, which the U.S. Energy Information Administration (EIA) called "the highest annual percentage decrease of any fossil fuel in the past 50 years." Part of this decline in domestic consumption has been spurred by the increase in exports of coal, which have grown from approximately 60 million short tons annually in 2007 to 125 million in 2012. This has contributed to the significant reduction in CO₂ emissions in the United States, which have fallen from 19.6 metric tons per capita in 2003 to 16.6 in 2013—still twice the European Union average. 2016 is predicted to be the year when natural gas replaces coal as the primary fuel for electricity generation. Unconventional gas extraction has skyrocketed in the last ten years, from 2 trillion cubic feet in 2005 to 12.3 trillion cubic feet in 2014. Technological advances in hydraulic fracturing and horizontal drilling and massive gains in production efficiency helped make gas more competitive vis-à-vis coal. These production increases are projected to continue through 2040, with swelling shale gas production constituting most of this growth. The projected slower growth in demand provides an opportunity for exports of natural gas to expand. Pipelines to Mexico already transmitted 2.9 billion cubic feet per day last year, and this may rise to 4.4 billion by 2020. The development of liquefied natural gas (LNG) terminals in the Gulf of Mexico has opened new markets across the globe: in Asia, the Middle East, and Latin America, where there is significant natural gas demand growth potential, and in the European Union, which sees →

U.S. LNG as a potential key to its energy security. Cheniere's Sabine Pass LNG terminal has been in commercial operation since early 2016, and four other LNG terminals are currently under construction in Maryland, Texas and Louisiana. The U.S. is projected to turn into a net natural gas exporter in 2017 or 2018, and LNG exports are expected to overtake pipeline and truck exports to Mexico by 2019. Oil has also seen significant growth. The shale revolution has spurred a surge in production: from 2010 to 2015, unconventional oil production rose sharply, with 52 percent of U.S. crude oil production—4.9 million barrels a day (b/d)—coming from shale (tight) oil in 2015. Drilling productivity and enhanced oil recovery (EOR) techniques have improved dramatically (the average cost per well had fallen by 25 to 30 percent between 2012 and 2015), bringing down breakeven prices for shale wells across the major plays (Bakken, Eagle Ford, Niobrara, and Permian). It also pushed the U.S. crude oil import ratio to its lowest level (from 9.3 million b/d during the first half of 2010 to 7.3 million b/d during the first half of 2015). Looking ahead, there is considerable uncertainty about the future of U.S. shale oil production, as its sensitivity to external price shocks leaves production levels volatile. Forecasts put crude oil production from U.S. shale formations between mid-2016 and the end of 2018 at 2.4 million barrels higher per year if the market price were \$80 per barrel than if it were \$30 per barrel. Though sustained low oil prices were predicted to devastate the industry, it has shown unexpected resilience so far, despite mounting financial pressure on many producers. The lifting of the 40-year ban on crude oil exports in December 2015 will also have a marginally positive effect on production. Since the ban was lifted, exports to countries other than Canada (which had already been excluded from the ban) increased seven-fold, though exports did not rise as quickly as experts initially predicted, largely as a result of the global oil glut.

Rapid rise of wind and solar

Fossil fuels remain the predominant source of energy in the United States, representing 82 percent of primary energy consumption. In 2015, wind and solar shares of total electricity generation capacity amounted to 6.7 percent and 2.0 percent respectively, while shares of actual generation in 2015 were only 4.7 percent and 0.9 percent, reflecting the intermittent nature of these resources. However, the share of energy generated by renewables is growing rapidly across the United States. Between 2009 and

2015, wind capacity grew by 100 percent and solar capacity by 900 percent. Nationally, wind (41 percent) and solar (26 percent) made up the majority of electric generation capacity additions in 2015. A record amount of distributed solar photovoltaic (PV) capacity was added on rooftops throughout the country in 2015. In Texas, wind has taken a serious place in the energy mix, now providing 11.7 percent of cumulative energy generation. On December 20, 2015, wind energy provided 40 percent of Texas's electricity for 17 hours straight. Oklahoma, one of the top natural gas-producing states, ranked fourth in net electricity generation from wind in 2015, which provided almost 17 percent of the state's net generation. Kansas, another major gas production hub, saw 21 percent of its net electricity generation coming from wind. California alone produces half of the nation's solar electricity generating capacity, with 9,976 MW of total solar capacity, more than the following 12 states combined. It was the first state to generate at least 5 percent of its electricity from utility-scale solar plants, which makes up more than two-thirds of its solar capacity. In 2015, renewable energy made up almost all new electric generation capacity in the state, with wind accounting for 41 percent and solar accounting for 26 percent of total additions. With the increasing competitiveness of both wind and solar, coupled with the extension of tax credits in the December 2015 congressional budget, this growth trend is likely to continue well into the next decade. The potential is certainly there: the National Renewable Energy Laboratory (NREL) estimated that the economic potential of renewable energy ranges from one third to over ten times the total 2013 U.S. generation from all sources. However, in the longer run, major questions remain regarding price and cost levels for competing fossil fuels, particularly gas in the absence of carbon pricing, the development of

the grid so that it can accommodate growth in renewables, the necessary political and regulatory framework on national and state levels, and ways to spread renewables beyond the electricity sector.

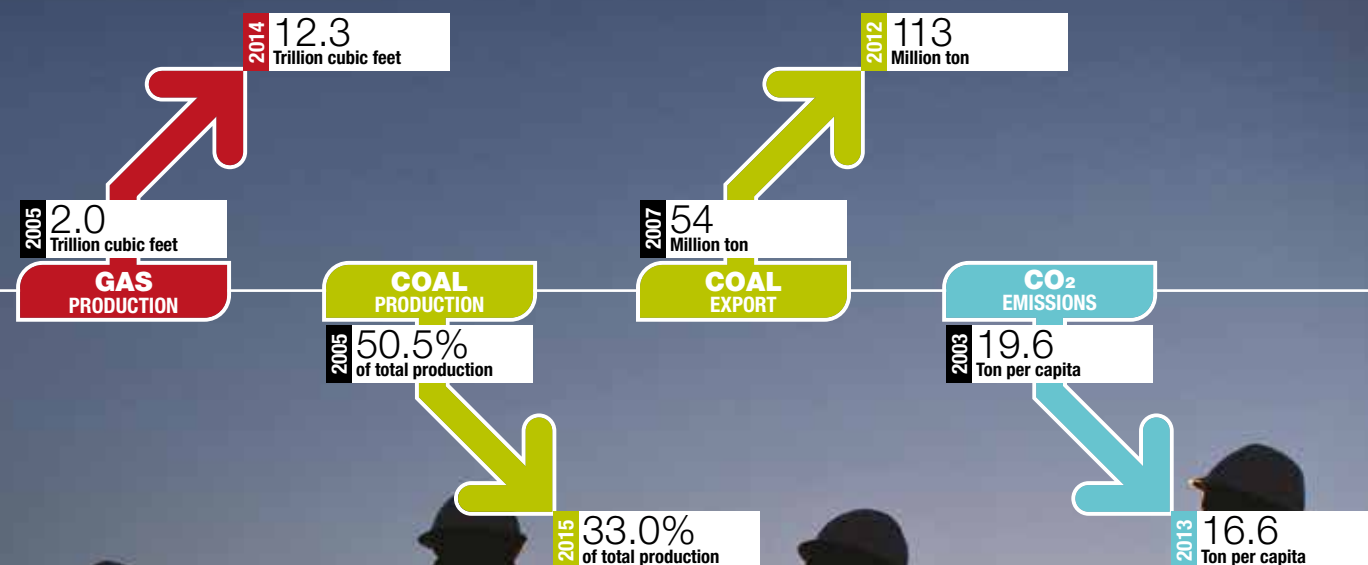
Disruptive technological changes

The United States has been at the cutting edge of energy innovation since the birth of the country, and the spirit of Benjamin Franklin and Thomas Edison lives on today in the competitiveness of the National Labs and Silicon Valley. Public and private actors in the United States play a leading role in technology changes in battery science, information technology, and nuclear energy technology that may have a disruptive effect on both energy production and consumption patterns, not only domestically but on a global scale. By far the most consequential development is the battery technology evolution spearheaded by the Department of Energy's National Labs, change increasingly fueled by the private sector. Affordable storage is key to the competitiveness and sustainability of a higher share of intermittent renewables in energy production. Recent improvements in battery technology have brought down costs of storage and are projected to continue doing so. Grid-scale energy storage costs are declining rapidly: by 2020, the cost of lithium-ion battery systems for the grid may drop by 50 percent, from about \$500 per kilowatt-hour (kWh) today to less than \$230. The tech company Tesla has built its ambitious business plan on the production of low-cost batteries. Its Gigafactory, which is being built in Nevada, will be able to produce enough battery packs for 1.5 million electric vehicles annually, and it is projected to lower the costs of its batteries by 30 percent, a game-changer for electric vehicle and home renewable energy installation competitiveness if successful. Information technology is also shaping major changes in companies'

approaches to energy hardware and supply and demand management. Utilities have been exploring ways to use big data analytics to approach an improvement of energy services, including projections of solar production and forecasts of demand. In trying to improve efficiencies along the value chain, companies are considering ways to capitalize on the concept of the internet of things. Information technology in energy hardware can help facilitate major changes in the approach to shifts in demand and efficiency. By adapting energy use to maximize efficiency through "smart" systems, energy companies can change consumption patterns among consumers. Tech giants have played a pioneering role in this space: Google's inroads to the energy sector with its purchase of Nest is a prime example of spurring growth of the market for home systems that can adapt to typical patterns of consumption and reduce energy use. In nuclear energy, small modular reactors (SMRs) may offer a possible new future for otherwise struggling nuclear power generation in the United States. SMRs are transportable, small-scale reactors that produce less than 300 MW, as opposed to the 1,000 produced by a typical reactor. They can be mass produced, assembled offsite, and can easily change output rapidly to respond to fluctuations in demand. SMRs could fill energy gaps by providing power in remote places or to small towns or buildings, and can be more flexible, cheaper, and safer than the traditional model. Their flexibility in responding to surges or reductions in demand would allow them to complement renewable energy. Though the principle of economies of scale would suggest that smaller reactors would be less economically efficient, International Atomic Energy Agency estimates have put costs for construction, maintenance and operation far lower than traditional reactors. Proponents argue that they are a safer and more efficient model that would change the entire makeup of energy production in many regions. Though there is much promise in SMR technology, there is little implementation so far. The U.S. Department of Energy has supported the accelerated deployment of SMRs and has promoted the NuScale SMR model of a lightwater reactor. The Tennessee Valley Authority submitted the first permit application for a SMR to the U.S. Nuclear Regulatory Commission in May of 2016, but there are currently no SMRs in use in the United States. Nuclear energy has witnessed a general stagnation in the percent of electricity generation it produces since the late 1980s, and while SMRs could help add to this,

UP & NMOD

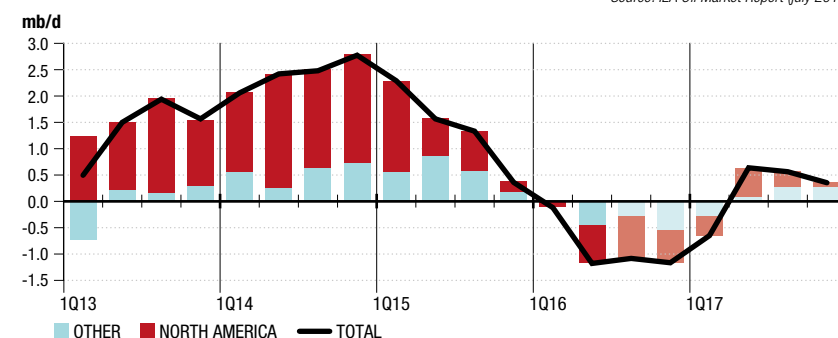
Gas production has surged considerably in recent years. Energy from coal production, on the other hand, has declined significantly over the past decade, though exports have soared. CO₂ emissions are also down significantly.



Source: data processed by the author

OIL, THE COLLAPSE OF NON-OPEC PRODUCTION

Source: IEA Oil Market Report (July 2016)



In 2016, much of the decline in non-OPEC oil production is attributable to North America. In 2017, estimates foresee a gradual recovery.

there is considerable political difficulty in rolling out new reactors that may significantly retard their adoption. The United States also plays a leading role in trying to advance and commercialize carbon capture and storage, the only technology to capture 90 percent or higher of the emissions from existing fossil fuel infrastructure. The Kemper project—though struggling with major delays and cost overruns—aims to gasify low calorific value lignite. The resultant syngas is burned to generate electricity with considerably lower amounts of CO₂ and other emissions, and the electricity can then be captured and sold or stored. The technique—if it proves to be technologically and commercially viable—could provide a longer term climate friendly future for coal from Poland, South Africa, India and China. The United States has also made measurable improvements in energy efficiency, but gains have been slow so far, due to poor insulation and low efficiency in trans-

portation in the United States. Transportation's low efficiency is especially due to heavy reliance on single-rider transit and the low growth in public transit, trends that undo the benefits from significant improvements in corporate average fuel economy standards, particularly since 2010.

Accelerated transformation amidst policy uncertainties

The major trends identified in this article—revolutionary realignment in fossil fuel consumption patterns, rapid growth of renewables albeit from a low base, and potentially game-changing developments in energy technology—together point to the acceleration of the energy transition to a lower-carbon economy in the coming decade. The continued decline of coal looks certain, and oil consumption will likely stagnate or further decrease in light of stricter fuel economy standards and the spread of electric vehicles. The future of cleaner

burning natural gas looks brighter, at least as long as it replaces coal, though significant uncertainties exist in the longer run, as many dispute the bridge fuel role for natural gas. Though the shifts of the last decade appear to be principally market-driven, public policies play a major role in the development and early deployment of new, disruptive technologies such as unconventional oil and gas or batteries. The professed goals in the United States intended national determined contributions (INDCs) in the United Nations Framework Convention on Climate Change (UNFCCC) process and particularly the long term decarbonization goals will also require more robust public policies to fast-track the energy transition. As the U.S. presidential and congressional elections approach, there are considerable uncertainties about the U.S. climate and energy policies post-November 2016. One can only speculate about the election out-

comes and corresponding policy directions. A Democratic win in the 2016 elections may put more emphasis on supporting renewables through either a continued regulatory approach (along the lines of the Clean Power Plan) or—in case of Democratic control of both chambers or bipartisan support—legislative action (e.g., in the form of a carbon tax or a cap-and-trade system). While a Republican win may slow progress in reducing carbon emissions in the energy sector, technological and market trends will make it hard to cement a fossil-fuel based economy in the medium- and long-run.



Elections/The energy position
of the candidates for the White House

Black, blue or green?

How will America prioritize
between oil, gas and renewables
in the years to come?
November's presidential election
will play a big part
in determining the answer

MOLLY MOORE



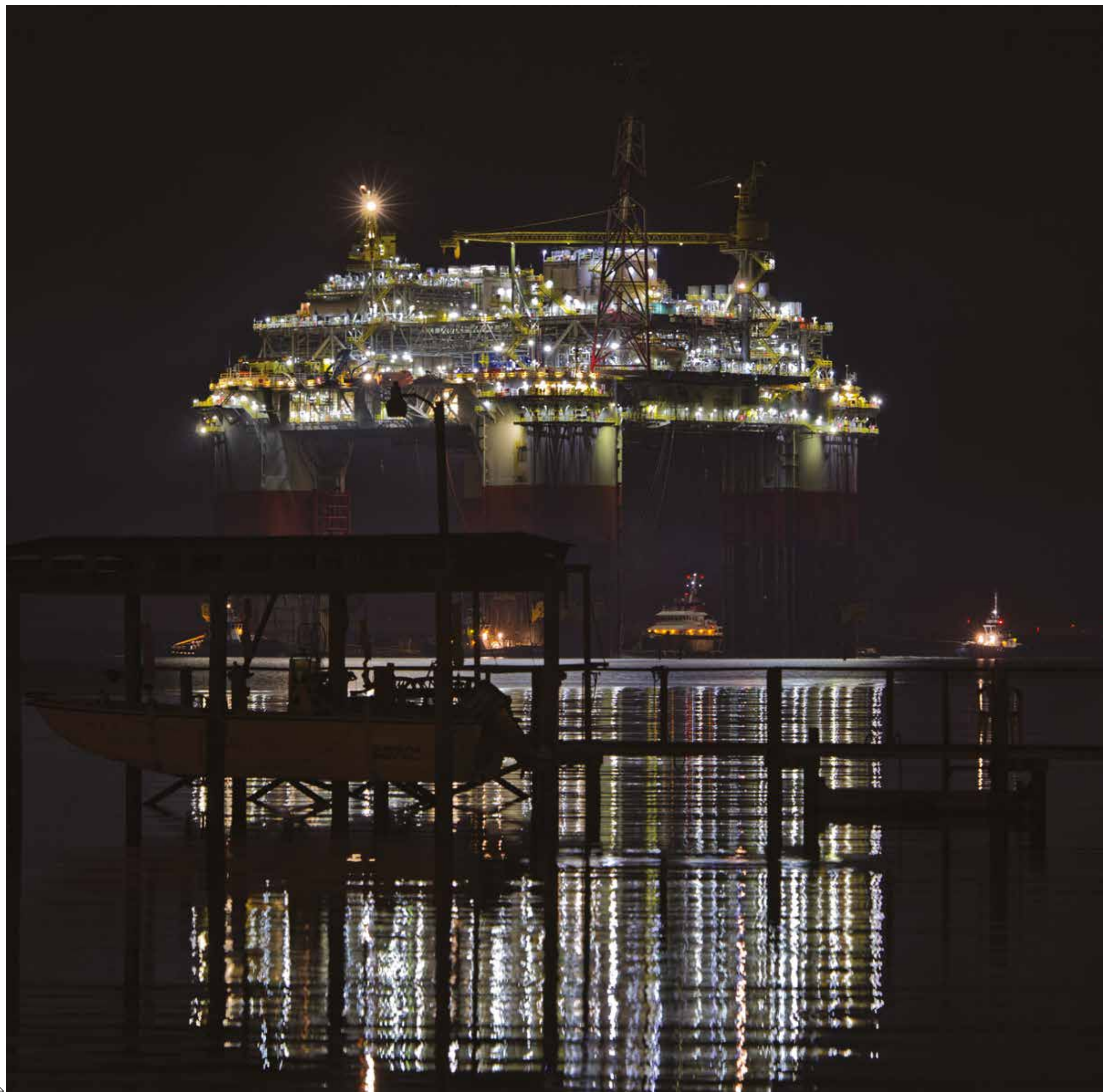
She is a senior vice president
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foreign correspondent.

The projections for America's energy future could not be more starkly divergent than the campaign positions offered up by Democrat Hillary Clinton and Republican Donald Trump. There is hardly an energy issue on which they agree. Under a Clinton administration, the U.S. would slash the country's reliance on oil, dramatically expand investments in renewable energy and wage all-out war on climate change. A Trump administration would advocate opening tens of thousands of new acres of federal land to oil drilling and exploration, abolishing the Environmental Protection Agency and pulling the U.S. out of the Paris climate agreement.

Environment or not, that is the question

Trump says he would dismantle decades-old environmental protections and fossil fuel industry regulations—many of which were put in place by past Republican presidents. His positions cater to the most anti-environment, pro-industry stances in his party, taking no account of the growing number of moderate Republicans who have moved out of climate change-denier territory. The Republican Party platform disdains the environmental movement as a “self-serving elite.” Clinton, on the other hand, views climate change as one of the nation's and the world's most pressing issues, would move the U.S. energy focus to renewable sources, would strengthen regulations on clean air and water and toughen

standards for hydraulic fracking and fossil fuel emissions. Regardless of party, however, the next president will likely find it difficult to implement many of their election-year platforms. Clinton's ambitious plans for cleaning up the environment, weaning the country off fossil fuels and boosting the conversion to renewable sources will hit many of the same political roadblocks President Barack Obama confronted with a Congress so deeply divided that he was forced to rely on executive orders to implement most of his energy policy. As for Trump's promises to forge full-steam ahead on fossil fuels and dump the EPA and the Paris climate agreement, he will be up against a rapidly changing marketplace, new sustainability demands by consumers and corporate boards, and the red tape involved in battling and unravelling behemoth bureaucracies. For the next administration, energy policy may be driven as much by global market trends, domestic consumer demands and changing public attitudes as by the positions of who lives in the White House. In recent years, the rise of hydraulic fracking and other oil and gas field technologies combined with plunging oil prices have upended the best efforts of U.S. experts to accurately project the nation's energy future. Even so, it is clear that the U.S. energy and environmental policies and actions will be affected dramatically by this year's presidential election. As U.S. voters head to the ballot boxes in November, here are the candidates' dia-





Energy highlights

- **Provisions of the Clean Power Plan** of the Obama administration which involves a 32 percent reduction in pollution from carbon dioxide linked to energy production, compared with 2015 levels. Within the same deadline, the plan also includes a 90 percent reduction in sulfur dioxide and a 72 percent reduction in nitrous oxides from power plants compared with 2005 levels.
- **Supporting the Oil&Gas industry**, the coal industry, the nuclear industry and curbing incentives for the spread of renewable energy. **Expansion of oil drilling rights.**
- **Revision of commitments** to reduce emissions undertaken by the United States during COP21 and elimination of subsidies.
- **Suspension of the program** to decommission/dismantle the most obsolete coal-fired electricity generating plants.
- **Greater recourse to natural gas**, produced domestically, for the production of electricity and for transportation.
- **Lifting** of any type of moratorium on the use of fracking.
- **Reduction in the powers** of guidance and control of environmental regulation agencies.

metrically opposing views—in their own words and in their party platforms—on some of the greatest energy and environmental issues of the campaign.

Different positions on climate change

Trump says, “I am not a great believer in man-made climate change.” He has gone so far as to declare, “The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.” The party’s official platform maintains that climate change is not a proven science and “climate change is far from this nation’s most pressing national security issue.” Clinton states on her website and repeats frequently in speeches: “Climate change is an urgent threat and a defining challenge of our time.” Her goal is to reduce greenhouse gas emissions more than 80 percent below 2005 levels by 2050 and to meet current U.S. pledges under the Paris Agreement. Trump has vowed to pull out of the Paris Agreement and will “forbid the Environmental Protection Agency to regulate carbon dioxide.”

Less oil & gas for Dems, oil independence for GOP

The Democrats’ campaign platform calls explicitly for “eliminating special tax breaks and subsidies for fossil fuel companies” and calls for the country to be running entirely on clean energy by midcentury. Democrats advocate “closing the Halliburton loophole that stripped the EPA of its ability to regulate hydraulic fracturing and ensuring tough safeguards are in place.” The party opposes the Keystone XL pipeline. Clinton also opposes drilling in the Arctic and off the Atlantic coast and wants to “phase down extraction of fossil fuels from public lands.” She also would support tougher regulations for hydraulic fracturing and would ensure communities and states have the right to ban fracking. Trump and the Republican party platform, in contrast, say, “We support the development of all forms of energy that are marketable...without subsidies, including coal, oil, natural gas, nuclear power and hydropower.” Trump says private capital, not government money, should pay for developing wind, solar, biomass, biofuel, geothermal and tidal energy. The Republican platform supports opening public lands and the outer continental shelf “to exploration and responsible production” and will push Congress to give states the authority to manage energy resources on federal lands within their borders. Trump says he would do away with the EPA’s Clean



BIG CHANGE IN THE NEXT FOUR YEARS

The differences in approach to energy and environmental issues have never been more dramatic in a U.S. presidential election. Trump has taken Republican positions to new extremes and Clinton has expanded the Democratic platform to even more forcefully embrace curbing climate change and protecting the environment.

Power Plan, which Republican’s describe as “the President’s war on coal.” Trump says he intends to finish the Keystone XL Pipeline, but raised concerns among energy companies when he said he would turn over “a significant piece of the profits” to American citizens. He also advocates ending prohibitions on U.S. energy producers from exporting to foreign markets.

For Trump, goodbye EPA; for Clinton, more incentives for the “green”

Clinton said her policies would make “the United States the clean energy superpower of the 21st century,” including generating enough renewable energy to power every home in America. The Democratic Party platform advocates “defending and extending tax incentives for energy efficiency and clean energy.” Trump has written: “There has been a big push to develop alternative forms of energy—so-called green energy—from renewable sources. That’s a big mistake.” He went on to describe renewable energy as “just an expensive way of making tree-huggers feel good about themselves.” He would eliminate all subsidies for alternative forms of energy, except nuclear. Trump’s Republican platform calls for transforming “the EPA into an independent bipartisan commission, similar to the Nuclear Regulatory Commission.” He would strip the federal government of authority over environmental regulation and turn it over to the states. He would also diminish the reach of the Endangered Species Act, which is designed to protect vulnerable species, and often leads to major battles between conservationists and businesses trying to operate in areas where those species live. While the oil and gas industry supports many of Trump’s positions, it also is skeptical of some of his proclamations. “We will become and stay independent of any need to import energy from the OPEC cartel,” Trump has declared. “Under my presidency, we’ll accomplish a complete American energy independence. Complete.” Many industry analysts

say that policy would likely only damage U.S. economic interests, prompting increases in oil and gas prices if the country were to cut off all foreign imports. Some of Trump’s positions have the ring of political expediency to placate the most extremist wings of his party. At the same time he calls climate change a hoax, Trump has asked Ireland for permission to build a multi-million dollar seawall to protect his oceanside golf course in County Clare, Trump International Golf Links & Hotel Ireland. In his application to Ireland, Trump’s company wrote: “If the predictions of an increase in sea level rise as a result of global warming prove correct, however, it is likely that there will be a corresponding increase in coastal erosion rates not just in Doughmore Bay but around much of the coastline of Ireland. In our view, it could reasonably be expected that the rate of sea level rise might become twice of that presently occurring.” Trump has also made the oil and gas industry nervous. Despite his latest declarations of support, in the past he described the industry as “a special interest” group and alleged that his former GOP primary competitor, Ted Cruz, was “totally controlled by the oil companies.” U.S. presidential nominees use their party conventions to lay out their visions and plans for the country should they be elected. Both Trump and Clinton used their speeches to tie their energy and environment positions to jobs and the economy.

Latest news from the national conventions

Trump told Republicans in Cleveland: “We are going to lift the restrictions on the production of American energy. This will produce more than USD 20 trillion in job creating economic activity over the next four decades.” In Philadelphia, Clinton told the Democratic convention: “I believe in science. I believe that climate change is real and that we can save our planet while creating millions of good-paying clean energy jobs.” The differences in approach to energy and environmental issues have never been more dramatic in a U.S. presidential election. Trump has taken Republican positions to new extremes and Clinton—egged on by the popular support of her former Democratic opponent, Senator Bernie Sanders—has expanded the Democratic platform to even more forcefully embrace curbing climate change and protecting the environment. Either way, U.S. energy and environmental policies are in for big change in the next four years.



Energy highlights

- **Extension of the Clean Power Plan** and the launch of a \$60 billion initiative (Clean Energy Challenge) which will involve the States, cities and rural communities in the development of renewable energy through a tax relief system.
- **Transition from coal to natural gas.**
- **Replacement of** coal-fired electric power plants with combined gas cycle turbine plants (CCGT).
- **Support to states**, urban centers and farming communities to encourage the replacement of oil and coal-fired heating systems with more efficient gas systems.
- **Distribution of natural gas** as the fuel for transportation through the creation of the conditions for the development of gas mobility.
- **Greater** and more stringent **environmental controls** on the use of fracking.
- **More space for renewable energy**, which will transform the U.S. into the clean energy superpower of the 21st century.



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Markets/The decline in U.S. tight oil output has limited the Brent-WTI spread

The American “counter-revolution” and the oil recovery

In the first two months of 2016, oil prices reached their lowest levels since November 2003. Since then, oil prices have almost doubled, despite the negative outcomes of the Doha meeting and Brexit



DEMOSTHENES FLOROS

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During the first half of 2016, North Sea Brent Crude and West Texas Intermediate reached their lowest levels, respectively, on January 20 at \$27.81 per barrel and February 11 at \$27.23 per barrel. The highest levels, on the other hand, were reached on June 8: The European benchmark reached \$52.72, while the North American benchmark reached \$52.08. In April alone, prices increased by approximately 20 percent, recording the greatest monthly increase compared with the same period of the previous year. This upward trend has indeed characterized the entire month, both prior to the Doha meeting and in the days following the failure of the summit between the main oil producers, held in the capital of Qatar. In the wake of an increase of approximately \$4 for both grades that occurred in May, not even the inability to reach an agreement regarding the freezing of production or, at least, the restoring of a production ceiling by OPEC member countries reversed the trend

of oil prices. On the contrary, prices reached the highest levels since the beginning of 2016, precisely in the days following the Vienna conference on June 2. The Leave victory in the British referendum led to an immediate reduction in oil prices by almost \$3.5, which was almost completely reabsorbed by the end of the month. The fall in oil prices that occurred, on the other hand, during July seems to be the direct result of the accumulation of refined products in the U.S. rather than crude oil, in addition to the role played by speculation: In fact, on the NYMEX in particular, where WTI is traded, short positions (selling) have almost tripled compared with the end of May, from 53 to 141 million barrels.

According to the IEA's Oil Market Report, the global oil supply was at \$95.4 million per day in May, down by 590,000 barrels compared with the same period last year. This is the first significant drop in production since the beginning of 2013. That mainly concerned the output of non-OPEC countries, starting with Canada – the fourth largest extractor in the world with approximately 4 million barrels per day, of which 2.2 million of oil sands, and the United States' top supplier, with 3,169 million barrels per day in 2015 – which was struggling with severe forest fires. Secondly, the decline has affected the production of U.S. crude oil which, after having reached its peak of 9.7 million barrels in April 2015, currently stands at around 8.622 million. With regards to the OPEC member countries, in May, supply fell slightly by 110,000 barrels per day to 32.61 million. Nigeria's significant losses due to continuous sabotages and, more generally, the political instability that the country is facing, were substantially offset by the constant, and unexpected, increase in Iran's production, of around 3.8 million barrels per day (+700,000 since the start of 2016). The latter figure partly contradicts the claims made in

March by the Vice President of Lukoil, Leonid Fedun. “Iran” he said “will not be able to significantly increase its output without more foreign investment. Also, Iran's domestic demand is very high given its large population. Consequently, the country may place 300,000–400,000 more barrels on the market: a marginal amount”.

On an annual basis, while OPEC's output has increased by 500,000 barrels per day, non-OPEC output, despite the Russian Federation having increased its extractions, has fallen by 1.3 million barrels. In 2016, it is estimated that the latter will drop by 0.9 million barrels per day, of which 500,000 barrels are due to U.S. tight oil. In the first half of 2016, demand grew by approximately 1.6 million barrels per day, increasing from 93.62 million to 95.17 million, mainly as a result of the greater energy demand of the emerging economies. In the whole of 2016, it is expected that global demand will increase by 1.3 million barrels per day. In 2017, it will reach 97.4 million.

These figures confirm the slow, but steady, decline in excess supply: from the 1.5 million barrels per day in January 2016, the excess is estimated at around 800,000 barrels per day as a combined effect of an initial slowdown in output – which then turned

into a decline in May – and a more robust increase in demand for black gold. If the next estimates confirm the tendential rebalancing of the oil market, this will no doubt act as a supporting factor for prices during the second half of the year. Currently, June forecasts show an increase in global oil supply amounting to 600,000 b/d for an overall output which reached 96 million b/d while, in the second quarter of 2016, demand increased by 1.4 million b/d compared with the same period last year.

The American dream of energy independence is fading

In 2015 alone, forty U.S. companies resorted to ‘Chapter 11’ bankruptcy proceedings, despite American frackers being able, at the same time, to reduce extraction costs by 40 percent and increase the productivity of wells by 48 percent. According to the forecasts of Wolfe Research, approximately one third of U.S. companies involved in the extraction of crude oil by means of the unconventional method could resort to Chapter 11 by the middle of 2017 if per-barrel prices do not remain at around at least \$50. Other analysts, however, believe this threshold to be too low to continue to pump. For instance,

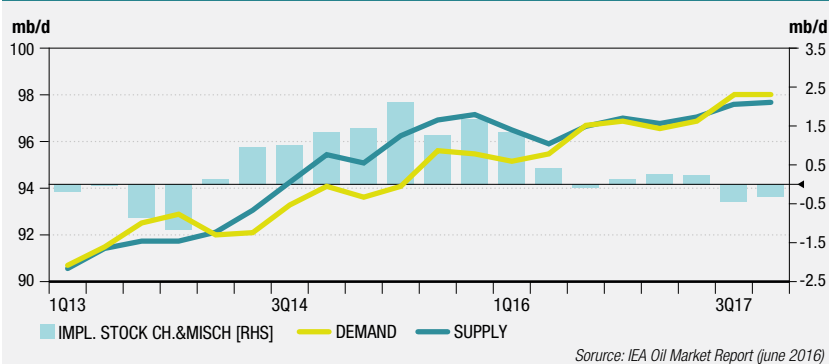
Fadel Gheit, Senior Oil and Gas Analyst at Oppenheimer & Co, told the CNBC that “half of the current producers need the barrel to be at \$70 to survive and, therefore, have no legitimate right to remain in a business where the price forecasts, albeit receding, fluctuate between \$50 and \$60”. According to a report by Goldman Sachs, although “limited storage capacity and a still significant excess supply will continue to fuel the volatility and instability of prices over the coming months”, the oil market is slowly rebalancing in parallel to the decrease in non-OPEC production and, specifically, that of the U.S. “No matter what OPEC does, supply will fall due to the decline in U.S. production. The latter will not stop the fall provided prices stand at around \$45–50 per barrel, and at that point it will only stabilize”, Roland Morris, Commodities Strategist at the VanEck center, told the Wall Street Journal. On May 24, the price of WTI reached \$49.04 per barrel, temporarily exceeding that of Brent (at \$49.01) for the first time since September 2010. According to the U.S. Energy Information Administration, during this period of time, the spread between the two grades of crude oil incorporated the excess supply at the Cushing terminal, in turn due to the fracking rev-

olution and to Canadian Oil Sands, in addition to the dollar trend and the geopolitical instability of North Africa and the Middle East which had influenced Brent more than WTI. The current fall in American unconventional production has significantly limited this spread. According to Bloomberg, U.S. oil & gas producers will announce losses totaling over \$15 billion in 2015 alone. If this is the case, the hope is that Nouriel Roubini was wrong when he said that the new global financial crisis could arise from the bankruptcies of companies involved in extracting oil and gas from shale. The impression, however, is that the dream of energy independence founded on the technical revolution of fracking is slowly fading, and not only due to the problems of water pollution and the increase in earthquakes. It is quite likely that the next president of the United States will have to implement a future policy strategy in a national energy context that is no longer as favorable as it was in the last decade.

Monetary policy, the dollar and the euro

The euro/dollar exchange rate opened 2016 at 1.086. On June 23, the euro stood at \$1.142. As a result of the electoral outcome regarding Brexit, the common European cur-

TOWARDS A NEW BALANCE



The oil market should achieve a stable equilibrium towards the middle of 2017. The growth in demand and declining production are helping to reduce the excess supply recorded since 2014.

rency immediately depreciated on the dollar to drop below 1.10, while the British pound reached its lowest level since September 1985 at \$1.32. The euro/dollar exchange rate therefore closed the first half at 1.11 (1.108 \$/€ at the end of July).

During this period, the dollar then partially depreciated against the euro (lowest level at 1.1569 \$/€ on May 3) despite, on March 10, the European Central Bank having cut the entire tri-lateral structure of interest rates, having increased the so-called corridor, and brought the amount of its Quantitative Easing program from 60 billion to 80 billion. In view of the inverse relationship that usually exists between the performance of the dollar and the price of the barrel, the weakening of the former could, to a certain degree, support the increase of the latter. Previously, on December 16, 2015, the Federal Reserve had already decided to increase interest rates by 25 basis points for the first time since the start of the financial crisis. The latter, in fact, stood at 0-0.25 percent from December 16, 2008. In addition to the end of the Quantitative Easing program, many analysts – wrongly believed that this option would be the first of a long series of rate increases by the FED that would have led to a phase characterized by an appreciation of the dollar. In fact, in the days following the decision of the Central Institute, the dollar reached its highest level over the euro at 1.0742 (January 6, 2016). Why did the Federal Reserve stop the launch of a generally restrictive monetary policy, despite the position taken by the Presidents of the FED of Atlanta, Dennis Lockhart, and of San Francisco, John Williams? In actual fact, Janet Yellen, head of the U.S. Federal Reserve, subsequently decided not to increase rates, both during the meeting of the Federal Open Market Committee (FOMC) of March 16, and during the meeting of June 15, although market expectations were that they would increase as demonstrated by the temporary appreciation

of the dollar in February and, especially, in May. It is worth noting that during these two months, there was no corresponding fall in the cost of the barrel.

The main reason for the interruption to the new monetary course of the FED lies in the data derived from the U.S. labor market, which have not been entirely comforting.

In April, only 160,000 new jobs were created, much less than the 200,000 plus expected on average by analysts, while the Labor Department revised downwards the number of newly employed recorded in the previous month. Despite an unemployment rate remaining unchanged at 5 percent, the expanded unemployment rate – which includes the underemployed and forced part-time employed – is at 9.7 percent, although down from 9.8 percent in March, while the rate of participation in the workforce fell again to 62.8 percent (from 63 percent), the lowest levels in almost forty years.

The first estimates for May, however, only indicate 38,000 new jobs, the lowest level in six years and against expectations for 160,000. Therefore, one should not be misled by the fall in the unemployment rate to 4.7 percent, given the simultaneous further decrease in the rate of participation in workforce at 62.6 percent. In truth, the possibility that the Federal Reserve should review the monetary policy program – which initially included four increases in interest rates during 2016 – was already clearly explained by the Vice President of the FED directorate, William Dudley, who had justified this by referring to the worsening of the U.S. macroeconomic context. Some macroeconomic data that seem to support the concerns of W. Dudley are outlined below. According to estimates recorded by the Bureau of Economic Analysis, the second reading of the real U.S. Gross Domestic Product showed a 0.8 percent growth in the first quarter of 2016, up from the 0.5 percent previously calculated. In 2015, over-

all growth stood at 2.4 percent, identical to 2014 and next to the disappointing average of 2.1 percent recorded in the entire post-recession phase, from 2009 to date. Undoubtedly, these figures are more positive than those of the Eurozone, but they cast some shadows. On November 13, 2015, the U.S. Department of Commerce stated that the relationship between stocks and sales was at its highest level since 2009, precisely at 1.38: against warehouse goods amounting to \$1,800 billion, something that, in itself, could overestimate the calculation of the GDP, sales until October amounted to \$1,300 billion.

Is the United States also facing another crisis of over-production? According to the data provided by the U.S. Treasury Department, the Federal government debt – estimated at around \$10.6 trillion when Barack Obama assumed the office of President – officially reached \$19 trillion. Considering that the 2015 output was at 17.9 trillion, the Public Debt/GDP has currently exceeded 106 percent. According to the estimates of the Congressional Budget Office, the \$8 trillion record of further debt is likely to continue to increase in the near future. After the war (1952), \$1.3 of debt created \$1 of GDP, while in 2014 the ratio increased to 3.5:1. That is, the United States creates \$3.5 of debt for \$1 of additional gross domestic product. The deficit of U.S. current accounts further increased by \$13 billion during the third quarter of 2015, reaching a total of \$124.1 billion. Finally, however, we cannot rule out that during the meeting in Shanghai in February, the main Central Banks worldwide did not secretly decide to avoid a sharp appreciation in the dollar given the negative consequences that this would cause the global economy, mitigating that currency war which saw the FED as the temporary winner, a fact that also benefitted China's economy. The impression is that the euro/dollar exchange rate is moving away from that equally assumed as imminent in November 2015. Moreover, as regards the future prospects of the U.S. monetary policies, J. Yellen herself took a partial backward direction with respect to her statements of May 27, in which she defined a move by the FED as early as in the following months as “likely,” arguing, just 10 days later, that interest rates will rise only gradually, avoiding any reference to a possible date. The monetary policies outlined and the effects that they could have on the dollar, suggest that they may take on a beneficial role in maintaining current per-barrel prices. That said, it can certainly not be ruled out, in the medium term, that the effects that Brexit may as-

sume, conversely, a countertrend role.

The geopolitics of energy between strategies and negotiations

On April 17, the negotiations underway between major oil producers, with the aim of freezing production, failed after Saudi Arabia, Qatar and the United Arab Emirates refused to reach an agreement that did not include Iran. In fact, Tehran had expressed its intention to increase its production up to same level as prior to the start of the sanctions, equivalent to 4 million barrels per day well before the meeting, in order to be able to gain an advantage from the lifting of the same following the agreement on the nuclear issue. The reasons for oil price increases during the second half of April could be as follows:

The Russian Federation, Saudi Arabia and Iraq, the second largest OPEC producer, were producing at a very high speed, both in January 2016 and in the first quarter of this year. Had an agreement been reached in Qatar, the Russians would have had

to freeze their output at 10.99 million barrels per day (record level since the end of the Soviet Union), the Saudis at 9.95 million and the Iraqis at 4.46 million, one of the highest levels since the post-Saddam Hussein era. Financial investments from hedge funds, whose total exposure of speculative buying conditions, both on Brent and WTI, had reached 656 million barrels per day, approximately 7 times the global daily oil production, have meant that paper bets on barrels would promote the rise of the real barrel. The maintenance of interest rates at 0.25-0.50 percent announced by the Federal Reserve on April 27, which followed the weak growth of U.S. GDP during the first quarter of 2016 (+0.5 percent) as well as the decline in North American unconventional production, did not promote the strengthening of the dollar. In contrast, Chinese demand—reaching 7.7 million barrels per day in March, up by 22 percent compared to the same month the preceding year—has driven prices up. The strategy of Saudi Arabia and its allies within OPEC – Kuwait, Qatar, and the United Arab Emirates – to push prices down

and to defend their own market share thanks to lower production costs, certainly obtained significant results: data reported on non-OPEC output speak clearly. This risky strategy also acted explicitly against the interests of one part of the Cartel, but without succeeding in the main goal to weaken Iran. It also had serious consequences on the national budgets of all OPEC members, who suffered the first substantial losses for 18 years, as demonstrated by the Current Account deficit of \$99.6 billion compared with the surplus of \$238.1 billion in 2014. This leads us to believe that Riyadh is reaching only a part of its goals and not as fast as previously thought.

From a strictly military point of view, we cannot help but observe that in Syria, the Saudis and their allies – except for Turkey – are the same OPEC member states that are succumbing against the loyalist army of the Arab Republic, the Russian Federation, Iran and Hezbollah. Sooner or later, will the Wahhabi and Shiite Iran petro-monarchy have to come to an agreement? Tehran – which, if it actually comes out the

winner of the conflict in Syria, would increase its political and economic influence in the entire Middle East – is not far from reaching 4 million barrels per day. As suggested by Davide Tabarelli, President of Nomisma Energia, “at the next meeting on November 30, 2016, the Iranians might actually accept a limit to production, while the Saudis, having found that production outside of the Cartel is falling, might renounce the market share strategy at all costs to damage Iran, rather as happened as of June 2014.”

In March 2016, U.S. crude oil imports reached 8.042 million barrels per day compared with 7.910 million in February and 7.675 million b/d in January. The last time the United States had imported more than 8 million barrels per day was in August 2013. Taking into account that, in 2015, U.S. crude oil imports stood at 7.351 million barrels (7.344 million b/d in 2014), the real risk is that the trend in demand is rising and that therefore the United States will need more crude oil imports from abroad, despite the figures for April indicating a decrease in imports to 7.637 mil-

lion b/d (although higher than the 2015 average). As for monetary policies, even all of these geopolitical considerations lead us to believe that it is unlikely, in the second half of 2016, that the barrel will sink back to the low levels of January. However, during the OPEC summit of June 2 in Vienna, the member states failed to reach an agreement on the freezing of production and on the return to a production ceiling. Brexit, therefore, dollar and speculation permitting.



Read on www.abo.net the articles by Molly Moore and Nicolò Sartori on the same subject.

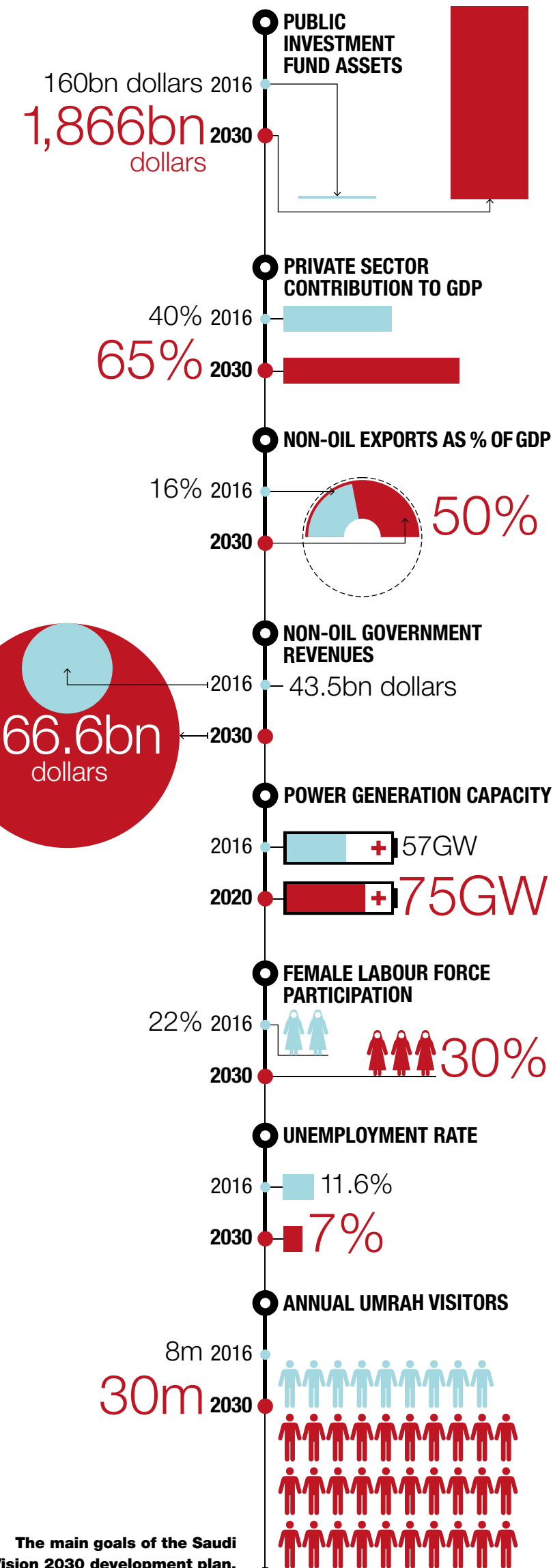


the SAUDI PERSPECTIVE

On April 25, 2016 Riyadh approved Saudi Vision 2030, a plan which, in the next 14 years, should ensure the Kingdom greater economic diversification and reduce its dependence on oil. The debate between four analysts with a deep knowledge of the country:

• Bassam Fattouh and Amrita Sen • Paul Sullivan • Eric Watkins

The main goals of the Saudi Vision 2030 development plan.
Source: Kingdom of Saudi Arabia



Scenarios/Economic and energy repercussions of the new strategy

A plan to “break free” from oil

The new strategy aims to diversify the Kingdom's economy. The development of gas will accelerate, while renewables will continue to account for a small part of the energy mix. Proceeds from black gold will still remain central

In late April, the Council of Ministers in Saudi Arabia approved an ambitious new strategy for the kingdom, known as Vision 2030. The vision is based on three main pillars, which are intended to help transform the Saudi economy and society by 2030.

- The central role that Saudi Arabia plays in the Islamic and the Arab world.
- An aim to transform Saudi Arabia into a global investment powerhouse.
- Exploiting Saudi Arabia's key strategic location to turn the country into a global trade hub connecting the three continents of Asia, Europe and Africa.



BASSAM FATTOUH AND AMRITA SEN

Bassam Fattouh is the Director of the Oxford Institute for Energy Studies and Professor at SOAS (School of Oriental and African Studies), University of London.

Amrita Sen is the co-founder and Chief Oil Analyst at Energy Aspects. Amrita's specialism is in energy commodities, particularly oil and oil products.

The vision does not contain specific details about implementation, but is built around three general themes—a vibrant society, a thriving economy, and an ambitious nation. A key goal of the thriving economy theme is to build a well-diversified economy which is less dependent on oil. To achieve this, Vision 2030 focuses on developing human capital through better education, particularly early childhood education. Another target is to boost the role of small and medium enterprises (SMEs) and to increase their contribution to the economy. Another key element is maximising the country's investment

capabilities, which involves restructuring the Public Investment Fund (PIF) and transferring the ownership of Saudi Aramco to the PIF, with the aim of creating the largest sovereign wealth in the world. It also involves the privatisation of government services such as healthcare and education, with the government increasingly playing the role of the regulator. Through these and other initiatives, Saudi Arabia aims to achieve some very ambitious goals including:

- Moving the economy from the current position as the 19th largest economy in the world into the top 15.
- Increasing the private sector's contribution from 40 percent to 65 percent of GDP.
- Raising the share of non-oil exports in non-oil GDP from 16 percent to 50 percent.
- Increasing non-oil government revenue from Saudi Arabian Riyal (SAR) 163 billion to SAR 1 trillion.
- Expanding the local share of oil and gas sector activity from 40 percent to 75 percent.
- Growing PIF assets, from SAR 600 billion to over 7 trillion.
- Increasing foreign direct investment from 3.8 percent of GDP to 5.7 percent.

Vision 2030 recognises that in order to achieve these goals, a major institutional shake-up is needed. The Saudi government therefore has, in parallel, announced a set of programmes, which include the National Transformation programme, the programme for Strengthening Public Sector Governance, the Privatisation programme, the Public Investment Fund Restructuring programme and the Saudi Aramco Strategic Transformation programme. The details of each of these programmes are only slowly emerging, with the National Transformation programme approved in early June, providing more information on the implications for the energy sector.

A more credible strategy than in the past

While such broad visions are hardly new (in 2005 Saudi Arabia published the Long-Term Strategy 2025, which included various goals including reducing the dependency of the economy on oil revenues) and diversification has been at the centre of each successive five-year development plan since the 1970s, there is much optimism that this time, the plan will be implemented (at least partially). The huge concentration of economic power in the hands of the Deputy Crown Prince Mohammed bin Salman, his willingness

to take risks, the breadth of the reforms announced, and an effective communication campaign have given Vision 2030 more credibility than previous initiatives.

Thus, it is no surprise that the announcement of Vision 2030 managed to capture the imagination of global markets. For many oil analysts, the replacement of veteran oil minister Ali Al-Naimi by Khalid Al-Falih, the creation of the enlarged Ministry of Energy, Industry and Mineral Resources, and the announcement of the Saudi Aramco Strategic Trans-

formation programme and plans to publicly list a minority stake in Saudi Aramco were taken as clear signs of a drastic shift in energy policy. One effect of the recent announcements has been to introduce much greater uncertainty about the foundations and direction of Saudi oil policy, with many analysts arguing that Saudi Arabia would abandon its policy of maintaining spare capacity and boost its output. This would put a cap on oil prices in the near-term while it will increase its oil productive capacity which is bearish in the long-term,

especially given that this may be taken as a signal that Saudi Arabia is moving beyond oil and rushing to monetize its reserves in a carbon constrained world.

While the recent organisational changes are substantial, the impact on oil policy and the energy sector is likely to be more subtle than current expectations, not least as the last few years have already seen some deep transformations in the energy sector, including initiatives to generate more value added through investing in downstream assets and inte-

grating refineries with petrochemicals, increasing the role of gas in the energy mix, deploying renewables into the power system, improving efficiency in energy use, and more recently increasing domestic energy prices.

Changing the oil minister does not imply a change in oil policy

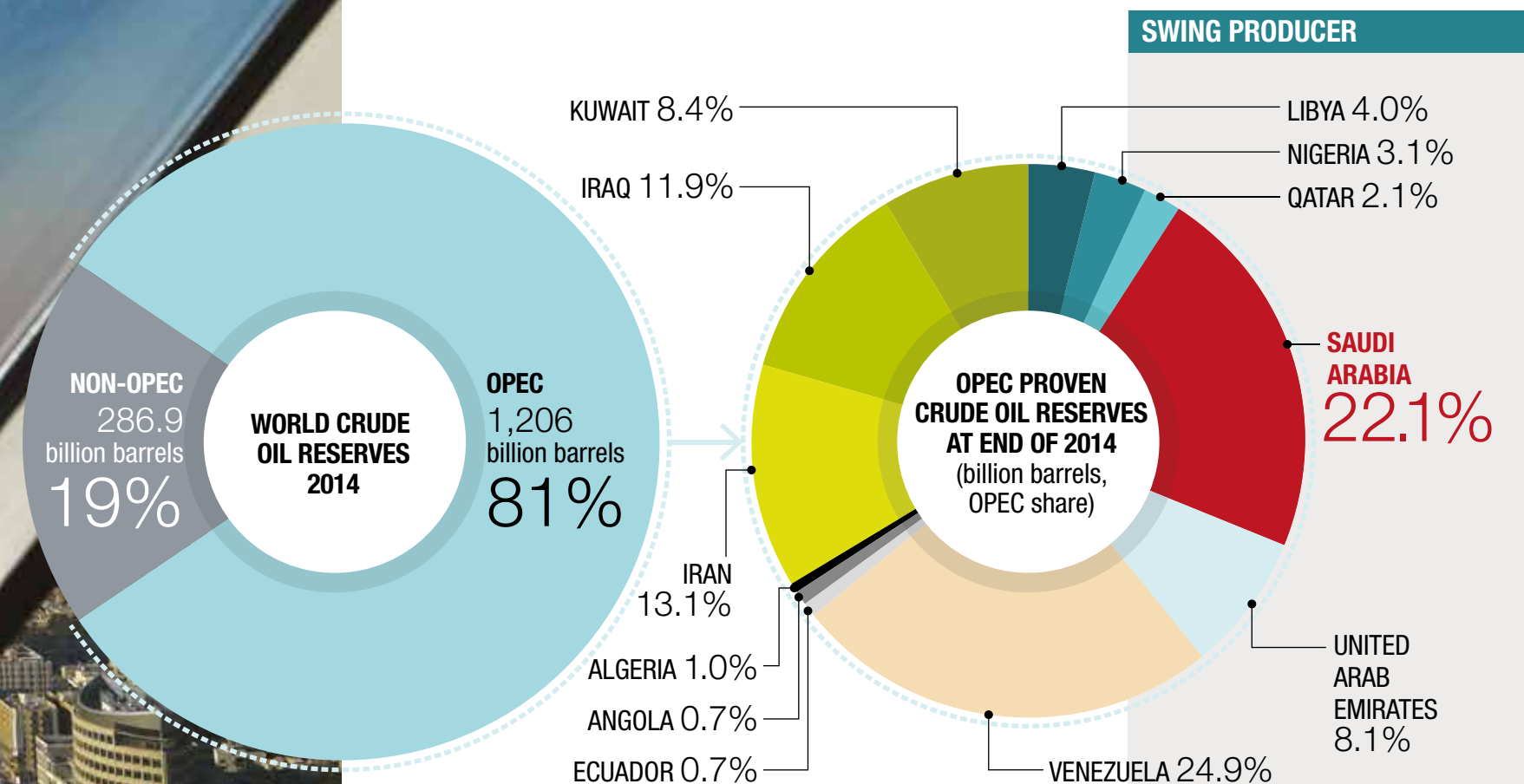
To begin with, the replacement of Ali Al-Naimi as oil minister represents a change of personnel but not of policy. The current policy is

based on a fundamental principle: Saudi Arabia will not act unilaterally to rebalance the market. Since 1986, Saudi Arabia has refused to act unilaterally (in 1998, it cut in agreement with OPEC and non-OPEC, and in 2008, it agreed to cut collectively with other OPEC members in the face of a financial market shock). Al-Falih has reiterated this position, arguing that Saudi Arabia "is not going to withdraw production to make way for others. If other producers are willing to collaborate, Saudi Arabia is willing to collaborate. But Saudi Arabia will not accept the role, by itself, of balancing a structural imbalance". In the absence of an agreement on collective cut, Saudi Arabia has opted for a market share strategy with the aim of pushing out high-cost producers. The output freeze deal discussed in Doha in April—which was perceived as a departure from this policy—is the source of much of the market's confusion. Doha mattered because it signalled a potential shift in tactic, which, if it had succeeded, could have been the start of more cooperation between producers. The Doha agreement failed for a variety of reasons, but this did not

prevent the Saudis from participating in efforts to reach an agreement on a collective production ceiling at the June OPEC meeting. The latest OPEC meeting also confirmed the view that the kingdom is not about to destabilise the market and increase production to flood the market regardless of the demand for Saudi crude. Al-Falih went as far as to state categorically in a press interview that "[t]here is no reason to expect that Saudi Arabia is going to go on a flooding campaign".

Oil revenues will remain central to Saudi Arabia's economy

During an interview with western media outlets, MbS alleged that the Kingdom is indifferent to whether the price of oil is \$30 or \$70. Not surprisingly, this was interpreted as meaning Saudi Arabia no longer cares about oil prices and its output policy is no longer tied to a desire to maximise revenues. An extreme interpretation was that Saudi Arabia might even welcome a low price environment, as that would make it easier to push through the substantial reforms contained in Vision 2030. Yet, the fact remains that the Saudi →



Saudi Arabia, which alone holds over a quarter of OPEC oil reserves and produces almost 10 million barrels per day, has abdicated its traditional role as 'swing producer' within the Organization. Riyadh does not, in fact, intend to cut its crude oil reserves to offset the market imbalances, unless other producers do the same.

Source: OPEC Annual Statistical Bulletin 2015

The men of renewal



CHANGE OF MINISTER, BUT NOT OF STRATEGY

In May, **Khalid Al-Falih** succeeded Ali al-Naimi as leader of the Saudi Oil Ministry. The succession, which took place after 21 years, will not involve any change of route in the policies of Riyadh.



THE POWER OF THE VICE PRINCE

The huge concentration of economic power in the hands of the Deputy Crown Prince **Mohammed bin Salman**, his willingness to take risks and an effective communication campaign Vision 2030 have given greater credibility than previous initiatives.



SAUDI ARAMCO TO THE CENTER OF THE WORLD MARKET

The CEO of Saudi Aramco, **Nasser Amin**, arrived in May to take the place of Al-Falih. It confirms that the Saudi state energy company intends to maintain its presence in the global oil market. The company, for the CEO hand, has plans to expand internationally.

economy, including the non-oil private sector, still relies heavily on government spending that is fueled by oil revenues. Furthermore, political stability is directly linked to the ability of the government to distribute rent to the population, including creating jobs in the public sector. As recently emphasised by the Saudi energy minister Khalid Al-Falih, the objective of reducing reliance on oil “does not mean that the kingdom’s opportunities of optimising its benefits from its natural resources, including oil, will receive less attention in the current economic phase than in previous phases. Increasing our oil revenues will help us to build a range of other economic sectors in the Kingdom, besides international investments.”

Despite the size of its fiscal buffers, low oil prices have been painful for the kingdom. Saudi Arabia has been drawing down on its foreign reserves, increasing its borrowing, exploring schemes to increase taxes including VAT, rationalising government spending, cutting energy subsidies and scaling back spending on capital projects. These adjustments are already having their impact on the economy with growth slowing down, stock markets falling from their high levels, the Saudi Riyal peg coming under pressure, and households’ adversely affected by the rise in energy prices and higher inflation.

One also cannot assume that further reforms such as entirely removing energy subsidies will not risk strong public opposition. Indeed, the recent increase in water charges is a case in point, as the water and electricity minister was fired following public complaints over a surge in prices, with MbS describing the ministry’s implementation of the new water tariff as ‘unsatisfactory’. It is true that the implicit social contract has proved to be elastic and sufficiently malleable to accommodate the recent energy price increases. However, it may not prove sufficiently resilient to accommodate further price increases. The Saudi government is already rethinking the subsidy reform programme and has plans to introduce compensatory schemes to offset the loss of income for households in low-income brackets to gather support for the reforms.

There are no plans yet to increase productive capacity

Closely linked to the swirling expectations of a big increase in Saudi output has been the belief the Kingdom is preparing to increase productive capacity. But even if Saudi Arabia were to decide to expand capacity, this is expensive and takes

time and requires massive investment in calibrating the whole system, including increasing the capacity of processing plants, building storage facilities and pipelines. To put things in perspective—in 2004, when Saudi Arabia had a productive capacity of 11 mb/d, Al-Naimi announced the ministry had developed plans to gradually increase Saudi Arabia’s sustainable production capacity to 12.5 mb/d. The expansion of 1.5 mb/d took six years, and was completed in 2010. Back then, Al-Naimi also said that scenarios to raise the capacity to 15 mb/d had been studied and could be set in motion if global demand required it. But given the large uncertainty engulfing oil markets, Saudi Arabia will exercise the option to wait and not invest. In fact, the recently approved National Transformation programme stated that capacity would stay at 12.5 mb/d through 2020.

In an environment of high uncertainty about global oil demand due to climate change policies, many have argued that Saudi Arabia will be keen to run down its oil reserves rapidly. While this is certainly a concern for a country like Saudi Arabia given its massive reserve base, there is a general belief that barring technological breakthrough, oil will be in demand for decades to come as a transport fuel and as a feedstock for petrochemicals. But even in carbon-constrained world, Saudi Arabia will be able to compete, given the low cost of its oil reserves and given its stable economic and political environment and the competence of Aramco to develop these reserves. However, this strategy of increasing production to capture larger market share from a declining pie does not compensate for the loss of revenue from lower oil prices, and therefore overall Saudi revenues will most likely fall in a carbon-constrained world.

There have also been suggestions that in this new global oil order, Saudi Arabia has no incentive to keep its official policy of maintaining spare capacity. But there may be a strong case for Saudi Arabia to play a more proactive role on the upside. One of the lessons for Saudi Arabia policy makers of the latest cycle is that a high oil price environment will accelerate supply and demand responses, especially as environmental concerns intensify, and therefore in the long-term, it is in the kingdom’s interest to prevent prices from rising to high levels, putting a cap on the oil price. To achieve this, Saudi Arabia would need to maintain healthy spare capacity and develop market tools to help influence the price on the up-

side. So far, there is no indication whatsoever that Saudi Arabia has abandoned its policy of maintaining spare capacity, which is still considered to be a cornerstone of world oil market stability.

The focus on developing natural gas reserves will accelerate

Another area of policy continuity is the goal of using more natural gas domestically rather than liquid fuels. The share of natural gas in total domestic energy consumption has risen from 23 percent in 1980 to over 41 percent last year. One of the key objectives is to increase the share of natural gas to more than half of total primary energy demand to satisfy the increasing demand from the new petrochemical plants and to reduce crude burn in the power sector, to free up crude oil for exports by mainly developing its domestic reserves without excluding the possibility of importing gas. According to the National Transition programme, the target for dry gas production capacity is an almost 50 percent increase to 17.8 bcf/d by 2020.

Renewable energy will be a very small part of the Saudi energy mix

The Vision 2030 reiterated Saudi Arabia commitment to renewables with plans to add 9.5 GW of renewable energy by 2023. However, no legal and regulatory frameworks for the deployment of renewable energy have yet been established. Even if the Kingdom achieves the new ambitious target, it is important to put things in perspective. The country has a meager 25 MW of renewable-energy generation capacity (mostly solar photovoltaic) installed as per the end of 2015 and even with the newly announced target, renewables would constitute just 5 percent of the country’s electricity consumption, as demand continues to grow too. For the foreseeable future, the rise in electricity in demand will be met mainly by oil- and gas-fired power plants.

The drive for downstream integration will continue

Turning from the power sector to the downstream, Saudi Arabia has been increasing its refining capacity significantly in recent years. Many factors can account for this drive. The most important motivation is that Saudi Arabia has been forced to import expensive petroleum products, as domestic demand has outstripped refining capacity in certain petroleum products such as gasoline and diesel. Investment in refining is also still considered by many policymakers as a key step towards creating

added value by converting crude oil into refined products and establishing the link between the upstream sector and petrochemicals, which in turn provides opportunities for diversification and downstream integration into the full value chain, including the development of new industries. Saudi Arabia has been increasingly encouraging their petrochemical industries to diversify the feedstock mix away from ethane towards refined products such as naphtha, butane, and propane. In addition to increasing feedstock availability, the use of refined products provides opportunities to produce more sophisticated petrochemical products that are needed to extend the value chain and generate employment opportunities. Finally, the limited availability of gas for use in the power sector and infrastructure issues have resulted in continued reliance on liquid fuels for power generation, further increasing domestic demand for liquid products.

Saudi Aramco IPO will face many hurdles

While many of these themes represent a continuation, and perhaps acceleration, of existing policy objectives, one new element of Vision 2030 caused a significant stir—the public listing of Saudi Aramco. No exact timeline has been announced, but 2017 has been mentioned as a desired target. The potentially biggest IPO in history is likely to be fraught with challenges.

Saudi Aramco does not own the reserves; it has the monopoly to produce from reserves. Thus, any valuation will not be based on the value of the reserve base, but most likely on the discounted cash flows into the future, which depends on the profit per barrel and the quantity of oil produced. The profit per barrel will depend on the level of taxes and royalties Saudi Aramco pays back to the government; if the taxes and royalties that go to the finance ministry are high (as they currently are), then the valuation will be low. The fact that the government can increase taxes on Saudi Aramco also introduces ‘sovereign risk’, and hence the comparisons with private companies such as ExxonMobil do not hold, as one cannot apply the same discount rate to Aramco’s cash flows given the higher level of risk.

But the hurdles don’t stop here. Given the size of the IPO, a listing in foreign exchange may be required, as the small size of the Saudi stock exchange can’t absorb such a high value IPO. However, listing outside the kingdom would raise the possibility of ‘frivolous lawsuits’ against the kingdom. Also, as Saudi Aramco loses the status of a ‘national oil com-



pany’, it could be subject to anti-trust suits.

In many ways, the question is less about how much cash the IPO raises, but whether the IPO will result in a shift in the fundamental behaviour of the Kingdom. Shareholders do not value spare capacity and would encourage faster development of reserves than a government. Given the IPO will put less than 5 percent of the company in the public, the minority shareholder will likely have no influence over such key decisions. Also, it is obvious that the separation of Aramco from the energy ministry is hardly simple. In fact, there was an attempt earlier to separate the two by removing Al-Naimi as the Chairman of Saudi Aramco, but we are back to the old system now with Al-Falih as the Chairman of the Aramco board and the energy minister, highlighting the complexities in separating the two.

Change but a slow and bumpy one

This point about complexity is broadly true for almost all of the topics explored above. However, these

immense challenges don’t mean that there would be no change in Saudi Arabia. Structural reforms are much needed to shift the economy to a more sustainable path and even if only a small part of the vision is being implemented, the Saudi economy will look very different in 2030 than it is now. In this transition, the energy sector will continue to play a key role. But amidst all the excitement, one also needs to be aware of the challenges ahead and the time it takes to implement such changes, particularly in a conservative society and in an oil-based economy where the sense of entitlement among citizens is high and institutional capacity to undertake deep reforms is low. Furthermore, structural reform is rarely a linear process, and there will be bumps on the way. Transforming the economy doesn’t just create winners; there will also be losers who need to be protected by the government to maintain public support for these reforms. This is key to ensuring a smooth transition to the ‘vibrant’ economy.

THE LARGEST IPO IN HISTORY

The arrival on the stock exchange of Saudi Aramco, the Saudi state-owned oil company, could be the largest listing ever. The transaction which, as desired by the government, should take place in 2017, promises, however, to be very complex.



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Markets/What changes if prices vary

The price trap



The push for reform embodied in Saudi Vision 2030 could weaken if oil returns to over \$70 per barrel. That level would ensure a balanced budget under the assumption that recent spending cuts will hold. Another challenge could come from the conservative nature of Saudi culture

FAR FROM BREAK EVEN

The fall in oil prices over the last two years has resulted in a drastic reduction in Saudi oil revenue, and, therefore, a rising budget deficit. The austerity policies implemented by the government have not been enough to cover the rapid collapse of oil prices.

According to analysts, in order for the Kingdom's budget to break even, crude oil prices would need to remain at around \$70 per barrel.

SAUDI ARABIA'S FISCAL BREAK-EVEN PRICE

70
\$/b

Source: Deutsche Bank



PAUL SULLIVAN

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Saudi Arabia is the world's 19th largest economy. It is the largest exporter of oil, the most important source of oil to the big Asian economies and an important source of oil for Europe, the U.S. and many other parts of the world. It has the largest conventional oil reserves known, at about 800 billion barrels in place with about 266 billion barrels in proved reserves, depending on the price of oil.

Islam started in what is now Saudi Arabia, and millions visit the country for the Muslim pilgrimages of the Umrah and the Hajj. There are 1.6 billion Muslims worldwide who pray to Mecca 5 times daily.

Saudi Arabia is also a major supporter of the linchpin states of Egypt and Jordan. Saudi Arabia is in the midst of complex and expensive conflicts in Yemen, Syria and elsewhere. Saudi Arabia is the anchor for the Gulf Cooperation Council, the GCC, which is not just an economic grouping, but also a defensive one. These are just a few of the many reasons why Saudi Arabia is an important country.

Internal and external threats

Saudi Arabia has had major problems with terrorism on its own soil, and there have been numerous attacks on the country from various extremist groups in recent years, including the multiple attacks in the country just recently. Contrary to the prevailing narrative, the Saudis are doing a lot to counter terrorism. If Saudi Arabia ever faces an existential threat from ISIS or another terror group, the entire world would face a major strategic calamity. Not only would Saudi Arabia be at threat, but also the U.S. 5th Fleet's base in Bahrain and the massive Al Udeid Air Base in Qatar would be at risk. The UAE, Qatar, Bahrain, Iraq, Jordan, Iran, and many more places would be threatened if Saudi Arabia fell to extremists. In short, the global impact would be huge if such a regional calamity took place.

Saudi Arabia's most important global concerns include its reliance on the price of oil and the effects of global financial markets, perceived threats to its security from various global actors and relations between the Muslim and non-Muslim worlds. Its most important regional concerns include the security and prosperity of the GCC and other allies and partners, such as Egypt, Jordan, and Morocco. These concerns also include the direct perceived threats that issue from Yemen, Syria, Iraq, and, most particularly, Iran. Some of its most important domestic concerns include domestic threats from terror cells and potential instability in its East Province, where the Shia are the most highly concentrated in this Sunni dominated state. The Saudis

are concerned about Iran stirring up further trouble in that part of their country, home to most of its oil production. Other domestic concerns include unemployment and underemployment and their actual and potential social and security implications.

Economics and national security

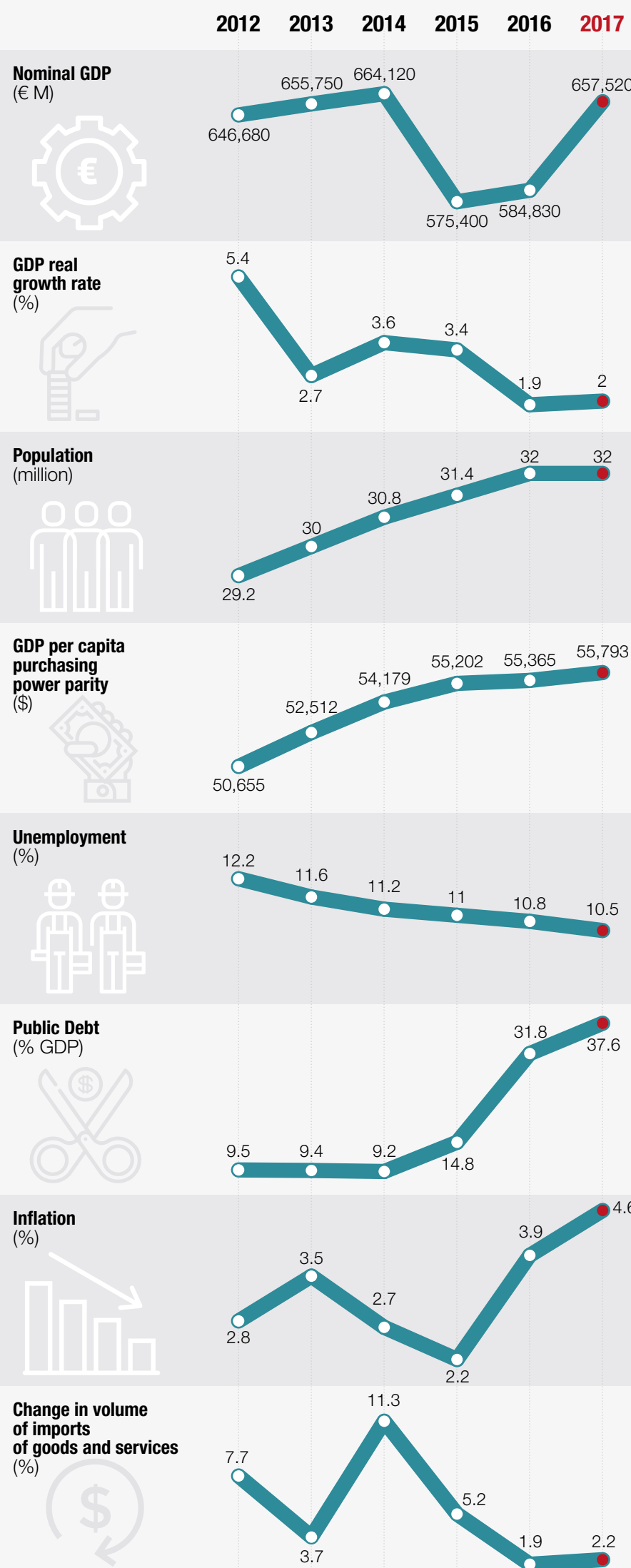
Like all countries, Saudi Arabia needs a healthy, stable and growing economy to support its global, regional and domestic concerns. Unemployment in Saudi Arabia is on average about 11.2 percent, but underemployment is much higher. Both unemployment and underemployment are sources of personal stress and potential social stress and instability. Further, the unemployment rate for people from 15 to 30 years old is, on average, 35 percent. For those aged 15 to 19, it is close to 50 percent. A full 60 percent of Saudis are under 30. And their job prospects seem limited. Women are a massively underutilized resource as they have a very low labor participation rate, at about 20 percent, and very high unemployment for those trying to participate, at about 30 percent. And they are half the population.

Most employed Saudis work in the public sector in jobs that pay on average about 70 percent more than the private sector, but the public sector is often far less productive than the private sector. Public sector compensation is a huge part of the government budget, and it has been growing rapidly since the "Arab Spring" shocked the region and the world. Unfortunately, while compensation has risen, productivity has been stagnant.

Most of those who work in the private sector are expatriates from South Asia, Southeast Asia and the Arab world. They are usually on short term, and often tenuous, contracts, whereas many of the government jobs are long term, if not for life. Moving Saudis from the public sector to the private sector will be difficult, but every time there is downward volatility in the price of oil, there are pressures to do just this.

There is a big disconnect between the Saudi education system and the sorts of employees they need. The primary education system is not performing up to the standards the previous King had hoped for when he poured money into education. The secondary schools are not up to international standards. Even with the growth of the number of universities and university students in the past few decades, not enough has been done to get Saudi students up to speed for the work force. Sadly, about 50 percent of Saudi college students drop out. There need to be far more busi-

SaudiEconomics



Source: Prepared by the Italian Embassy based on EIU and IMF data. N.B.: for the year 2017, EIU forecasts are given

ness, engineering, science, entrepreneurship and other university and training courses to connect Saudi students to the needs of their country. For many decades, oil has dominated the economy and has been related to changes in the economy. Oil is roughly 35-45 percent of the GDP of Saudi Arabia, while oil exports are about 30-40 percent of GDP. Oil exports make up roughly 75-80 percent of all exports. Oil revenues are about 80-90 percent of all revenues. The lower percentages apply at times of low oil prices. There is a distinct correlation between the changes in the price of oil and the changes in the GDP of Saudi Arabia—the curves nearly shadow each other.

When the price of oil increases, Saudi Arabia has responded with increases in government expenditures: money dedicated to large construction projects, ambitious plans for new cities, infrastructure and more. When the price of oil drops, Saudi Arabia responds with cutbacks on government expenditures and other development plans.

Saudi Arabia has massive social contract programs, which can include free education, free health care, and other social benefits. It also has considerable military programs and recently has been involved in expensive conflicts. When oil times are good, the Saudi government is flush with funds. When oil times are bad, Saudi Arabia has had to dig deep into its financial reserves.

Saudi fiscal balances have been increasingly in the negative range since the recent drop in oil prices. At present, Saudi Arabia has a small foreign debt, but it could grow much larger if oil prices remain low. Recently, they have been going to international financial markets for bond issues. This has all happened before, but it is time to stop this disruptive cycle.

The disruptive changes of Vision 2030

The challenges that Saudi Arabia is taking on with its Vision 2030 are breathtaking. They want to reduce official unemployment from over 11 percent to about 7 percent. This is possible. They want to increase women's participation in the economy from about 20 percent to 30 percent. This is technically and economically possible, but socially this may create strains and cause pushback from ultra-conservatives.

They want to increase non-oil revenues to about 7 times what they are now. Success on this will depend on how taxes are increased, how other fees are increased, and how the country moves toward a more diversified set of industries and services. There are ambitious goals for tourism,

which are technically and economically possible, but socially they could raise real issues. Saudi Arabia wants to drastically increase the importance of the private sector, including small to medium sized industries and non-profits. It also wants to attract larger amounts of foreign direct investment and to considerably increase domestic savings. It wants to start the privatization of health care, increase renewable power (although lately some of these goals have been cut back), and make big changes in other parts of its energy sector. Saudi Arabia wants to be far more competitive and be one of the top logistics countries in the world. Saudi Arabia wants to reform its defense sector and start developing a viable defense industry of its own. The leadership wants to make its government one of the most effective in the world.

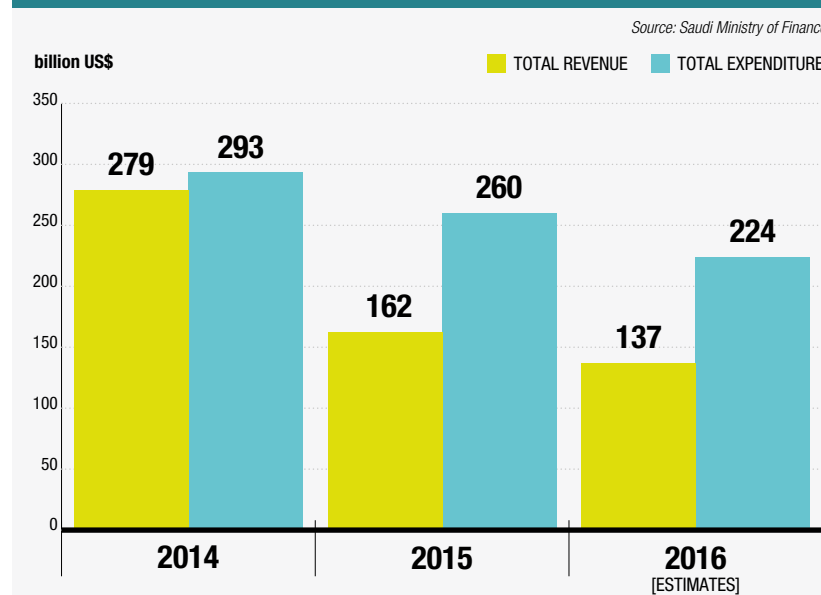
Saudi Arabia wants to modernize its education and training systems, as this is vital if other parts of this program are to work. If education and training do not keep up with and enable needed changes, Vision 2030 is in deep trouble. There will also need to be a change in behavior towards taking private sector jobs, and work ethics and behaviors will have to change among some workers. Entrepreneurship and the entrepreneurial spirit will need to be developed quickly.

The Aramco IPO, the PIF and other sources of funding

Saudi Arabia is developing ideas for an IPO for Aramco, and it will have to make public a lot of data on this massive company and its subsidiaries. There is no accurate, audited valuation of the company, and there seems to be a lot of guesswork about its valuation. The most common guess is about \$2.5 trillion, but guesses range from \$2 trillion to about \$12 trillion. Data and analyses supporting any of these guesses are not public and may not actually exist in a cogent form. Figuring out the present value of its massive and complex assets could take considerable time and effort, so an accurate estimation will not appear tomorrow or even in the next few months if it is done properly.

The planned Aramco IPO seems to be for only 5 percent of the company, a figure that may increase later. Which 5 percent of Aramco will be sold off and to whom is not clear at all. What the value of that 5 percent may be is not clear, but the numbers most commonly used for the 5 percent are between \$135 billion and \$150 billion. The Saudi government has publicly stated that the income from the IPO will be put into its Public Investment Fund (PIF). Aramco would be transitioned into a holding

SAUDI BUDGET REVENUE AND EXPENDITURE



In 2014, with oil at \$110 per barrel, the Saudi deficit amounted to \$14 billion. In 2016, despite a substantial cut in public spending, the gap rose to \$87 billion.

company with an independent board and maybe other changes in leadership structures and strategies. Other assets, such as the financial center of Riyadh, would also be moved into the PIF. Funds will also come from a reduction in some subsidies, a change in the economic social contract of the country, and some tax changes, all of which do not seem firmly set yet. Saudi Arabia still has massive financial reserves, considerable mineral and other resources, and especially human resources that have yet to be fully tapped. However, there are some serious questions about how long it can continue to drain its reserves and continue on similar economic paths. It is vital that the right decisions be made with this money.

Hopes and worries

If the oil price shoots up to \$70, \$100 or even \$150 per barrel, then this may take the edge off the need for a Vision 2030. Saudi Arabia can get oil out of the ground for an average total cost of about \$10 per barrel, but it needs over \$70 a barrel to get to a breakeven government budget given the importance of oil revenues to the budget. So the \$70 and \$100 targets are something to keep an eye on. If the coffers of the reserves in SAMA (the Saudi Arabian Monetary Agency) and others start to fill up quickly and the budget pressures are dissipated, then there may be social and leadership pressures to move away from the disruptive changes that Vision 2030 would bring. This would be a short run view that could prove dangerous. If Saudi Arabia brings back its previous expenditure levels or more, then the breakeven budget could be even higher.

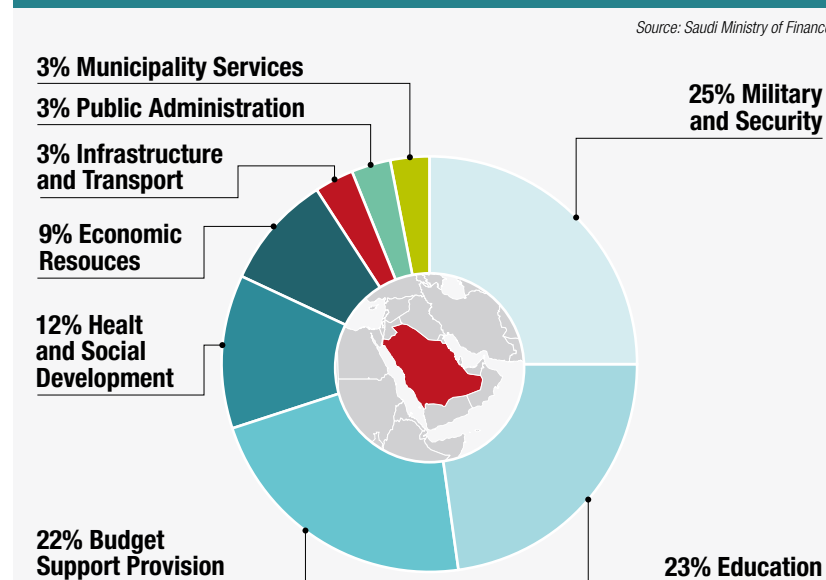
Oil prices can drop again. There

could be new huge finds in tight oil fields globally that could see the increase in non-Saudi oil production, much like what happened in the U.S. in the last few years. There is likely to be greater global emphasis on a movement toward electric, natural gas and far more efficient transportation vehicles. Globally transportation vehicles are now fueled 95 percent by oil-based products, and about 65 percent of global oil use is for transportation. Other uses of oil, such as in industrial processes, chemicals, and more, could also begin to move further from oil-based feedstock if there is yet another upward oil price shock.

There is increasing pressure to move from fossil fuels for environmental reasons as the threat of global climate change gets closer and more pronounced. If many countries enact regulations and laws to respond to perceived and actual climate change threats, the oil markets could suffer from those changes. The recent COP21 meetings in Paris could be a strong indicator of where this might be going.

The conservative nature of Saudi society could bring challenges to Vision 2030. One must consider what happened to Saudi Arabia's rival Iran in the 1970s when the Shah tried to move the economy and the society forward too quickly. The Vision 2030 program, even with its breathtaking ambition, is far more realistic than the Shah's program. However, there are still possible problems with how well Saudi culture can absorb the changes that Vision 2030 entails. This may be especially so in the change to the ratio of the public to the private sector and in the greater incorporation of women into the labor force, and hence into public life.

SAUDI 2016 BUDGET ALLOCATION



The distribution of the Saudi budget for the year 2016. The main share is absorbed by military spending, followed by education.

Sharp and fast economic changes can also produce unexpected social dislocations.

The Shah did not have a project to move away from oil, but he had massive ambitions for his country, ambitions that contributed to shattering Iran's economy as roads and ports clogged, inflation and unemployment skyrocketed, and the country's economy literally choked on the changes. Iranian society also reacted badly to his societal and economic "modernization" plans and their effects.

Vision 2030 focuses mainly on economic change, without much planning for political or social change, but with more and more women entering the labor force, some social change will occur. When there is a major movement from the public to the private sector, work behaviors will have to change. Moving away from oil, a rentier commodity that has allowed Saudi Arabia to grow and develop by pumping it out of the ground and selling it, to the complexity of more manufacturing, service, and value-added and more competitive industries and projects could also bring social changes. Many of these changes could be an improvement for some Saudis, but some others may object. Also, many government jobs are far less stressful and demanding than these new and different private sector jobs. An entrepreneurial class would have to be enlarged from what exists now. The pressures of being successful in the private sector could bring significant changes to some Saudi lifestyles.

Saudi Arabia has come a very long way since the days when the King lived in a fairly small earthen palace or a tent, and his treasury could fit into a camel bag – and when the King

was more interested in finding water than oil because there were few uses for oil during those early times. The Saudi Arabia of today is astonishingly different from what it was in 1940, 1950 or even 1990. Saudi Arabia has experienced economic and other changes in its past, but there has been nothing as substantial as what is planned in Vision 2030 in speed, depth and breadth. If they get this right, they could save themselves from political, economic and resource troubles coming their way, and possibly help stabilize the region. If they fail to diversify, change and use and develop their resources and people better, and with Saudi society moving smoothly with these changes, we will all be in trouble. The real problems with such ambitious and disruptive programs are often found in the details. What Saudi Arabia says it wants today for 2030 may not be what happens by 2030. Expectation management will be vital, most particularly for Saudis under 30, who represent about 60 percent of the population and a growing labor pool in need of many jobs and a lot of economic hope.



Read on www.abo.net, the articles by Giuseppe Acconcia, Paul Betts and Yao Jin on the same subject.



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Saudi Arabia's former oil minister Sheikh Zaki Yamani thought he saw the handwriting on the wall years ago. In remarks that have now become almost legendary, Yamani said in the year 2000 that "Thirty years from now there will be a huge amount of oil—and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones, and the oil age will come to an end not because we have a lack of oil." Yamani believed that advancing technology would eventually satisfy global demand for energy and would thereby render oil redundant, a reference to stranded assets long before the phrase became popular or even known.

Yamani's bête noir

There could be no greater bête noir than Yamani's vision for anyone in the oil industry, but especially for Saudi Arabia, whose national income is 90 percent dependent on oil revenues. As hard to imagine as Yamani's vision might be for many people in the oil industry, today's government in Saudi Arabia seems to have taken it very seriously. Indeed, it can hardly be an accident that Saudi Arabia's ambitious plan for the future coincides with the date seen by Yamani as marking the end of the oil era: Vision 2030. However, even as Saudi leaders may acknowledge the vision of Yamani, it does not follow that they share his vision. To the contrary, as will be argued here, Saudi leaders have developed their own vision of 2030 to prolong the oil era, not to mark its demise. Saudi Arabia's Vision 2030 was unveiled in April 2016 amid an economic downturn that had seen international oil prices drop by more than 50 percent since June 2014. Given that international collapse in oil prices and the attendant drawdown of Saudi financial reserves, many pundits saw Vision 2030 as a reactive effort by Saudi leaders to begin shoring up the country's finances and diversify the economy away from its near dependence on oil. Bloomberg News provided a clear example of that attitude in a story carrying the headline "The \$2 Trillion Project to Get Saudi Arabia's Economy Off Oil."

In the story, Bloomberg writers opined that there was "near-panic" among Saudi advisers as they discovered the country was "burning through" its foreign reserves at a faster pace than anyone knew, "with insolvency only two years away." The story went on to intone that, "Plummeting oil revenue had resulted in an almost \$200 billion budget shortfall—a preview of a future in which the Saudis' only viable export can no longer pay the bills, whether because of shale oil flooding the market or climate change policies." Pub-

lished four or five days before the unveiling of Vision 2030, the Bloomberg story was almost sensational enough to short-circuit critical thinking into the belief that Saudi Arabia is looking to abandon oil altogether in its rush to an economic model based more on investment income than on its highly developed petroleum industry. A few days after the announcement of Vision 2030, The Economist magazine added its own sensationalism to the prevailing view, stating that Muhammad bin Salman, Saudi Arabia's 30-year-old deputy crown prince, unveiled "a string of commitments to end the kingdom's dependence on oil by 2030." It is hard to understand how the normally staid Economist could have missed a key point in Vision 2030, which clearly states that, "We will continue to manage effectively oil production to ensure a rewarding flow of oil revenue and reinvestment."

Oil essential to the Saudi Vision

Oil is and will remain very much at the heart of the Saudi economy both now and in 2030. That point was made clear by Khalid Al-Falih, the country's recently appointed minister of petroleum and mineral resources. According to Al-Falih, "nobody has the intention of turning off the oil economy in Saudi Arabia." To the contrary, Al-Falih said, Saudi officials believe global economic growth will support rising energy demand of about 1.5 million barrels a day (b/d) of oil for the foreseeable future. To help meet that demand, as well as disruptions of supplies if other producers falter, the Saudis are investing heavily in their spare production capacity.

Al-Falih was also sanguine about the place of oil in the face of competition from other sources such as renewable energy. "We're not afraid of it, but we're also realists and we know that oil will be a significant part of the energy mix for decades to come," Al-Falih said. "Even if the share of oil goes down from, say, 30 to 25 percent, 25 percent of a much bigger global demand means a much higher absolute number of barrels that will be in demand by 2030 or 2040."

Even as the Saudis are trying to build up the country's oil sector, Al-Falih nonetheless hoped that, "the non-oil economy will grow even faster." That fits with the thinking behind Vision 2030 where a partial sell-off of Saudi Aramco is destined to play a key role in helping the non-oil sector grow. With the Saudi firm valued at \$2-\$3 trillion, the proposed sale of five percent would generate income of \$100-\$150 billion and provide funding for investment abroad as well as in the Saudi private



Energy/Oil in the center of economy

The battle for market share

The main objective of the document is not to make the Saudi economy independent from oil, but to protect the oil sector and to try to offset the loss of revenue for the state coffers resulting from the "price war"

sector, both key aims of Vision 2030. From the standpoint of investors, optimistic observers say the sell-off could provide “access to one of the Kingdom’s prized industries” and pave the way for greater internationalization of the Saudi economy.” That appears to be wishful thinking as it is not yet clear what investors could expect from a stake in Saudi Aramco. But they are unlikely to have anything like control or even access to the company’s inner workings, much less the entire Saudi economy. According to Al-Falih, even after an initial public offering, the Saudi government will continue to make sovereign decisions on the firm’s oil production and spare capacity. Al-Falih said that is something that “investors are going to have to accept” as “part of the package of buying into the lowest-cost producer.” In fact, as suggested in Vision 2030, stakes purchased in Saudi Aramco might well have nothing to do with the oil industry at all. “We believe that Saudi Aramco has the ability to lead the world in other sectors besides oil, and it has worked on a sweeping transformative program that will position it as a leader in more than one sector,” the document states. In a word, investors might find themselves holding shares in an Aramco subsidiary working on projects outside of the oil industry altogether. Nor is there any timetable for an IPO. According to Al-Falih, an initial public offering of Saudi Aramco would require “extensive rewiring of our financials and the relationship with the government.” And that, he said, “would require a significant amount of time.”

Vision 2030 aims to prolong the oil era

Instead of a document aimed at weaning the Saudi economy off oil anytime soon, Vision 2030 represents an effort to protect and prolong the country’s petroleum industry in the face of an extended and expensive battle for market share. While Vision 2030 clearly does not share Yamani’s apocalyptic vision of an oil industry in demise, the Saudi document must be understood in the context of the kinds of technological advances Yamani felt would make the industry redundant by 2030. Not least, Vision 2030 needs to be understood in the context of the current struggle over climate change and renewable energy. The most visible sign of that struggle came over a year ago in Paris at the UNESCO Business and Climate Summit. At the time, Saudi Arabia’s former oil minister, Ali I. Al-Naimi, made news by announcing his country’s seeming desire to switch production from its vast petroleum resources to solar power. “In Saudi Ara-

bia, we recognize that eventually, one of these days, we’re not going to need fossil fuels,” he said. “So we have embarked on a program to develop solar energy ... Hopefully, one of these days, instead of exporting fossil fuels, we will be exporting gigawatts of electric power.” As with Vision 2030, world reaction was immediate and sensationalistic. “Saudi oil minister: ‘Fossil fuels doomed, we’re switching to solar,’” said one headline. “Saudi Arabia’s solar-for-oil plan is a ray of hope,” said another. Similar headlines appeared a few weeks later, when Al-Naimi told reporters ahead of an OPEC meeting that solar energy represents an opportunity for everybody. “At OPEC the Saudi Oil Minister Mainly Wants to Discuss Solar Power,” read one headline, which also ran the subhead: “What does it say about oil when Saudi Arabia embraces solar?”

Postponement of the solar program

Pace headline writers, Saudi Arabia, which holds at least 260 billion barrels of conventional oil reserves, the earth’s largest, has no plans to drop petroleum for solar power or any other form of renewable energy. Saudi leaders may recognize that oil is a finite resource and that a new era of energy may eventually arrive, but they are staving off that era as long as possible. “I see renewable energy sources as supplementing existing sources, helping to prolong our continued export of crude oil. And this is why we are investing in solar energy,” Al-Naimi once said. At the UNESCO meeting in Paris, Al-Naimi acknowledged Saudi plans for solar energy, but rejected the idea that solar energy could replace oil as an affordable fuel any time soon. He suggested that solar energy is a luxury that can be afforded by developed nations but not by developing ones. “We can afford to go after solar, but many people in Asia and many people in Africa cannot afford that. They’re still burning dung and wood and what have you for energy,” he said. Then he summed up the Saudi position: “Let us focus our attention on how we can manage emissions so that we can continue using fossil fuels until we are able to develop the alternatives that we are working for: solar, wind, renewables—whatever.” Saudi Arabia has abundant supplies of the cheaper alternative in its 260 billion barrels of crude reserves—a point the minister underscored in Paris by asking fellow panelists if the world was ready for him to end his country’s oil production. “Can you afford that today? What will happen to the [oil] price, if today I remove 10 million barrels per day off the market?” It was a rhetorical question but

one that made his point. For now, the widespread use of solar and other forms of renewable energy has been delayed while oil continues as the affordable choice. Saudi Arabia has played a key role in creating that affordable choice. The UNESCO Summit came amid a global price war that saw oil prices dropping by 40-50 percent over the preceding year—a price regime that continues today. During all of this time, more than two years, Saudi Arabia has refused to cut production and has successfully urged OPEC to do likewise, preferring to see prices fall than to lose its market share. At the time, Al-Naimi put it in a very clear manner: “If I reduce, what happens to my market share? The price will go up and the Russians, the Brazilians, U.S. shale oil producers will take my

share.” He might have added that renewable energy producers also would like to take his share.

The Saudi’s competitive advantage

Saudi Arabia’s influence on world energy markets rests on its ability to produce some 10 million barrels of oil a day at \$4-\$5 a barrel. That’s a competitive advantage that no other energy producer can match, especially since Saudi reserves enable it to sustain production of ten million barrels of oil a day for the next seventy years or more. That’s more efficient and long lasting than any other producer on earth, and it explains why Saudi Arabia can rock—or stabilize—world energy markets. Saudi Arabia’s strategy for market share affects all higher-priced pro-

ducers of energy, including solar. That was evident in January when plans to implement a \$190 billion solar energy program in Saudi Arabia were delayed from 2032 to 2040 or later. The plan, which aimed at creating electricity from solar energy to offset domestic demand for oil, was delayed because of the low petroleum prices, which weakened near-term incentives to save oil for export. As shown by this delay in its own solar program, Saudi efforts on the market can slow the transition to renewable energy by making it less affordable than oil. Saudi leaders may acknowledge that the world is in transition from the era of oil to another yet to come. They may even concede that the oil era will end because technological advances will introduce a new form of energy,

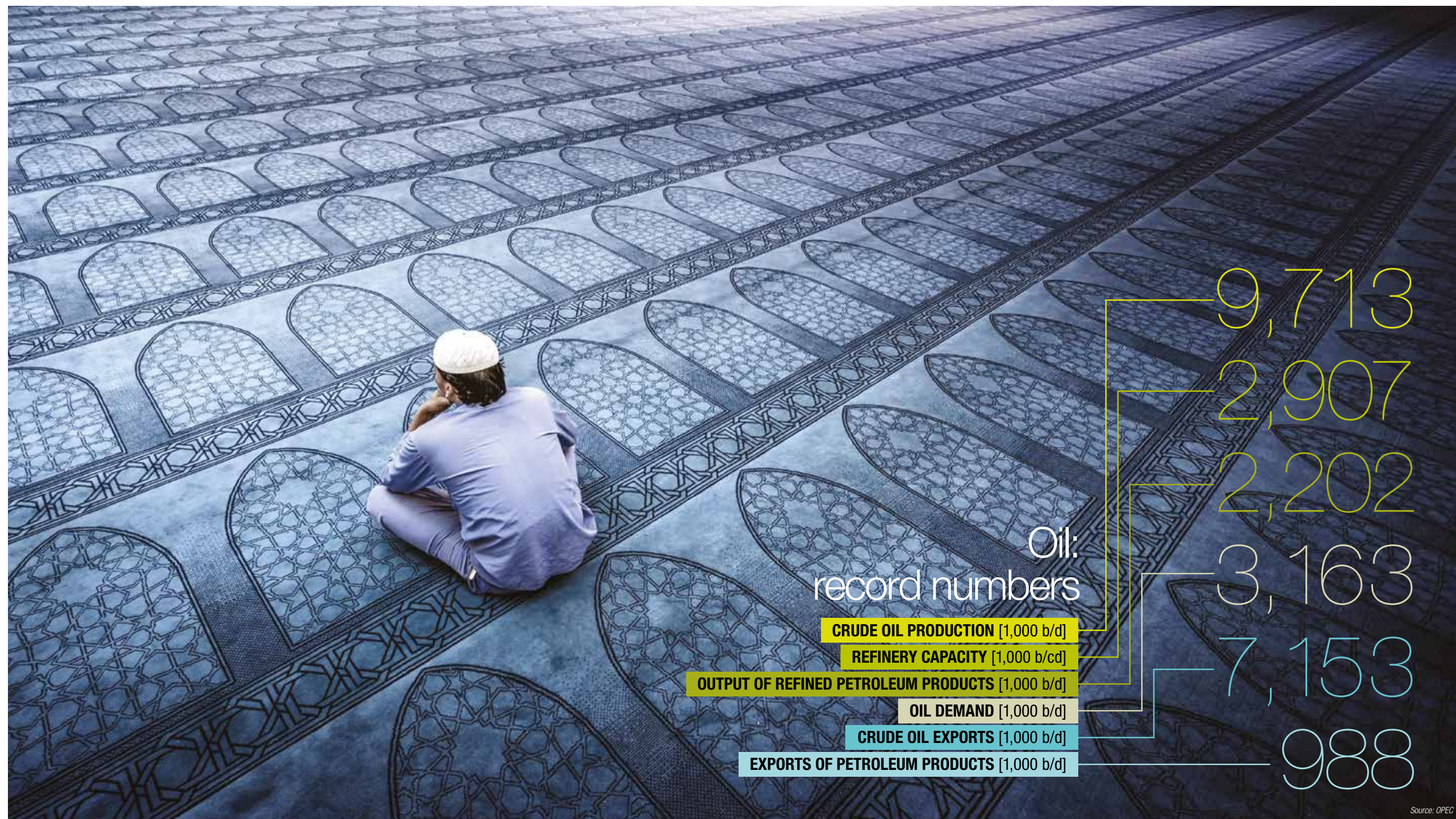
not because oil will be depleted. New technological advances are at hand, and they may recognize that potential. But the Saudis are not prepared to cede their country’s predominant position on energy just yet. It comes down to the price war, and their policy on producing abundant low-cost supplies is currently winning the war for oil’s market share and for Saudi Arabia’s share of the oil market.

Vision 2030 offsets high costs of market share

Yet, this battle for market share comes at a high cost to the Saudi economy, and that is precisely where Vision 2030 comes in. As Saudi coffers deplete due to the prolonged battle over market share, a battle that could extend years into the future,

there are potentially fewer funds available to cover the subsidies that Saudi citizens have long enjoyed. As a result, a new policy has to be developed that will make a virtue of that financial necessity. A new policy has to be developed that will enable the Saudi government to compensate for a potentially long-term period of reduced income that could create unrest among its populace. That policy is Vision 2030—a policy that sees inflows of private foreign capital as a means of filling any shortfalls the country may experience due to the continuing struggle for its share of the energy market as a whole and the oil market in particular. Vision 2030 is not Yamani’s apocalyptic vision from 16 years ago. Unlike Yamani, Vision 2030 does not see the end of the oil era as inevitable. To the contrary, Vi-

sion 2030 sees the oil era as elastic, as a period of time that can be stretched into the future as long as Saudi Arabia has low-cost oil to be produced and sold. Vision 2030 implicitly recognizes that high oil prices actually work against Saudi market share by making high-priced producers of energy more competitive. To reduce that competition and maintain its own share of the energy and oil markets, Vision 2030 recognizes that Saudi Arabia may have to settle for lower prices for an indeterminate future. As that means potentially fewer funds for public subsidies, Vision 2030 extols the virtues of private foreign capital as closing the potential gaps between the country’s oil earnings and its social expenditures.



Iran/Meeting the world after sanctions

Between Europe and the Asian Giants

Oil production has returned to pre-embargo levels with surprising speed. Facing re-election, President Rouhani has tacked between the world's major economies; he must now find a way to cement deals made with Europe while continuing to develop relationships with Asia



ELLIE GERANMAYEH

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The cornerstone of President Hassan Rouhani's mandate has been the reintegration of Iran into global economic and political platforms. His tenure has so far focused on reaching a nuclear deal that rolls back sanctions, reaping the economic dividends from that deal and on distancing Iran from its pariah status. Tehran has so far used the positive momentum following the nuclear talks to re-engage with Europe after a period of political hiatus and to deepen its pre-existing economic ties with its neighbors in Russia and Asia. Now, a year after the Joint Comprehensive Plan of Action (JCPOA), Iran has increased its oil exports close to their 2011 pre-sanctions level and begun to put in place deals with a range of international investors. However, Iran has been disappointed with the slow pace at which preliminary agreements put in place with Europe over the past year have moved forward. In this light, and given Iran's immediate and strategic priority to boost its economy and create job growth, Tehran is hedging its bets between Europe and the big Asian economies.

Opening with Europe

Rouhani's election and the process of diplomacy over the nuclear issue created the political space needed for Europe to begin a détente process with Iran. Over the past three years, foreign ministers from almost all E.U. member states have visited Iran, accompanied by trade ministers or large business delegations. Just days after the JCPOA entered implementation day in January of 2016 and sanctions were eased, Rouhani visited Italy and France, marking the first official European visit by an Iranian president in over fifteen years. During these visits, Iran signed a range of political, cultural, and high profile trade deals to signal that Iran is back in business. In Italy, the Iranian delegation signed deals involving the mining, shipbuilding, energy and infrastructure sectors totaling roughly \$18.4 billion. During Rouhani's visit to France, Iran agreed on more than 20 contracts with French companies estimated to be worth over \$40 billion in the energy, auto and aviation sectors. The most publicized deal was one reached between Iran and Airbus for the sale of 118 planes worth \$27 billion. Shortly after, the Greek and Italian Prime Ministers became the first Western leaders to visit Iran in over a decade. During the visit, Italy announced it was extending a \$5 billion credit line to facilitate Italian trade with Iran. This was followed in April by a visit to Tehran by the E.U. High Representative Federica Mogherini and seven E.U. Commissioners to start a formalized and

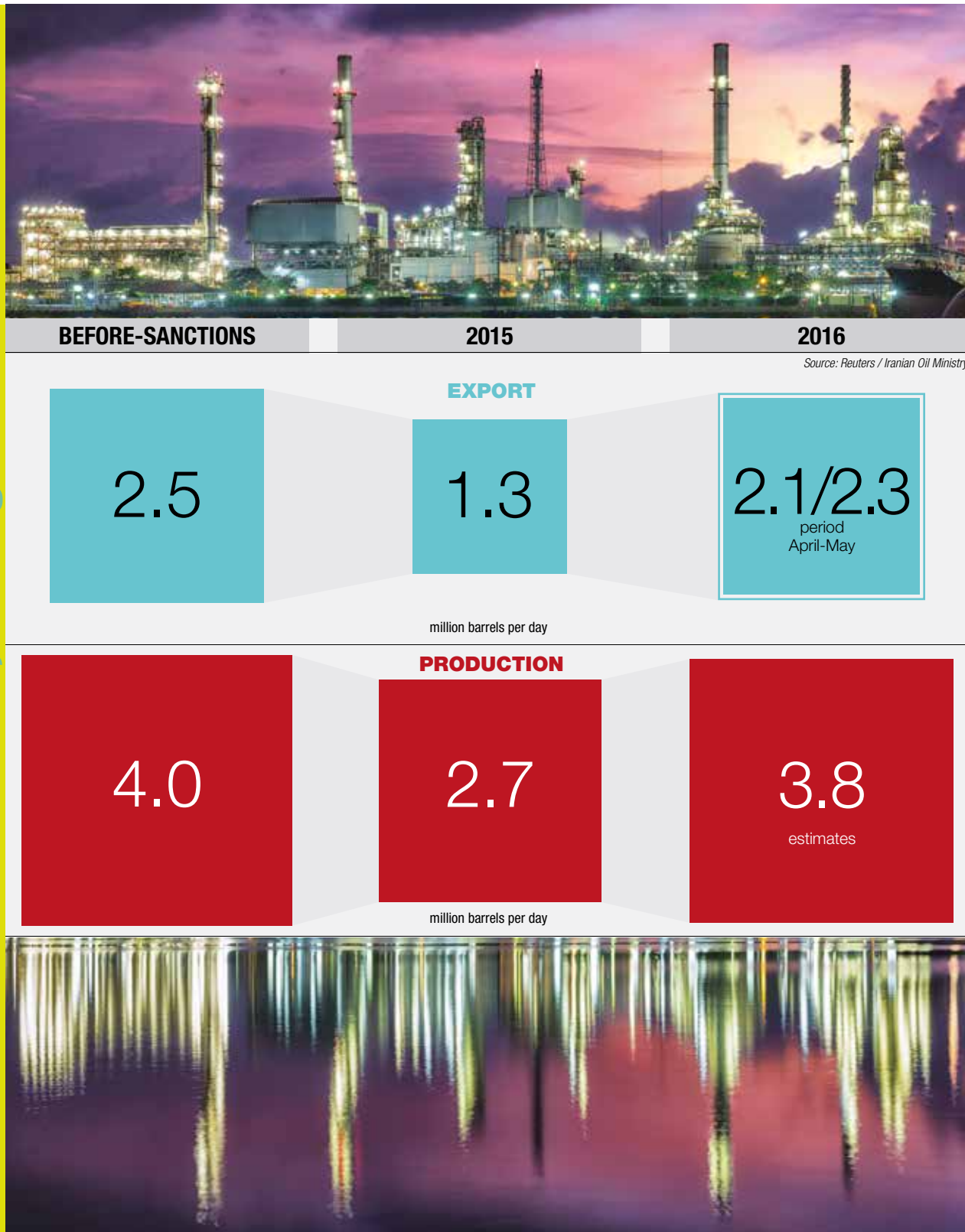
structured dialogue between the E.U. and Iran. Stacks of preliminary contracts have been signed between Iran and Europe, ranging from small to major deals. So far, though, many of these, including the Airbus deal, have been unable to move forward primarily due to problems with securing necessary banking and financial support or the necessary U.S. Treasury OFAC authorization. The large European financial institutions needed to transact such volumes of business are either unwilling (due to a mix of political risk in doing business with Iran and the perceived unpredictability of future U.S. sanctions on Iran), or unable (given their high exposure to the U.S. market and risk of falling foul of U.S. primary sanctions) to do so. There is a growing perception amongst Iran's political and economic leaders that Europe has been overcautious and slow at re-entering the Iranian market to regain its place as the top trade partner. The Rouhani administration wishes to allow more time to test a European comeback, but simultaneously the government has welcomed greater investment from the likes of Russia, China, India and South Korea, countries that have shown both strong interest and a greater ability to enlarge their presence in the Iranian market.

Iran's Asia pivot?

Iran has long been doing business with Asian countries; even throughout sanctions, many Asian companies were given special exemption by the U.S. Treasury to continue dealings with Iran, particularly to meet their energy needs. China perhaps profited the most during the decade long sanctions on Iran's nuclear program. During this period, China overtook Europe as Iran's top trading partner with roughly \$52 billion worth of trade in 2014. In January 2016, President Xi Jinping was the second P5 member, after the Russian President, to visit Tehran specifically to ensure that China remained a frontrunner in the Iranian economy. Xi and Rouhani agreed on a 25-year roadmap for developing relations between their nations, including 17 agreements focused on energy and infrastructure. Based on this, they estimated that bilateral trade would rise to \$600 billion in the next decade. Iran is assured that China has both the financial capacity to invest in Iran and the need for Iranian energy resources. While China also depends on Saudi Arabia for its oil (and indeed Xi's visit to Iran marked the final leg of his Middle East tour), Iran has an added advantage given its geographical positioning, which makes it an important player in China's One Belt One Road initiative. South Korea has also re-entered the

STILL IN THE RACE

Hassan Rouhani, the current moderate President of Iran, is a candidate for the next Presidential elections, to be held May 19, 2017. In the photo, Rouhani poses for photographers at the airport of Ramsar, Iran.



Iranian market in a big way. During a visit by President Park Geun-hye to Tehran in May, the two countries agreed on a financial package pledge by South Korea to cover deals with Iran worth an estimated \$25 billion. Iran is expected to plan for LNG exports to South Korea (having already signed a memorandum of understanding to this effect in May). Another significant and emerging economic partner for Iran is India. During Prime Minister Narendra Modi's visit to Tehran in May, a tripartite deal was reached between India, Iran and Afghanistan for the construction of Chabahar port in southern Iran. Under this deal, India has agreed to contribute \$500 million to finance the development and pledged

to invest \$16 billion in a free trade zone around the port. The deal also sets in motion a transit agreement for new railroads and roads connecting Chabahar to Afghanistan, with the objective of creating direct trade routes connecting India to Central Asia. If these agreements were implemented, it would enable India to bypass Pakistan's rival Gwadar port when transiting goods to landlocked Afghanistan. In April, India's energy minister signed contracts for developing Iran's Farzad-B gas field and increasing export of Iranian oil to India. This deal in effect mitigates some of the profit Iran has lost as a consequence of a largely failed "peace pipeline" agreement with Pakistan, one intended to create a transit route

for export of Iranian gas to Pakistan. Discussions for this project began in 1994, and various complications have delayed the completion of the Pakistani segments. While Pakistan is a significant economy in Asia, it carries more geostrategic than economic importance for Iran, as signified in Rouhani's official visit to Pakistan, where the roadmap for cooperation focused more on security issues. Another important deal in which India plays a key role for Iran, and which is perhaps the biggest game-changer for regional trade, will be the North-South Corridor project, connecting St. Petersburg to Mumbai, with Iran as the transit hub. This development has been underway for a number of years and part-

ly stalled when Iran came under nuclear related sanctions. Completion of this project is estimated in the next five years and will provide Russia with access to the sea via the Persian and Omani Gulf. This reduces the need to carry goods via the expensive Suez Canal and is estimated to cut cargo transport times in the region by 50 percent. Once complete, the corridor links Russia, India, Iran and Central Asia and will carry with it huge geopolitical ramifications.

Year ahead

Iran, like the United States, has entered a presidential election year in which the nuclear deal will become one of the litmus tests for judging candidates. The stakes are high for Rouhani, who is expected to stand for re-election in Spring 2017. During his previous election campaign, he prioritized economic growth for Iran and promised Iranians an end to sanctions and isolation in addition to reintegrating the country into the global political and commercial platforms. In the run-up to the presidential race, Rouhani will be judged first and foremost on his record of delivery on the economy. His administration has targeted European trade and investment as a major part of its plans for Iran's economic revitalisation. Iran always recognized the growing technological advantage of Western goods, but the period of sanctions provided clarity that Iran's most profitable industries could not achieve their full potential with Russian or Chinese investment. Over the summer, Iran will focus its political weight on resolving the existing deadlocks for access to global financial networks and to find pathways to execute the high profile deals it has negotiated with European companies. At the same time, Iran is increasing efforts to update its banking sector with assistance from the International Monetary Fund. However, if European companies continue to face hurdles in re-entering the Iranian market, it seems unlikely that Tehran can look to Europe for an immediate economic boost. Therefore, the Rouhani administration has pragmatically hedged its bets with Asian countries, notably China, India and South Korea, which may prove to have greater economic maneuverability for trade and investment with Iran.



Masdar City/Interview with Yousef Baselaib, Executive Director of Sustainable Real Estate

A model environmental city

In Abu Dhabi, a plan to build "the world's most sustainable eco-city" is taking shape, implementing cutting-edge technology to simultaneously facilitate rapid urbanization and reduce energy and water use



SIMONE CANTARINI
[AGENZIA NOVA]
A journalist, has covered the Middle East and North Africa for the last seven years. In 2010, he began to cover Libya, writing articles and analyses in economic and social fields. He moved to Agenzia Nova in 2014 and continues to deal with Middle Eastern issues, paying particular attention to the energy and defense industries.

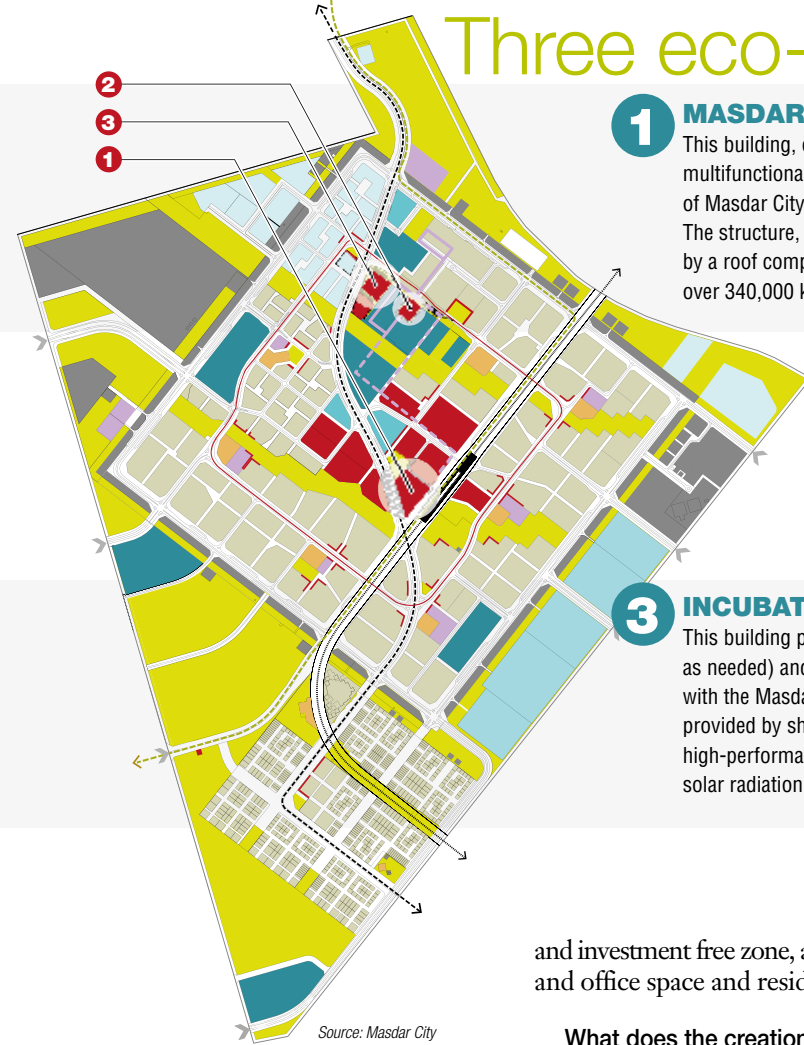
In the heart of the United Arab Emirates, a few kilometers away from the big city of Abu Dhabi, the low-carbon city has been designed and conceived: Masdar City. Its name literally means "Source City," because the entire project was thought of as a "source" of alternative energy, allowing the city to fuel itself. The idea, launched in 2008, immediately captivated the entire world: a city in the middle of the desert, which has become the center of the most innovative technological principles of environmental sustainability. The global crisis has certainly led to the redefinition of the city's development model, in order to involve investors from third parties. This has led to delays in funding and deadlines. However, according to Yousef Baselaib, Executive Director of Sustainable Real Estate of Masdar City, the goal of making the project a sustainable development model is near: "In April, we announced the approval of the detailed Master Plan by the Urban Planning Council, which has paved the way for a major expansion. This will allow us to reaffirm our desire once again to provide a model of sustainable development of our cities now and in the future. Masdar City aspires to achieve the 4 Pearls Community rating of the "Estidama" project and would be the first in the United Arab Emirates to do so."

What is the idea behind the Masdar City project?

Masdar City broke ground in 2008 to build a template, or "greenprint," for sustainable urban development and to promote an innovation hub in the emirate of Abu Dhabi. Today, the city is growing as a thriving community and a genuine innovation ecosystem that has already made great strides in connecting education, R&D, technology and business opportunity. The city is a living demonstration of the potential of clean energy deployment, clean-tech innovation, sustainable urban development, and human capital creation. There is a wealth of clean energy pilot projects around the development; for example, in solar energy, electricity storage, biofuels, district cooling, and sustainable architecture.



Masdar's approach to urban development is based on the three pillars of sustainability—social, economic, environmental—to attract investment and encourage entrepreneurship, improve quality of life, and limit the carbon footprint of our towns and cities. The innovation we have overseen is supporting the deployment of clean energy in the U.A.E., the region and overseas, and the realization of future projects and the commercialization of new technologies. Over the next five years, Masdar City's footprint will increase nearly fourfold as we develop its education facilities and apply research projects even further, enhance the services and infrastructure of its business



Three eco-friendly buildings

1 MASDAR&IRENA GLOBAL HQ
This building, one of the most advanced and environmentally-friendly multifunctional complexes in the United Arab Emirates, is the headquarters of Masdar City and of IRENA, the International Renewable Energy Agency. The structure, measuring 32,000m², comprises three individuals blocks joined by a roof composed entirely of photovoltaic panels that generate over 340,000 kWh per year.

2 SIEMENS BUILDING
This office building is a model of sustainable engineering, and ensures a high level of energy efficiency over a surface area of 20,000 m². It is also the first LEED Platinum certified building in Abu Dhabi. The structure has 9 lobbies, built to provide natural light to all work spaces inside the building.

3 INCUBATOR BUILDING
This building provides "flexible" office space (with panels that modify the spaces as needed) and mainly serves business men and scholars working in partnership with the Masdar Institute, located nearby. Built around a courtyard, with access provided by shaded walkways, the building uses an innovative design, high-performance facades and smart shading strategies that reduce solar radiation by almost 40%.

ANNUAL ENERGY CONSUMPTION /m ² GFA	ENERGY DEMAND REDUCTION (ASHRAE STANDARD 90.1-2007)	ENERGY DEMAND REDUCTION (1)	SOLAR HOT WATER GENERATION ON SITE
121 kWh/m ² /yr	42%	64%	75% of Hot Water
109.5 kWh/m ² /yr	46%	67%	75% of Hot Water
125 kWh/m ² /yr	45%	62%	75% of Hot Water

(1) ENERGY AND WATER BASELINE AND RESOURCE CONSERVATION MEASURES, MARCH 2010, ARUP GULF LTD.

and investment free zone, and continue to build new commercial and office space and residential communities.

What does the creation of a "zero emissions city2" represent for an oil-producing country, which is also heavily dependent on hydrocarbons?

First of all, I should mention that Masdar City is "low carbon" as opposed to "zero carbon." Minimizing the development's carbon footprint is an ongoing process. With each new building or phase of the development, we try to push the envelope further. Masdar City is designed to consume 40 percent less energy and water than built-up environments of a comparable size. Our vision remains "zero carbon." However, no zero-carbon urban development exists today. Although the U.A.E. is seen as a country dependent on hydrocarbons, there is a strong rationale for building a sustainable city that can lead the drive towards the greater use of renewables and clean technology. We live in one of the harshest desert climates in the world, and keeping cool in the summer months is energy intensive. However, the U.A.E. is aware of its energy needs and its environmental impact. That's why we're doing something about it, as there are tangible benefits from investing in and generating renewable energy in the U.A.E. Diversifying the global energy mix is critical if we're to meet rising power demand, address energy security and build a sustainable future. It will help reduce our natural gas imports, diversify our energy sector and increase the security of our energy supply. Investing in renewable energy also supports Abu Dhabi's goal of transitioning from an economy based on exporting natural resources to one based on knowledge capital. Renewable energy is part of the future, and the U.A.E. is poised to maintain its leadership in the energy sector because we recognize the economic, social and environmental benefits of deploying sustainable forms of energy. Seeking additional secure sources of power also boosts our national energy security because oil and gas are commodities that are naturally subject to price variations due to the volatility of international markets. The use of oil as a fuel for power generation has decreased substantially in recent years. Today, it accounts for under 5 percent of the global electricity supply (down from 25 percent in 1973) and hence, a decrease in oil prices does not substantially alter renewable energy competitiveness within the power sector. In contrast, renewable energy costs are predictable and provide a hedge against this volatility, as they are based on technological development. That is one reason why more and more countries are investing increasingly in renewable energy.

In your opinion, how important is this project to the other Gulf countries, those currently struggling with ambitious programs in order to change their economic policy strategies?

Over the last decade, Masdar and Masdar City have grown from a bold idea into an innovative global brand at the center of clean energy and sustainable development. Masdar has led the adoption of technically and commercially viable renewable energy in the Gulf and the Middle East and North Africa region (MENA) region. We are proud to have acted as a catalyst for our industry in the Arab world: the result is that Abu Dhabi is recognized today as a hub for sustainability and a global platform for policy debate and business opportunity. Clean Energy does not only embrace our capabilities as a developer and operator of renewables-based utilities. It also includes the emerging technologies and applied research that are bringing about the renewable energy and water solutions of the future as required by all of our Gulf Cooperation Council (GCC) neighbors and further afield in the wider MENA region. Masdar will continue to perform a critical role in cultivating an environment where renewable energy is a viable and cost effective part of the energy-mix. Today, the MENA region is set to attract USD 35 billion worth of renewable energy investments every year by 2020 (Source: IRENA), with governments increasingly prepared to engage with the market to ensure success. We feel that Masdar has played a critical role in helping to make this happen.

What is the status of the Masdar City development and what is the financial impact of the project? Could you tell us how many companies are involved?

After the global economic downturn in 2008, Masdar City's development model was redefined to include third-party investors. Since Masdar City is no longer only self-developed, providing a meaningful estimate of costs and output is very difficult. Masdar City is a business unit of Masdar, which is a subsidiary of Mubadala Development Company PDJC, an investment vehicle of the Government of Abu Dhabi. Only the self-developed parts of Masdar City are government funded. The rest will be managed through third-party investment and joint venture development which will be the majority of the overall investment, according to sustainability guidelines drawn up by Masdar City and the development objectives of the Abu Dhabi Urban Planning Council. In April, we announced the approval of the Urban Planning Council of the Detailed Master Plans for Phase 2 and Phase 5 of



Masdar City new research centre incorporating Masdar Institute of Science and Technology for developing clean and renewable energy in Abu Dhabi (U.A.E.).

the City, paving the way for major expansion. This will allow us to further demonstrate our ambition to provide a template for the sustainable development of our cities now and in the future. Masdar City aspires to be a 4 Pearl Estidama Community, the first in the U.A.E. Around 35 percent of the planned built-up area will be completed over the next five years, and 30 percent has already been committed to, including private homes, schools, hotels and more office space. At present, more than 370 companies from six continents operate from Masdar City, from start-ups to multinationals, including the Middle East headquarters of Siemens, Lockheed Martin, GE, Mitsubishi Heavy Industries, and Schneider Electric. The City also hosts the International Renewable Energy Agency (IRENA), the first intergovernmental organization to be located in the Middle East. The offices of Emirates Nuclear Energy Corporation (ENEC) recently relocated to the City, bringing more than 700 full-time staff. A division of Etihad Airways has also just moved into the City, with the addition of a further 550 full-time staff.

Do you think that the project will have a positive effect on Emirates economy in term of growth? Do you have any estimate?

We believe that innovating and commercializing new renewables technologies will have a demonstrable impact on the local economy. Although Masdar is not solely responsible for meeting the U.A.E.'s clean energy targets, it is committed to working with the Abu Dhabi utility sector to ensure that it is met. The U.A.E. aspires to meet 24 percent of its electricity needs from alternative energy sources by 2021. Our efforts to support the Abu Dhabi government include the delivering of 10 MW at Masdar City and the 100 MW Shams 1 solar power project inaugurated in 2013. These and other projects have already proved the viability of solar energy in the U.A.E. A Masdar-led consortium is also the selected bidder to develop the third phase of the Mohammed Bin Rashid Al Maktoum Solar Park in Dubai, involving the development of an 800 MW photovoltaic array, the largest of its kind in the region. At Masdar, we understand that bringing about a sustainable future is not only about investment. It is also a mix of innovation, knowledge transfer, research & development, and awareness building. The Masdar Institute of Science and Technology, the nucleus of Masdar City, is teaching and mentoring the next generation of leaders in renewable energy and clean-tech through its world-class curriculum. In addition, Masdar is the Middle East's largest exporter of renewable energy and has the potential to export our expertise in urban su-

tainable development to other parts of the U.A.E., the region and overseas.

What are the opportunities of the project in terms of innovation, especially for energy consumption and the possibility of reducing energy dependence from fuels?

Diversifying the global energy mix is critical if we're to meet rising electricity demands, address energy security and build a sustainable future. Renewable energy is part of the future, and the U.A.E. is poised to maintain its leadership in the energy sector. In fact, we recognize the economic, social and environmental benefits to developing and deploying renewable energy. The world will continue to rely on fossil fuels for the foreseeable future—but balancing the energy mix and introducing cleaner forms of power is necessary to enhance our energy security and to promote sustainable development. Masdar City uses clean energy generated on site from rooftop solar panels and a 10 MW solar power plant supplying the national grid. The plant produces 17,500 MWh of clean electricity annually—enough to power more than 1,000 homes—and diverts 15,000 tons of carbon emissions per year. Pilot research projects located at Masdar City, many of them led by or closely involving Masdar Institute scientists and students, are accelerating the acquisition of scientific knowledge in the clean-tech industry and paving the way towards the development of real-world commercial applications.

Do you think that Masdar City project will be exported abroad in the future, i.e. to highly polluted areas such as Western and Asian cities?

Masdar has been a global flagship for Abu Dhabi and the U.A.E. We have achieved ten years of innovation, and this inspires us to set our sights even higher for the next ten. The design and innovation process applied at Masdar City to develop a city with a low carbon footprint could be applied in many other locations around the world. With more than half of the world's population (of 7.3 billion) already living in town and cities, and with the total population expected to reach 9 billion by 2030, Masdar is applying technologies and solutions aimed at minimizing the environmental impact of urban communities and providing a viable template, or "greenprint," to accommodate greater urban population density more sustainably. We hope to inspire and help others.

Work in progress

● **Eco-Villa prototype**, an advanced design that will be offered either as a 'standard' design using only 97 KWH per square meter per year, or in a 'Net Zero Energy' format that deploys 80 state-of-the-art PV panels to generate 40,000 kWh of renewable energy each year – thereby enabling this villa design to achieve a net zero energy annual performance;

● **The Masdar Solar Hub Photovoltaic Test Centre**, which provides independent and accurate measurement of the performance, reliability and durability of PV modules, the coatings of PV modules and other PV related equipment;

● **The Masdar Solar Hub: CPV Testing Facility**, an initiative testing of CPV systems under Abu Dhabi's environmental conditions to facilitate the design of future CPV technology and deployment of CPV technology in the wider Middle East region;

● **The Electric Energy Storage Solutions Hub**, a project developing Redox Flow Batteries (RFBs) that will offer more effective electrical energy storage as chemical energy which could then be converted back into electrical energy when needed;

● **The Smart Home Energy Management System** for the Masdar City Eco-Villa, a project developing intelligent control algorithms to help ensure optimal energy use for the benefit of home occupants;

● **The Masdar Institute for Science and Technology Field Station**, an advanced, stand-alone building facility with advanced water-cooled chiller and a double enthalpy wheel air-handling systems; day-lighting systems using two sun-tracking daylight collectors on the roof that collect sunlight, and building-integrated PV panels;

● Research into the feasibility of District Cooling Powered by **Geothermal Energy for Masdar City**, involving into systems within which cold water produced by cooling systems can be stored and reused to help cool a building during high-usage periods.

Africa/Governments and institutions working for changing energy future

A virtuous commitment

The countries of the continent must create a modern infrastructure network and increase their use of renewables to expand access to electricity. This is a hard challenge, because they are simultaneously attempting to meet rising demand and extend energy to those who don't yet have it



African oil&gas

	2014	2015	% CHANGE
OIL	PROVEN CRUDE OIL RESERVES [million barrels]		
	127,334	128,049	0.6%
	ACTIVE RIGS		
	265	205	-22.6%
	CRUDE OIL PRODUCTION [1,000 b/d]		
	7,135.6	7,072.8	-0.9%
GAS	REFINERY CAPACITY [1,000 b/d]		
	3,490.8	3,490.8	0%
	OIL DEMAND [1,000 b/d]		
	3,904.2	3,992.7	2.3%
	CRUDE OIL EXPORTS [1,000 b/d]		
	6,071.4	6,178.1	1.8%
GAS	IMPORTS OF CRUDE OIL [1,000 b/d]		
	801.5	660.7	-17.6%
	PROVEN NATURAL GAS RESERVES [bn standard cu m]		
	14,705.2	14,665.5	-0.3%
	MARKETED PRODUCTION OF NATURAL GAS [m standard cu m]		
	215,420.7	211,146.4	-2.0%
GAS	NATURAL GAS EXPORTS [m standard cu m]		
	89,437.0	85,769.4	-4.1%
GAS	NATURAL GAS DEMAND [m standard cu m]		
	129,146.5	129,864.6	0.6%

Source: OPEC

ATEF MARZOUK

Head of Unit of the Energy Department of the Infrastructure and Energy Commission of the African Union since November 2015, Marzouk was previously Senior Policy Officer at the Department of Renewable Energies for infrastructure and energy as part of the African Union Commission.

are suffering from a crisis that shook the global economy and is leading the world towards a "disruption," a change of course that involves many individuals and industries. This disruption is caused by many inter-related factors tied to the processes of technological, political and economic change sweeping over the world of energy. In this article, I will propose that future energy is not only affected by climate change and resource scarcity. Rather, there are other elements that contribute to "disruption," elements that involve changes in technology, demographic and social change, shifts in global economic power, and rapid urbanization. The era of the non-renewable, extraction-resource-based energy sources will not end solely because the world is running out of petroleum and natural gas. Rather, this era will end because of the implementation of superior technologies and innovations that are more efficient and environmentally friendly. The disruption taking hold in the power sector is just the start of an energy transformation; accordingly, international organizations and companies need to fully factor into their strategic planning the megatrends and changes that might take place in this sector. Climate change and resource scarcity are considered the main ingredients that shape power market policy. The energy sector as a whole is responsible for about two thirds of global greenhouse emissions, with just over 40 percent of this stemming from power generation. Accordingly, a growing emphasis on renewables is a response to both climate change and security of supply concerns. Currently, there are many countries shifting their power supplies into a more eco-friendly renewable energy sources; for instance, in the U.S. alone, over 30 percent of new electricity generation capacity added in 2010-2013 involved solar and wind power. Solar photovoltaic (PV) is now utilized in more than 1.2 million Australian homes. In Germany, renewables accounted for 24 percent of gross electricity consumption in 2013, placing the country slightly above the growth

trajectory needed to reach its 2025 target of 40 to 45 percent. All these transformations clearly justify the disruption now taking place that focuses on shifting our energy resources into more renewable ones. Unfortunately, this transformation is more difficult for developing countries, many of which face the triple challenge of meeting existing demand for electricity while at the same time facing huge demand growth and the need to extend access to those who don't have electricity. Consequently, technological advances are critical for enabling this response as well as considering approaches for expanding power in ways that can leapfrog the traditional grid evolution route.

Demographics and technology: the factors that will make the difference

Technological breakthroughs are at the heart of the changes occurring in the power sector. Some components of the old incorporated framework are becoming stranded, and it's necessary to locate advanced alterna-

tives that recognize and utilize better technology. In numerous situations, renewable energy is supplanting fossil fuel generation due to the fact that transformative technological breakthroughs are being taken more and more seriously. Smart grids are leading to better interactivity with customers. Different advancements, prominently the blend of the internet, cell phones, information investigation and cloud computing with smart grids and smart metering, present open doors for service organizations to get nearer to the client, play an improved 'energy partner' part, and present adventure data opportunities. Analytics capabilities should be a central concern if organizations are to fight off rivalry from new participants who have these capacities at the heart of their business.

Demographic changes are strongly influencing energy transformation. By 2025, the world will have added another billion individuals to reach a total of eight billion. Unstable population increases in some regions set

against decreases in others contribute to different power market development potential in various parts of the world. Africa's population is expected to increase twofold by 2050, while Europe's is projected to shrink. Despite the fact that the prize for power companies that serve growing populations is a major one, the infrastructure challenge in numerous nations is colossal, and not all growth markets are promptly open to worldwide extension. Companies trying to model themselves on the policies of faster-growth nations will need a clear understanding of the influence of energy transformation on these nations. The possibility of bypassing the grid and jumping to new local circulated innovations and business sector models is not implausible if the pace of technological advance increases and cost decreases continue.

The role of the international capitals and the new urbanization

Energy disruption can also be traced to a shift that has taken place in

global growth that has resulted in a shift in economic power. We are already witnessing significant east-west and east-south venture streams in the power markets, ones involving both financial investors and power sector corporate investors. For instance, Chinese state-owned power and utilities companies have been dynamic in their search for international power utility and grid investment opportunities. Europe, South America, Australia and parts of Asia have all been targets for development. Sovereign wealth funds and pension fund investments in the sector have also become multi-directional. The challenge for many power companies is to access scarce capital from this worldwide stream of capital, minimizing the risk of stranded investments, and looking for imaginative methods to secure investment in replacement assets. Last but not least, urbanization will increase over the next few decades. By 2050, the world's urban population will have grown to no less than 2.5 billion, 66 percent of the world-

wide populace. Quick urban expansion introduces a challenge and an open opportunity for power utility companies. The pace of urban growth will put a huge strain on infrastructure development. However, power companies can play a vital part in guaranteeing future urban areas get to be 'urban brilliant' as opposed to 'urban sprawl.' They can possibly be lead players in the development of future city infrastructure; however, this will require a new mindset, another outlook, and the development of new partnerships.

Energy development programs in Africa

In the past, the energy needs in Africa have grown relatively slowly compared to the rest of the world, but now, due to the modernization of Africa's economies coupled with social progress, energy demand in Africa is growing fast, at an average of 5.7 percent annually. The continent's per capita energy consumption is expected to rise to 1,757 kWh per capita by 2040. This translates to an unprecedented 3.7 percent increase per year. Accordingly, Africa is now undertaking a major challenge in terms of financial and technical capacity to achieve this level of development. Another challenge is to meet the continued and increasing dependence on petroleum products from continental resources through the development of refineries supplied by African crude oil and the installation of pipelines to transport the increased volume of petroleum products.

The biggest challenge in the energy sector is how to accelerate access to sustainable modern energy services in Africa where there are numerous barriers that include:

- Inconsistent levels of political will across countries,
- Lack of effective policy, regulatory and institutional frameworks
- Unattractive energy market to potential investors due to poverty,
- High investment costs,
- Low technical skills and implementation capacity,
- Inefficient databases and information systems at different levels of member states, RECs and the continent.

The main issue in the energy sector is how Africa can convert its huge energy resources into sustainable and modern energy services to meet basic human needs and other productive uses. The African Union Commission (AUC) is taking steps to increase the access to modern energy services through several initiatives that include:

- 1 The Program for Infrastructure Development in Africa (PIDA),

which is a consolidated continental program of the partnership between AUC, the African Development Banks (AfDB) and NEPAD-NPCA dedicated to facilitating continental integration through improved regional infrastructure. The implementation of PIDA is prioritized and divided into three phases: Short-term (2012-2020); Medium-term (2020-2030); and Long-term (2030-2040). The PIDA program covers four sectors that include Energy, Transport, Information & Communication Technology (ICT) and Water (Trans-boundary). Priority Action Plans (PIDA-PAP) for this program have been developed, which work on quick-win projects that are to be implemented in the short-term. PIDA was approved by the African Union (AU) Assembly during the eighteenth ordinary session of the AU held in Addis Ababa, Ethiopia, in January 2012 with the objective to transform the infrastructure landscape of Africa and contribute to the building of the African Economic Community outlined in the 1991 Abuja Treaty. The PIDA-PAP has 15 Energy programs/projects including nine hydropower projects to generate the required energy and to increase access to electricity, four regional transmission power lines to connect the continent's power pools and permit a large increase in inter-regional energy trade and cooperation, one oil pipeline and one gas pipeline.

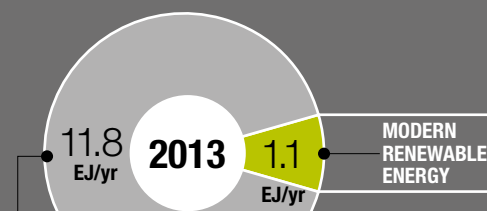
- 2 The Geothermal Risk Mitigation Facility (GRMF), which was established by the African Union Commission (AUC), the German Federal Ministry for Economic Cooperation and Development (BMZ), and the EU-Africa Infrastructure Trust Fund (EU Africa ITF) in cooperation with the German government-owned development bank KfW. The overall objective of the GRMF is to encourage public and private sector developers by providing grants for partial financing for surface studies and drilling for reservoir confirmation in order to mitigate the risk associated with geothermal resource exploration. The GRMF project phase 1 targeted five pilot countries that include Uganda, Kenya, Tanzania, Ethiopia, and Rwanda. The second phase, announced last year, increased the number of countries to include Burundi, Comoros, Eritrea, The Democratic Republic of Congo (DRC), Djibouti and Zambia.

Africa green

Cumulative investment needs between 2015 and 2030

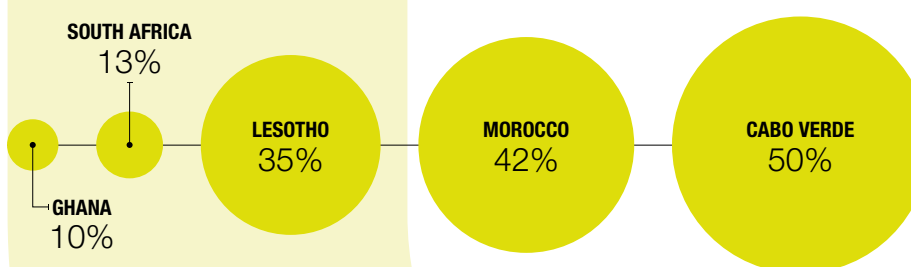
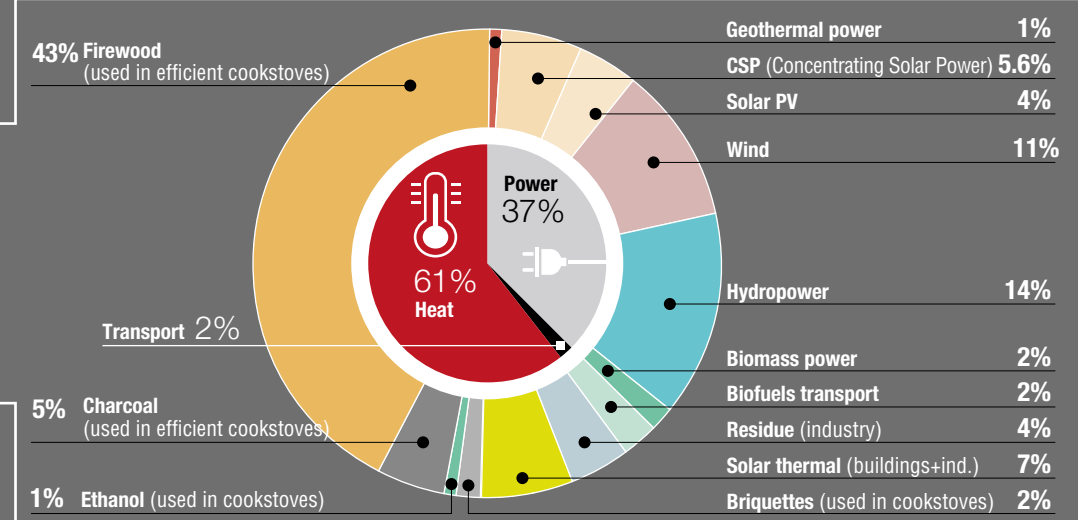
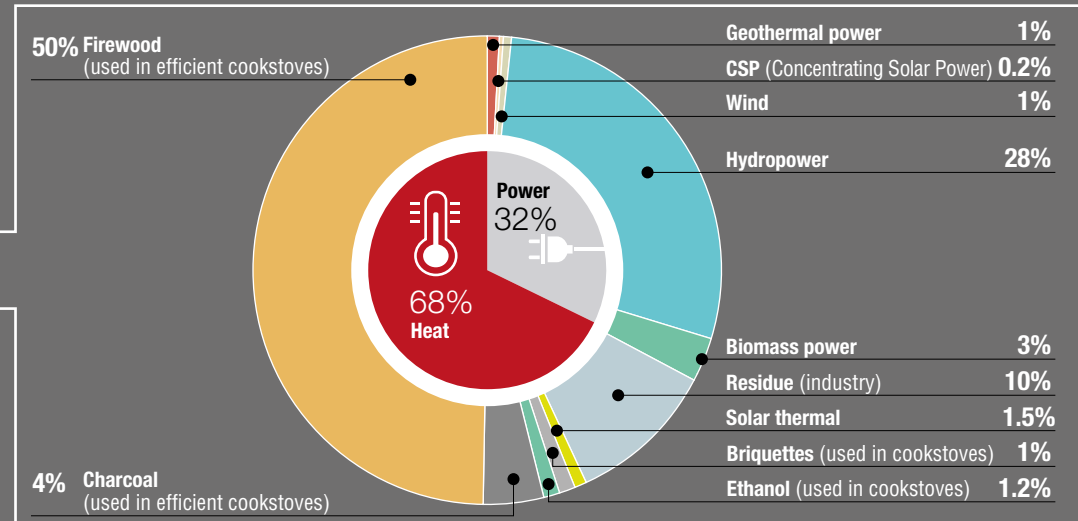
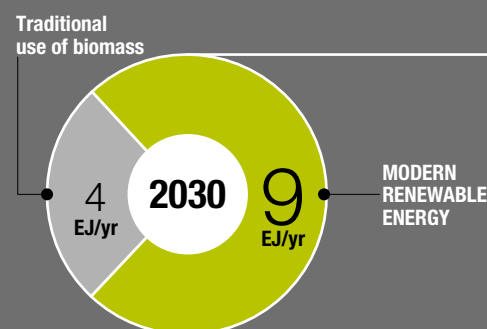
Investment billion USD (2015 – 2030)

	ALL GENERATION	OTHER RENEWABLES	LARGE HYDRO	T&D
North Africa	342	2	218	186
West Africa	89	36	31	52
Central Africa	32	13	17	14
East Africa	72	36	21	49
Southern Africa	145	18	94	74
Total	681	106	381	375



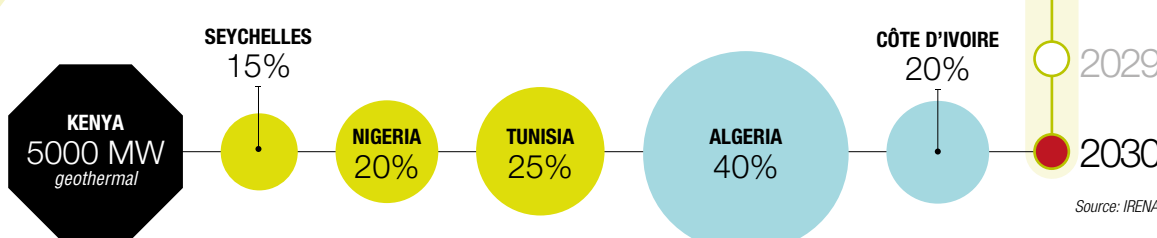
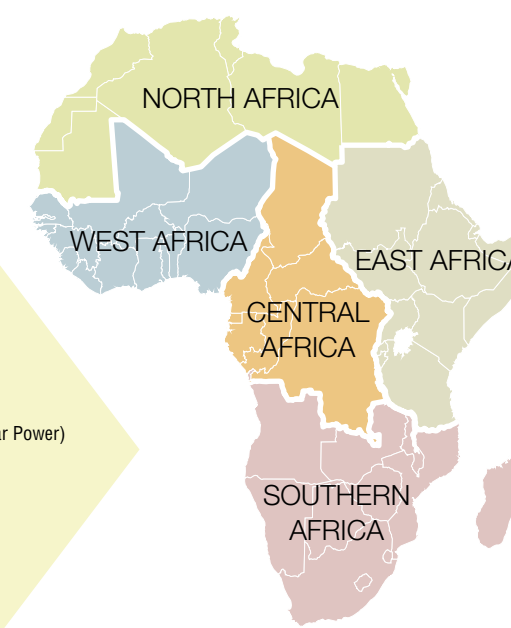
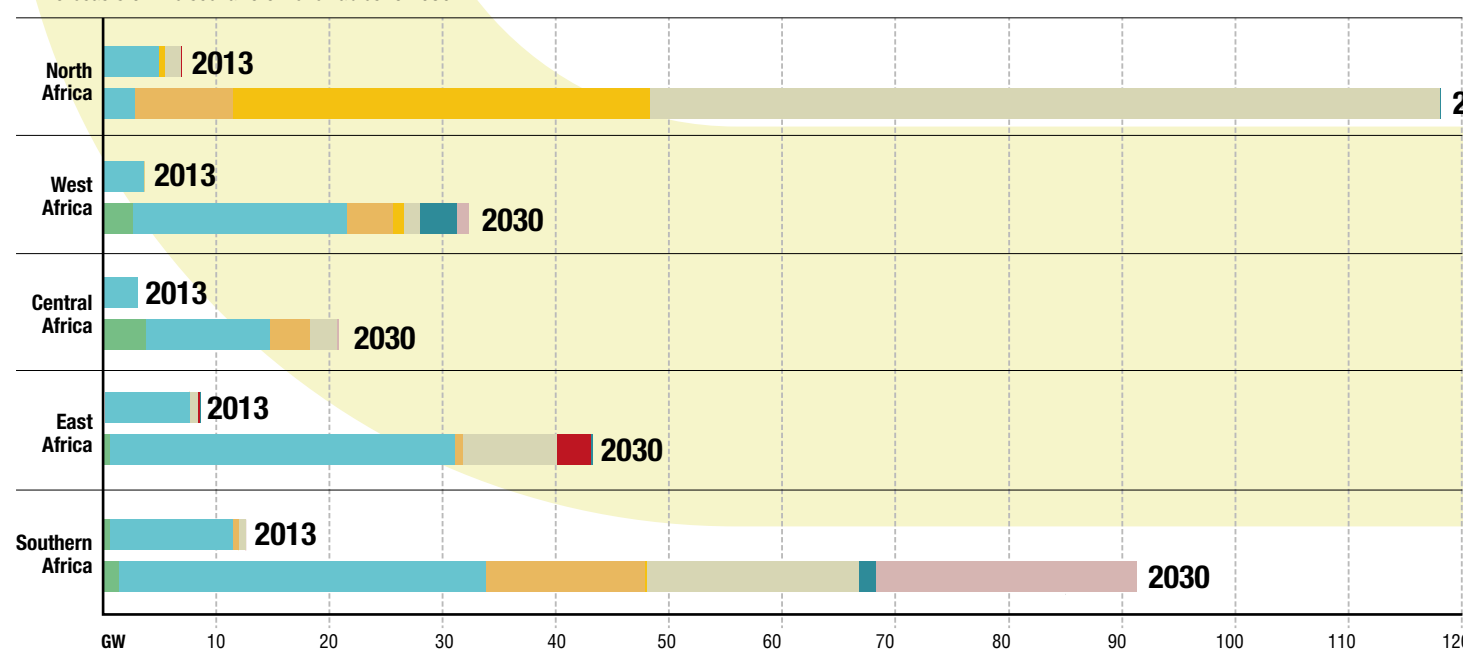
Modern renewable energy use in 2013 (above) and 2030 (below)

EJ = exajoules yr = year



Capacity development of REmap Options in 2030

The REmap 2030 is the Renewable Energy Map, a report drafted by IRENA with forecasts on the scenario of renewables to 2030



Renewable energy targets of African countries

Share of total energy
Share of electricity
Planned capacity

n.a.

2010

2011

2012

2013

2014

2015

2016

2017

2018

2019

2020

2021

2022

2023

2024

2025

2026

2027

2028

2029

2030

Source: IRENA

THE POWER OF WATER

One of the measures taken by the African Union Commission (AUC) to increase access to modern energy services, is the "Hydropower" program, aimed at driving the development of major water projects in the continent. The photo shows a hydroelectric dam in South Africa.



- 3 | The African Bioenergy Policy Framework and Guidelines is a joint initiative of the African Union Commission (AUC) and the United Nations Economic Commission for Africa (UNECA), which was initiated in 2010 to enhance energy security and access, as well as rural development in Africa. This Initiative aims to provide principles and guidelines for RECs and African countries to guide policies and regulations that promote a viable sustainable bioenergy sector. This project has now reached a level where the following is going to take place:
- To publish and launch the African Bioenergy Policy Framework and Guidelines;
 - To organize a workshop to mainstream gender issues in the Policy Framework and Guidelines;
 - To build capacities of governments and RECs; and
 - To identify high priority bioenergy programs in Africa to be developed to bankable level.

- 4 | The Program for Solar Energy Development in Africa was man-

dated to the AUC at the 14th AU Summit to prepare a study for exploitation of solar energy potential in the Sahara Desert. The first phase of the study for the Sahara and Shale region was completed, validated and adopted at the AU January 2011 Summit. The second and third phases of the study are on-going for the Kalahari and Ogden deserts, respectively.

- 5 | The Hydropower Program is where the AUC has carried out a study aimed at stimulating the development of major hydropower projects on the continent. Under this program, the AUC organized a training workshop specifically for the Inga III project on how to model a Public-Private-Partnership for the Ministry of Energy and the Power Utility (SNEL). Now the government of DRC is following this model to negotiate with three private sector entities to develop the project.

- 6 | The Africa-EU Energy Partnership (AEEP) is one of the eight partnerships of the EU-Africa Joint Strategy with focuses on

three areas of energy access: Energy security, renewable energy and energy efficiency with the following indicators:

- Bringing access to modern and sustainable energy services to at least an additional 100 million people.
 - Increasing the energy security by doubling the capacity of cross border electricity interconnections; and doubling the use of natural gas in Africa, as well as doubling African gas exports to Europe.
 - Increasing renewable energy by 10,000MW of new hydropower, at least 5,000MW of wind power, 500MW of solar energy; and tripling other renewable energy sources such as geothermal energy and modern biomass, and improving energy efficiency in all sectors.
- The current status report shows that the targets will be achieved as indicated through the ongoing projects and also projects in the pipeline that have 25,230MW of hydroelectric power, 3,490MW of wind power, 3,100MW of solar power, 4,570MW of geothermal

and 4,780MW of other sources like bioenergy. Both the European and the African entities are heavily involved in delivering on these developments with the European Investment Bank and the African Development Bank among those committed to providing more resources.

- 7 | Other Initiatives Supporting the Energy Sector and Involving AUC include:

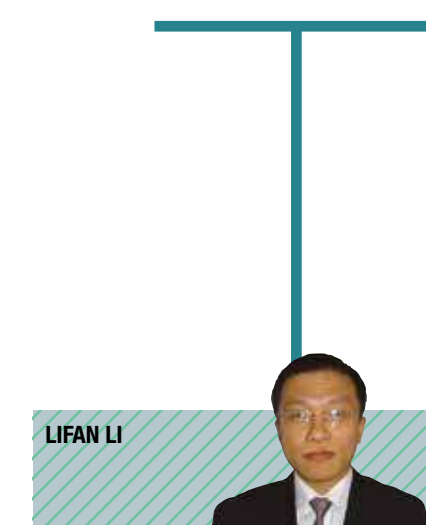
- Sustainable Energy for All (SE4ALL), whose objectives include ensuring universal access to modern energy services by 2030, doubling the rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix. The AUC is actively involved in this Initiative as part of the Africa Hub on SE4ALL agenda in Africa.
- Regional Power Pools initiated by the RECs to develop integrated regional energy infrastructure and markets.
- Energy Expansion Agenda from Member States who have programs and projects aimed at improving energy access in the urban and rural areas.
- Power Africa Initiative, which is a program from the USAID that started in 2013 and is in its early stages of preparing to work with Ethiopia, Ghana, Kenya, Liberia, Nigeria and Tanzania with the target to add more than 10,000MW of clean, efficient electricity generation capacity and to make electricity access available for 20 million people and commercial entities.
- International Renewable Energy Agency (IRENA), which has a program on Clean Energy Corridor for the Eastern and Southern Power Pools that started in 2013 and intends to accelerate the production of electricity from renewable energy source in Africa with the intention to expand to the rest of the African regional power pools. They also have a program of Global Atlas for Renewable Energy that is collaborating with AFREC in mapping out the energy resources on the continent.
- The World Bank development in the Great Lakes Region, together with the RECs, is supporting regional infrastructure and catalyzing economic development; initiatives include energy projects of the Ruzizi Hydroelectricity project and the East African oil pipelines.



China/Lingering questions about the transition to renewables

The Dragon's skepticism

Beijing may focus in the near term on making the current system more efficient rather than taking definitive steps toward transitioning to sustainable energy



LIFAN LI
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The oil price war, which began at the end of 2014, initiated the decline of the entire oil industry, and China, India and other consumer countries have benefitted from lower crude oil prices. China, for example, imports approximately 7 million tons of crude oil every day; so whenever oil prices drop \$10, the country saves CNY 400 million. In the future, the Asian region will continue to develop energy sources, with the result that the previous model of "competition for energy in East Asia" will weaken. Cooperation in the energy industry in northeast Asia or in the entire continent offers important opportunities for funding and resources. Natural gas consumption is increasing in most Asian countries, but many gas fields are located in remote locations, and for this reason Iran find itself in a uniquely advantageous position. If Iran manages to rapidly enter the Asian natural gas market, the prospects for cooperation between Asia and the Middle East will increase.

The effects of the global economic crisis on China's development

The slowdown in the growth of China's GDP has not only affected the performance of the entire country's real economy but has also caused turmoil in global financial markets. In the first quarter of 2016, the increase in China's GDP was 6.7 percent, down from 6.8 percent in

ChinaGreen

■ 2014
■ 2015
● % CHANGE 2014-2015



TOT. RENEWABLES ENERGY*

+14.5 %

454,007 MW

519,748 MW



HYDROPOWER

+6.4 %

301,830 MW

321,230 MW



MARINE ENERGY

0.0 %

4 MW

4 MW



WIND ENERGY

+26.6 %

114,604 MW

145,104 MW



SOLAR ENERGY

+53.5 %

28,061 MW

43,062 MW



BIOENERGY

+8.9 %

9,480 MW

10,320 MW



GEOTHERMAL

0.0 %

27 MW

27 MW

* The renewable power capacity data shown in these tables represents the maximum net generating capacity of power plants and other installations that use renewable energy sources to produce electricity.

Source: IRENA

the fourth quarter of 2015, and such a low increase had not been recorded since the first quarter of 2009. The growth rate of China's GDP for the whole of 2015 was 6.9 percent. Until the development of China's industrial manufacturing sector, there had been a positive trend, although the use of raw materials, machines, and other factors were equally high. In contrast, with the slowdown of the national economy, imports from Chinese companies have started to decline. In April this year, Chinese imports fell by 10.9 percent, to \$127.2 billion, a significant drop of 30.6 percent when compared with the peak of March 2013. The decline in Chinese demand has contributed to the decline in exports in international markets. The phenomenon is particularly evident in the Chinese energy sector, since crude oil imports account for 6 percent of the country's total imports. According to data from the Energy Information Administration, crude oil imports from OPEC account for 58 percent of total Chinese crude oil imports. Of these, most come from Saudi Arabia, amounting to 16 percent. Following the collapse in prices, the proceeds of Saudi Arabia's oil industry have seen a sharp decline, forcing the government to make cuts to public spending. Currently, with the Chinese economy's transition towards the tertiary sector, the growth in energy demand is in decline overall. Added to this are the research and development of renewable energy sources worldwide, which will further increase crude oil consumption in China. Beijing is also promoting the diversification of import sources, a further challenge for oil producers in the Middle East. The country has already replaced its supply from Sudan, Iran and Syria by boosting its oil trade with Russia. In the future, the share of crude oil imported from Saudi Arabia, Angola and Oman will be reduced to some extent, always to Russia's benefit. Although the lower oil prices could encourage a significant increase to China's consumption, in the first quarter of 2016, Saudi exports to China increased by only 7.3 percent. In the future, OPEC member countries and non-OPEC countries such as Russia, Kazakhstan and Iran will continue to compete with each other

for Chinese market share. With the start of 2016, China increased its imports of cheap energy from Iran, further influencing the international crude oil market, and the competition for the Chinese market could undermine the cohesion of OPEC countries.

The oil and gas industry countries in China and abroad are taking steps to adapt to the new situation and address the serious problem of the prolonged fall in international oil prices. Their actions include "complete programs to optimize resources, reduce costs and increase efficiency," by lowering the cost of supplies through the revision of contracts, reducing staff to control labor costs and fees for executives, and initiating programs to improve production efficiency. At the same time, in order to cut costs and improve efficiency, the industry's foreign companies are implementing the "second use" of oil fields, effectively reducing the decline in productivity of old oil fields, increasing the recovery rate in the concession period and aiming for maximum production efficiency. Prospecting activities abroad focused on highly efficient oil fields, and ongoing oil and gas research lead to many new discoveries. Foreign companies in the oil and gas industry initiate cooperation projects, which minimize the work required, the prospecting period, and the extent of the research. Exploration is focused on the rapid exploitation of oil fields, such as those in Africa, and the number of high-risk geological projects is being reduced, especially as regards investment projects in the Middle East. To lessen the volatility of international crude oil prices, Chinese energy companies (mainly CNPC, SINOPEC and CNOOC) have launched the "Go Out Policy" strategy, by increasing mergers with and acquisitions of foreign energy companies. In 2015, CNPC boasted over 90 oil & gas cooperation projects in over 30 countries and has supported projects for new gas pipelines between Iraq and Central Asia and between China and Myanmar. The SINOPEC group operates in 27 countries worldwide, with 53 cooperation and investment projects in the six major oil and gas field regions: Africa, America, Middle East, Russia, Central Asia and Asia-Pa-

cific. It is also cooperating with Russia's Rosneft in two oil and gas fields in Russia, with a 49 percent stake in the companies. CNOOC's foreign activities account for 39 percent of the company's assets; its oil and gas production for abroad accounts for 42.3 percent of this total and the company has signed 206 cooperation agreements with 79 oil companies in 21 countries and regions.

Renewables: Beijing's new passion

Moreover, following the climate conference in Paris, China continues to pursue "South-South Cooperation" projects. The country has signed a bilateral memorandum of understanding with Egypt and Iran and has begun a program that donates material and ecological and sustainable devices to various countries. Also, in the period 2016-2017, it will continue to organize courses related to climate change by providing training centers in developing countries. In the meantime, the "Chinese Fund for the South-South Cooperation on Climate Change" has already started. Through the training of staff on climate monitoring, this fund promotes green technologies in underdeveloped countries, in the islands, in African countries and in other developing countries. In order for the great Chinese energy transformation to be realized, it is essential that China controls the production of electricity from coal and improves the regulatory framework on energy efficiency by optimizing its policies to the "level of demand." By 2025, China will have to improve its subsidies policy by gradually reducing funding for fossil fuels, increasing incentives for renewable energy consumption, establishing reasonable quantitative indicators for amounts, and managing the efficiency of renewable energies. At a later stage, between 2025 and 2035, the country will have to strengthen and enhance its objectives related to the amount of renewable energy, further promote the development of sustainable energy, and, in areas where conditions are particularly favorable, reach an electricity supply of at least 60 percent from renewable energy. In the third stage, between 2035 and 2050, it will be necessary to continue to promote

the development of renewable energy, strengthen and improve energy efficiency standards, and apply low-carbon green technologies on a large scale. This is how the great energy transformation will be achieved in China. Clean energy devices represent one of the main directions for the development of energy equipment. The full exploitation of special construction funds for energy creation, of the investment fund for the advanced manufacturing industry, and of the national venture capital fund for emerging industries will support the research, industrialization and improvement of conditions for producing essential technologies. By 2020, the energy equipment production industry will become a new driving growth factor for Chinese industry. The technological level and competitiveness of electrical equipment and of other high-tech sectors will ensure international leadership, leading to the formation of groups of manufacturing businesses with the ownership of intellectual property rights and characterized by greater competitiveness.

The decisive development of the "energy transition" focused on alternatives to fossil fuels and the reduction of carbon emission, thanks to renewable energy sources already at the center of many national energy policies. In China, however, the current conflict between the "need" and the "economic feasibility" of the development of renewable energies, the obstacles to this development created by interest groups for traditional energies, and the disagreements on the development path make a program for replacing fossil fuels with renewable energy difficult to effect. There has always been a paradox in the country regarding energy transition. On the one hand, there is an emphasis on the development of renewable energy at a theoretical level, and policies continue to be introduced to support renewable energy. On the other hand, there are questions about how to change the existing energy system and to what extent the national energy structure, focused on coal, will be able to accept the challenge, and when the country will cease to provide subsidies for natural gas. Changes to policies are a subject of enormous resistance and pressure,

and the obstacles to reform are as follows:

- 1 The issue of China's energy transition is managed by various ministries and commissions, and each ministry autonomously establishes, within its area of competence, priorities, orientation and times. The trend and effects of the policies relating to the energy transition are not subject to any macro-level analysis or scientific assessment. Numerous policies have been introduced, and there are many problems related to the energy transition, but no ministry is able to come forward to correct and resolve the situation.
- 2 The current reform of the energy system does not reflect the orientation and needs of the energy transition. The problem involving the failure to open the market in the Chinese energy system, based on poor distribution efficiency, is extremely serious. The vigorous promotion of greater openness is already the goal and requirement of energy system reform.
- 3 The traditional energy giants (i.e. the various interest groups) cannot pursue the advancement and processes of the energy transition. The traditional energy giants are of course the key players in the energy transition, but the direction and progress of the transformation cannot be dictated by the electrical companies and by other traditional fossil fuel giants, as they can derive economic benefits from slowing down the transition process. Only if the transforma-

tion is led and pursued by the state, with the adoption of framework laws and policies in support of energy transition, will it be possible to prevent the advancement and pace of the energy transition from being dictated and undercut by the traditional fossil fuel giants.

- 4 Investments in the energy sector must go beyond the pursuit of "short-term effects" or the "change of pace but not of substance." The energy system of the next 50 years depends on today's investments. The global economy is, overall, unstable: economic recovery seems a utopia and, at this stage, further investment seems unfeasible. Current investments in the energy sector must meet the needs of the energy transition, and errors can not be allowed. Otherwise, in the future, the costs of the energy system transformation will be much higher.

Although the direction of the energy transition is similar in every country, the availability of energy resources and the political structure change and determine the differences at a national level. Therefore, it is necessary to pay attention to the development problems of the transition to renewable energies in China: First, there is a huge gap between the need and the urgency of the development of renewable energies and the economic feasibility of the transition. The plans of use and energy transition are a product of market competition. Currently, the transi-

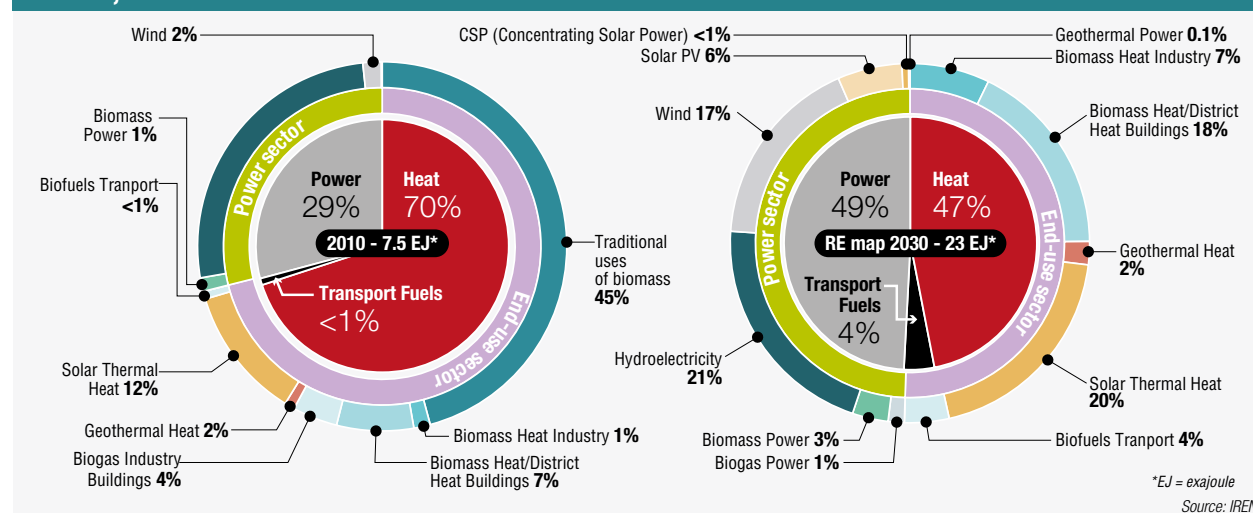
tion to renewable energies, on a global level, is taking place in the wake of the new international guidelines that require China to address climate change and the policies on "carbon emissions" approved by the western countries. The replacement of fossil fuels with renewable energies is taking place in an environment that still has great potential for improving the efficiency of fossil fuels. Since the replacement of high-density energy with a low-density energy for "decarbonization" is able to grow the economy, there must be clear differences between developed and developing countries in terms of transition levels and rate of efficiency.

Moreover, is the reform of the current energy systems capable of acquiring new "suitable" features in terms of the development of renewable energies? The large-scale production, consumption and transport of traditional fossil fuels are closely related to the high energy density, storage possibilities and uneven distribution that characterize them, while the wide distribution, low energy density and impossibility of storing wind and solar energy will ensure that local production and consumption models represent the best choice. In China, the current energy systems, fully corresponding to the features of fossil fuels, cannot consciously transform into energy systems adapted to the features of renewable energies, since traditional energy companies often voluntarily hinder this process in favor of their own short-term interests.

Still, how can we scientifically define an indexing system for the new energy sources? The definition of energy indicators is a complex scientific and political process. China needs to assume clear assessment criteria, especially for investments in clean energy. It is necessary to understand that the actual value of the investment in renewable energy must not exceed the cost. It is also necessary to pay attention to political objectives, that is, external dependence. Also, as regards the physical indicators of efficiency, the physical efficiency is lower than that of developed countries, and in many cases the energy savings will not be reasonable. The same applies to the indexing system. Finally, there is no single type of renewable energy, such as hydropower, wind power, solar power or biomass, that has the potential to become the main energy source. The transition to renewable energies requires the combination of many different elements. The technological features of the various types of renewable energies are not exactly the same: hydropower is essentially compatible with the current energy systems; wind power and solar power are more suited to a wide distribution of low-power systems; while biomass can be distributed or centralized. In order to bring these energy exploitation technologies into a "new" organic energy system, a large number of complex technical, organizational and institutional issues still need to be addressed.

As a responsible major power, China must adapt to the international economic situation, to the new features and changes of the energy market, by reducing costs and the loss of interest deriving from the energy transition. This transformation will bring with it some collateral damage, but the gradual introduction of new energies will open up the path to a revolution and profound changes for the entire Chinese industry, and will encourage the emergence of innovative sectors and modern production processes.

CHINA, RENEWABLE ENERGY USE 2010 AND REMAP 2030





Latin America/The potential for a bright future of the oil industry

The true flywheel will be a new policy

AN ENERGY EXAMPLE
Brazil has performed well in oil production over the last two decades, enough to be considered a model for regulatory policies of oil. In the photo, a view of Ipanema and Copacabana, Rio de Janeiro.

MEXICO -21%

reserves of oil equivalent (13.02 million barrels in 2014/ 10.24 million barrels in 2015) *Source: National Hydrocarbons Commission*

VENEZUELA -50%

values of petroleum exports 2015/2014 (35,802 million USD in 2014/ 71,731 million USD in 2015) *Source: Opec*

BRAZIL -3.8%

GDP growth rate 2015 *Source: World Bank*

ARGENTINA +23%

estimated increase of oil production by 2015 (from 531,000 bbl/d – 2015 to 653,000 bbl/d – 2015) *Source: IEA*

The area, which has always possessed a huge energy potential, has in recent years exhibited a disappointing performance, especially in terms of production of crude oil production. The true growth opportunity is in a clear administration, efficient and based on strengthening investment

FRANCISCO J. MONALDI

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The Americas, North and South, concentrate the largest hydrocarbon resource endowment outside of the Middle East. The Western Hemisphere has 33 percent of the world's proved oil reserves, while the Middle East holds 47 percent. The geological potential is enormous, but the remaining resources are largely unconventional (shale and extra-heavy oil) or in deep waters, so costs and risks are higher and technology/knowhow more crucial. In the U.S. and Canada, which hold 13 percent of the world's proved oil reserves, high oil prices fueled an energy revolution with substantial increases in oil and gas production. During the last ten years, oil production increased 73 percent, from 9.9 million barrels a day (mbd) in 2005 to 17.1 mbd in 2015. In contrast, in Latin America, with 20 percent of the proved oil reserves, oil production declined 7.2 percent, from 11.1 mbd to 10.3 mbd, and the region lost more than two percentage points of the world market share.

That is a remarkably poor performance, given that it happened during the largest oil price windfall in history. Using alternative measures of resource endowments, the same inescapable conclusion arises: the region's oil industry generally wasted a tremendous opportunity to grow. Latin America's striking underperformance was largely the result of production declines in three countries: Mexico, Venezuela, and Argentina, and was partly compensated for by production increases in Brazil and Colombia. However, even Brazil, the star performer of the last two decades, has recently underperformed, and its national oil company is in a serious predicament. The recent oil bust has hit the Latin America oil industry very hard; both investment and production have been falling rapidly throughout the region. The decline in production in 2016 could reach as high as 400 to 500 thousand barrels a day, a dramatic 4 to 5 percent fall in just one year, with Venezuela and Mexico again the

highest drops. However, it is important to stress that even though the troubles in the Latin American oil industry were made much worse by the collapse in oil prices in 2014, the problematic trends predate it. The oil price boom had been hiding unsustainable trends that are now painfully clear. If its geology is so attractive and prices were so favorable for more than a decade, what has been the source of the region's oil industry blues? The answers lie in the dysfunctional politics of oil, the cycles of resource nationalism, and the mismanagement of national oil companies. The cycles of short-sighted resource nationalism have been a recurrent feature of the oil industry in the region, damaging the long term potential of the sector. During the boom years, 2003-2014, Argentina, Bolivia, Ecuador, and Venezuela, forcefully renegotiated contracts and/or nationalized the oil sector. Mexico remained a closed and inefficient state monopoly, missing a great opportunity

to attract private investment to its oil industry. Although Brazil did not change contracts retroactively, it made future deep-water projects much less attractive. Even in Colombia, the only relevant oil producer that did not worsen contract conditions, the overall policy environment turned less welcoming to oil investors. Thus, to an extent, foreign investors were victims of the price boom and their own success in increasing production and reserves, particularly in oil exporters. In turn, as a result of the problematic trends facing the oil industry in the region, a new wave of liberalization began to surface even before the oil price collapse; and as expected, these trends significantly strengthened with the financial troubles faced by countries and their NOCs after the bust. However, the reputational costs of the highly volatile institutional frameworks would make it even harder to attract investment and develop the region's full potential. Another key reason for the region's

underdeveloped oil industry has to do with the inefficiency, underinvestment, and corruption which have plagued its dominant players: the national oil companies (NOCs). Brazil, Mexico and Venezuela produce 3 out of 4 barrels in the region and contain more than 90 percent of its reserves, so what happens in these three countries is crucial for understanding the future of the world oil supply. Their NOCs are the largest in the region and among the largest in the world. PDVSA (Venezuela), Pemex (Mexico), and Petrobras (Brazil) are currently in deep financial trouble, made worse by the oil price fall, but they were all on an unsustainable path long before it happened. PDVSA was gutted by Hugo Chávez after he fired most of its senior management and technical staff. Since then, production has been declining, despite having by far the largest oil reserves in the region. Pemex, until recently an oil monopoly, underinvested for decades, which led to a sharp reserve decline and

eventually to a production collapse starting in 2005. Overstaffing, corruption, and politicization have been historical problems for Pemex, as they are now, to an unparalleled extent, for PDVSA. Petrobras long a symbol of national pride for Brazil, one of the few NOCs capable of operating deep-water projects, has been involved in a spectacular corruption scandal that has rocked the country's political system.

VENEZUELA.

The colossal basket case

In Venezuela, a successful opening of the oil sector paradoxically helped to create the conditions that led to oil nationalization; while the stagnation of the industry, in turn, is restoring pragmatism to deal with the decline. In the 1990s, facing low oil prices, recurrent fiscal crises, and significant investment needs, Venezuela opened the oil sector to private investment in the riskier and less profitable projects. This was a major departure from the nationalization in 1975, which had made state-owned PDVSA the monopoly producer. The opening attracted significant investments by major international players, including Exxon, Shell, BP, Chevron, Total, and Eni, leading to a substantial increase in production of more than one million barrels per day (equivalent to more than 40 percent of current production levels).

In 1998, Hugo Chávez was elected president with a resource nationalist rhetoric, just when prices bottomed out, but he did not change the existing oil deals until 2005, after all major investments had been made and prices had swung up significantly. The protracted and confrontational expropriation process that ensued significantly increased the government-take on profits. It also affected Venezuela's reputation and attractiveness, delaying all major new investments and generating very high opportunity-costs in terms of foregone future production. Lately, as production faltered and the regime became desperate for more revenues, realism pushed the government to offer investors better terms and guarantees. Although investors continued to be very cautious, the change in the Venezuelan government's attitude was palpable. The pragmatism—better described now as desperation—has become more obvious after the price collapse because of the urgent need to increase investment and production.

PDVSA, which had been considered one of the best run NOCs in the world, suffered a massive setback in 2003 when Chávez fired most of its management and technical staff, as a result of a power struggle that led to a massive oil strike. Since then, the

company has never fully recovered. It has a limited pool of qualified human resources and was able to avoid production collapse by relying heavily on foreign contractors and joint-venture partners in a favorable price environment. Nevertheless, the number of employees grew three-fold, while the production per-employee rapidly fell to its lowest level in history (to levels similar to Pemex's). Moreover, production operated alone by Pdvs has collapsed by more than half since its peak in 1998, and has only been partly compensated by the JVs with foreign partners.

The government has over-extracted resources from PDVSA. The company's financial debt increased from \$3 billion in 2006 to \$44 billion today and debts with suppliers are above \$20 billion. The company has also been borrowing heavily from the Central Bank to cover operational expenses in domestic currency. Overall, the situation of PDVSA—critical even before the price collapse—is now desperate, unless oil prices go back up. Only a major overhaul of the company and an intensive use of partnerships with the private sector can reverse its decline.

MEXICO. Production collapse brings reform, price collapse accelerates it

Mexico was an exception to the liberalizing trend in the 1990s. Historical and ideological reasons can help explain this exceptionalism, but the major factor behind the lack of reform is that Mexico's production kept increasing without significant new investments. The giant oil field of Cantarell, which produced more than two million barrels a day at its peak (or close to two thirds of the country's production), allowed the government to over-tax and conceal the significant inefficiencies of the national oil monopoly, Pemex. The future costs of the lack of investment were not perceived by the political leadership and even less by the general public, so there was no rush for reform.

Once Cantarell's production started to collapse in 2005, the need for reform became clearer, but high oil prices made it initially less urgent. However, as Pemex capital expenditures increased five-fold but barely slowed declining output, the case for reform became much stronger. Cantarell's production has declined more than 85 percent from its peak. With Peña Nieto's election, institutional gridlock eased, and reform was finally passed. Mexico, as Venezuela in the past, is opening the riskier and/or marginal projects, some of which require large investments and complex technology. Pemex kept most of the proved reserves

and all the high rent low risk areas, and so far, the first bidding round of oil areas has had limited impact. Few attractive areas have been assigned, and some bids have been unrealistically high, generating uncertainty over the magnitude of investments that will actually materialize. In December of 2016, the auction of deep-water areas is set to take place. This would be by far the most relevant event yet in the oil opening; there are high expectations that the upstream reform would finally prove meaningful with the allocation of areas with high potential to major oil companies.

In contrast to Venezuela, Mexico is building a much more robust institutional framework to support reform. It is also much more integrated into the world economy than its South American neighbors. These factors might deliver a longer life for the investment cycle. However, if the incentives for expropriation appear in the future, high oil prices, major discoveries, and high sunken investments; one cannot discard the possibility of a partial reversion to reform, especially given the enduring strength of nationalistic ideology in Mexico. In fact, the popular leftist presidential candidate Lopez Obrador has threatened to halt the reform if elected in 2018.

In 2015, Pemex for the first time had a loss before taxes, and it had to massively cut investments. As an indication of the extent of the cut, the number of oil rigs in operation fell from 44 in January 2015 to just 16 in July 2016 (a 64 percent decline). Rating agencies downgraded Pemex debt, and the government had to inject capital to Pemex to enable pay for suppliers and pensions. It also improved its fiscal regime to limit further financial strain and changed the leadership of the company with a mandate to cut costs, sell assets, and partner with private companies. The new CEO Jose A. Gonzalez Anaya, a highly respected economist, has moved swiftly to take advantage of the opportunities given by the new legal framework and move the reform further than initially planned, concentrating Pemex's limited investment capacity in the most profitable areas, while partnering, transferring, or selling non-core assets. However, the challenges of Pemex reform remain formidable, particularly for a weak lame-duck president like Peña Nieto.

BRAZIL. Still the country of the future?

Even though Brazil is still a net importer of oil, it has increased its production more than fourfold over the last two decades, matching the production levels of Mexico and Venezuela. That success is in large

Developments of oil production

U.S. & CANADA VS LATIN AMERICA
In the United States and Canada, over the past ten years, oil production increased by 73 percent from 9.9 million barrels per day (mb/d) in 2005 to 17.1 in 2015. In contrast, in Latin America production fell by 7.2 percent, from 11.1 mb/d to 10.3 mb/d.

THE THREE BIG COUNTRIES
Brazil, Mexico and Venezuela account for three out of every four barrels produced in the region and hold over 90 percent of reserves. The fall in Latin America's oil production was largely caused by the declines in Mexico and Venezuela and was partly offset by growth in Brazil.



part the result of the liberalization of the oil industry in the 1990s, when Petrobras, the national oil company, was partially privatized and the petroleum sector opened to foreign investment. As a net importer, the country was eager to maximize its production and, until recently, did not focus on extracting fiscal rents. However, the discovery of massive deep offshore reserves, began to change governmental incentives. In contrast to its South American counterparts, Brazil did not nationalize or force contract renegotiations. However, it did increase the government take for future offshore projects. It required Petrobras to be the operator and established an ambitious policy of increasing the local content of investments. Moreover, the participation of private shareholders in Petrobras was diluted when the government exchanged oil reserves for equity in the company, in a move that many analysts considered a form of expropriation.

Thus, even though Brazil had been considered a model of oil regulatory policy, the effects of its success and the prospect of becoming a net oil exporter also induced a milder version

of resource nationalism. This has already had negative implications for investment and production, which have not reached their targets during the last few years. Petrobras investment plan of 2014 forecasted production at 4.2 million barrels a day by 2020. The last investment plan reduced that forecast to 2.8 million barrels a day, and it may have to revise it down further.

The corruption scandal involving Petrobras dealings with its contractors, a result of the politicization of the local content program, has been a big blow for the company and for the government, which still is having significant consequences related to investment. Most of the main local contractors were involved. In early 2016, Petrobras' market capitalization collapsed to less than 10 percent of its peak value in 2008.

There were some mild signs that the Rousseff administration was moving back to a more pragmatic stance, particularly after the lack of investors' interest in the last offshore auction and given the recent oil price collapse. After the Rousseff impeachment process started, the interim president Michael Temer signaled that he will support

a reform of the legislative framework to give a larger role to the private sector in deep-waters and revise local content rules. Still, as Brazil becomes a net exporter and the federal and regional governments face a fiscal crisis, the risks of fiscal pressure over the oil sector might increase.

The future of the Latin American oil industry

Latin America has been more prone to cycles of resource nationalism and liberalization than other regions in the world, possibly due to the combination of factional democracies, weak rule of law, and high inequality. Given the right circumstances, resource nationalist ideologies could come back. After a cycle of significant investment that adds substantial production and reserves, changing the rules may become tempting again. Conversely, a prolonged period of low oil prices could induce further pragmatism and liberalization. In general, net importers or countries that have both declining production or reserves and a portfolio of high-risk projects would be pressed to be more open. Institutions that encourage governments to take longer-term

approaches, which limit their ability to opportunistically renege on deals, could moderate the effects of such volatile incentives. Independent regulatory agencies, as well as progressive and effective fiscal and contractual regimes that properly tax windfall profits, would be helpful to attract private investment. A pragmatic nationalist perspective requires substantial participation of the private sector to help develop the frontier and unconventional resources, utilizing a strong regulatory framework that both captures rents and provides incentives to develop the sector to its full potential.

NOCs are likely to remain major players in the region, as they are in almost all significant oil producing developing countries; but if they are not significantly reformed, the region's potential will remain underdeveloped. They have to be restructured to concentrate on the lower risk profitable upstream areas and partner, or exit altogether, non-core areas and frontier developments. Their corporate governance has to be strengthened, providing them with financial and operational autonomy, but guaranteeing more accountability and the exis-

tence of a hard budget constraint. Having private shareholders is not a panacea, as the Petrobras case shows, but it could still be a useful mechanism to discipline management and limit politicization.

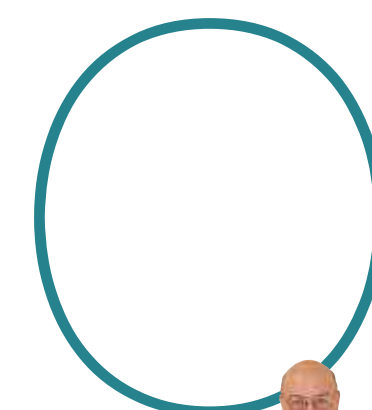
The oil industry in Latin America could have a bright future, given that it has the largest resource base outside of the Middle East, but in addition to dysfunctional policies, there are other risks to consider. In the short term, the key risk is a continued low oil price environment that makes high cost projects uncompetitive. In the longer term, the regional oil industry, along with the rest of the world, faces the risks generated by climate change and the policies to mitigate it, as well as the potential displacement of oil as the lead transportation fuel. Oil dependent countries, like Venezuela and Ecuador, could face an existential challenge if they do not change path. Other countries like Argentina, Brazil, Colombia and Mexico, although less affected, also might suffer due to the economic importance of the oil sector and their NOCs.



Arctic/ The potential of a strategic area for transport and for energy

Oil and new shipping lanes

Due to climate change and the progressive melting of ice, superpowers are increasingly interested in the North Pole, which will be crossed by future sea motorways. The region holds considerable hydrocarbon reserves



SEBASTIANO FUSCO
[AGENZIA NOVA]

A journalist for over 40 years, he mainly worked on foreign policy and related issues in energy, defense and geopolitics, collaborating to newspapers, agencies print, magazines and broadcasters radio and television. Currently, he is director responsible for Agenzia Nova.

In June 17, 2016, Russia launched at the construction sites of Baltijskij Zavod, in St. Petersburg, the largest and most powerful icebreaker in the world. It was named Artika: A huge steel leviathan measuring 173 meters wide and 34 meters long, with a prow like the snout of a shark. It is propelled by two nuclear engines powerful enough to break up sheets of ice up to four meters thick. Its entry into service in the seas surrounding the North Pole is planned for 2017. It is the first of three similar units, the last of which will be delivered in 2020. The value of the agreement is 85 billion rubles, approximately \$1.3 billion. That is roughly one-third the cost of the even larger icebreakers, though that cost has yet to be determined, to be built by the United States, as announced by President Barack Obama. Each will cost \$1 billion. The U.S. already has three nuclear icebreakers, only two of which are operational. These are evidently not enough, as Obama often emphasized during his visit to Alaska in September last year: "Icebreakers are one of those things that cannot be postponed," he said, because they serve "to protect the national interests and the management of natural resources." The Chinese also agree. For some time, the China Shipbuilding Industry Corp., one of the two leading Chinese shipbuilding companies, has said that one of its research centers has obtained government approval and funding to launch the study of nuclear propulsion, with the aim of building a nuclear icebreaker entirely through domestic production.

It is obviously the gradual melting of polar ice that draws the interests of the superpowers to the most inhospitable region of the globe. Since the age of specific satellite detection in the late seventies, Arctic ice has lost half of its volume, and the trend does not seem to be lessening. The ice in this region is melting at twice the speed of that in most of the rest of the world, albeit with fluctuations that climatologists are still evaluating, in search of a model that may explain and, above all, predict future melting.

The two routes that cross the Arctic Ocean

In 2007, the European Space Agency (ESA) declared that the so-called "Northwest Passage," the route connecting the Atlantic to the Pacific passing through the Canadian Arctic Archipelago, which historically has been blocked by ice, is now totally passable. The first ship transited in 2008 and, in 2013, the first commercial freighter passed through. It is now a summer destination for tourist cruises.

The situation of the "Northeast" →

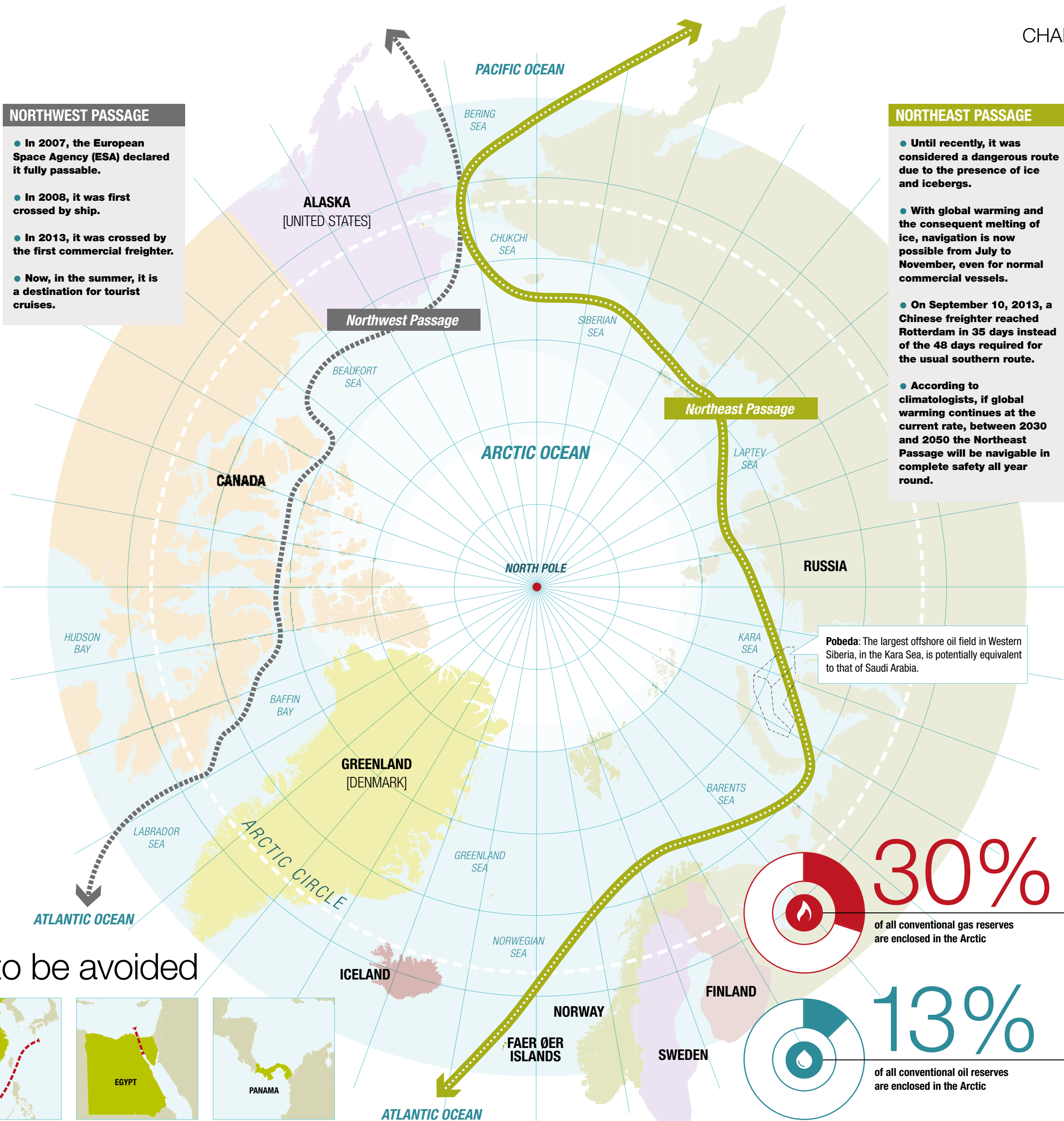
THE CONQUEST OF POLE

The world's major powers—Russia, the U.S. and China—are investing billions of dollars to acquire icebreaking ships. The Russian Artika, a giant steel ship measuring 173 meters in length and 34 meters in width, was launched on June 17 of last year. The progressive ice melting drives a growing interest in the North Pole.

Passage” is slightly more complex. This route to the Pacific Ocean starts from the North Sea and continues in the Arctic Ocean along the Siberian coast, then crosses the Bering Strait and Bering Sea to reach the eastern coasts of Asia. It was, until recently, considered a dangerous route due to the presence of ice and icebergs, and was not included in the ordinary trade routes between China and Europe. In the last 50 years however, due to global warming, the temperature in the areas surrounding the North Pole has risen almost four degrees, and for certain months of the year, ice does not form. From July to November, navigation is now also possible for merchant ships, with great advantages for commercial companies that transport goods from China to Europe. On September 10, 2013, a 19,000-ton Chinese freighter, the Yong Sheng, reached Rotterdam after having left on August 8 from the port of Dalian on the Yellow Sea. Travelling along the northeast route, it took 35 days instead of the 48 required by the usual southern route, which passes through the China Sea, the Straits of Malacca, the Indian Ocean, Suez, the Mediterranean, Gibraltar and along Europe to cross the English Channel. Not only did it save time and fuel, but it also avoided the expensive freight passage fees for crossing the Suez Canal. It is still too early to say whether the northeast route will become the preferred route for Beijing's goods transported by sea to Europe, but the Chinese freighter was the first to demonstrate its feasibility, with advantages, at least in the summer months, and it is a feasibility set to expand. According to cli-

NORTHWEST PASSAGE

- In 2007, the European Space Agency (ESA) declared it fully passable.
- In 2008, it was first crossed by ship.
- In 2013, it was crossed by the first commercial freighter.
- Now, in the summer, it is a destination for tourist cruises.



NORTHEAST PASSAGE

- Until recently, it was considered a dangerous route due to the presence of ice and icebergs.
- With global warming and the consequent melting of ice, navigation is now possible from July to November, even for normal commercial vessels.
- On September 10, 2013, a Chinese freighter reached Rotterdam in 35 days instead of the 48 days required for the usual southern route.
- According to climatologists, if global warming continues at the current rate, between 2030 and 2050 the Northeast Passage will be navigable in complete safety all year round.

matologists, if global warming continues at the current rate, between 2030 and 2050 the Northeast Passage will be navigable in complete safety all year round. Quite a long time ahead, but not so much that the nations bordering the Arctic, which claim their rights on the surrounding seas, will give up defending their interests.

Who do the routes through the ice concern?

For obvious reasons of strategic conflict, the nations most affected are the United States and Russia which, among other things, have their own unique geographical point of contact precisely in the Arctic: the Bering Strait. The two superpowers reveal a different approach, linked to the approaches that, historically, are their vocations in terms of military strategy. Russia is investing in icebreakers and the deployment of permanent bases in the Arctic, while the U.S. is relying on technologically advanced systems, such as nuclear submarines and stealth aircraft. Moscow focuses on icebreakers to create, in the event of conflict, routes in the pack ice that can move faster than their naval units. Washington relies on submarines to counter enemy ships and to serve as platforms to operate in Arctic expanses. For this reason, the new military strategy document approved by the Kremlin emphasizes the need to deny the Atlantic Alliance dominance of “deep waters,” from the Mediterranean to the extreme north. Within twenty years, those routes could become the main navigable routes of the globe, avoiding dangerous bottlenecks such as the Strait of Malacca, which is still infested by pirates; politically unstable areas or areas of dispute, such as the China Sea; routes subjected to expensive freight charges, such as the Suez and Panama Canals; and routes with shorter sailing times.

Beyond the effort to control the highway future of the sea, there is another factor that is rapidly making the North Pole one of the most important regions on the planet in terms of geopolitics. According to estimates dating back a decade ago, the Arctic contains 30 percent of all conventional gas reserves, 13 percent of which are oil, and large deposits containing a variety of minerals such as uranium, gold and tungsten. Estimates are certainly tentative because there are no precise analyses due to the lack of explorations. In this sense, the country most interested in knowing the true situation is Russia, which already obtains 15 percent of its GDP from resources located beyond the Arctic Circle. On June 15, the CEO of Rosneft, Igor Sechin, said that the potential of the largest off-

shore oil field in Western Siberia, in the Kara Sea, is equivalent to that of the whole of Saudi Arabia. “The company is consolidating its position in the Arctic region. Eighteen months ago, we discovered the Pobeda oil and gas field in the Kara Sea, as a result of explorations in the extreme north of the Russian Federation,” explained Sechin. The Kara Sea is part of the Arctic Ocean, located between the 60th and 90th meridian east, bordered to the west by the island of Novaya Zemlja, which separates it from the Barents Sea. In this latter sea, at a point located 85 kilometers from the northern coast of Norway, there is someone who is already extracting oil. On March 13, 2016, Eni announced the start of production of the Goliat oil field, in License 229, in an ice-free zone. Goliat, the first oil field to enter into production in the Barents Sea, was developed through the largest and most sophisticated floating production and cylindrical storage unit in the world, which has a capacity of one million barrels of oil and which was constructed with the most advanced technologies to deal with the environmental and technical challenges linked to operations in the Arctic environment. Daily production will reach 100,000 barrels of oil per day (65,000 of which by Eni). According to estimates, the oil field contains reserves of approximately 180 million barrels of oil. Production will take place through an underwater system comprising 22 wells (17 already completed), of which 12 are production wells, seven serve to inject water into the oil field and three inject gas. Goliat also uses advanced technological solutions to minimize environmental impact. It receives electricity from the ground by means of underwater cables, which allows for a 50 percent reduction in CO₂ levels compared with other approaches, while the water and gas produced are re-injected into the oil field. The launching of Goliat is an important milestone in Eni's growth plan and will significantly contribute to generating cash flow. Eni holds a 65 percent share in License 229, while Norway's Statoil owns the remaining 35 percent. Beyond the financial considerations linked to oil prices, what is important in such an investment is the technological supremacy achieved with the construction of the northernmost mining structure in the world. When the Arctic seas are more accessible and climate conditions are less prohibitive, what will count, more than dollars, will be the experience gained from working in extreme conditions, in the northernmost well that has ever been exploited.

Bottlenecks to be avoided



The Strait of Malacca, which is still infested by pirates



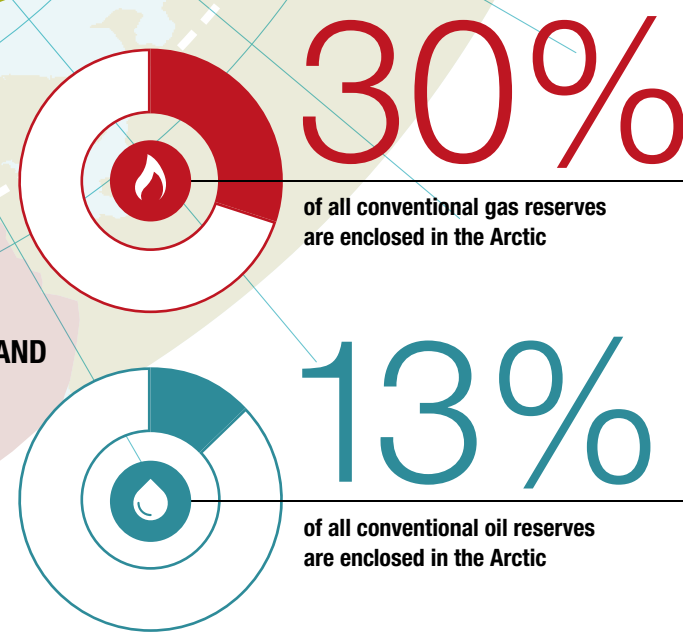
The China Sea, a politically unstable area



The Suez Canal, subjected to expensive freight charges



The Panama Canal, subjected to expensive freight charges



Source: data processed by the author

Samsø is an island located in the Strait of Kattegat between Sweden and Denmark's Jutland peninsula. Its small population—fewer than 5,000 inhabitants—nonetheless dream to change the world. The news is that they have succeeded. Since 1997, the island has been liberated from dependence on fossil fuels: its energy is clean and generated on site by wind turbines, solar panels and geothermal heat pumps. It has 100% renewable energy, which completely covers the domestic demand and which produces, every year, millions of kWh of surplus electricity sold to Denmark. The turbines have revived the local economy and stopped the emigration of young people.



Changing route is possible

Alessandro Grassani

(b.1977, Italy) is a storyteller who uses photography and video as his main form of expression. His job brought him around the world covering international events and stories about social themes in more than 30 countries in the world. He works, among others, with The New York Times, National Geographic and l'Espresso.

He has won numerous awards including Sony World Photography Awards, Days Japan International Photojournalism Awards and Premio Luchetta International Award and his works have been exhibited at festivals and galleries worldwide including the United Nations and the Royal Geographic Society in London.



Samsø is one of the three ecological islands in the world. The others are King Island in Australia and Utsire in Norway. It has an area measuring 114 Km², of which 8,100 hectares are cultivated. Agriculture is traditionally its main activity, along with fishing. In the homes surrounded by greenery, all domestic appliances run on wind energy, and heating is provided by the sun. Boilers and pellet stoves are fired by biomass chips and straw, and heat pumps are fueled by geothermal probes. The island's wind farm is impressive: 10 offshore plants operate off the North Sea coast and 11 operate on the mainland, having become part of the landscape. The goal of the government of the island is to be CO₂ free by 2030.



SERGIO ROMANO

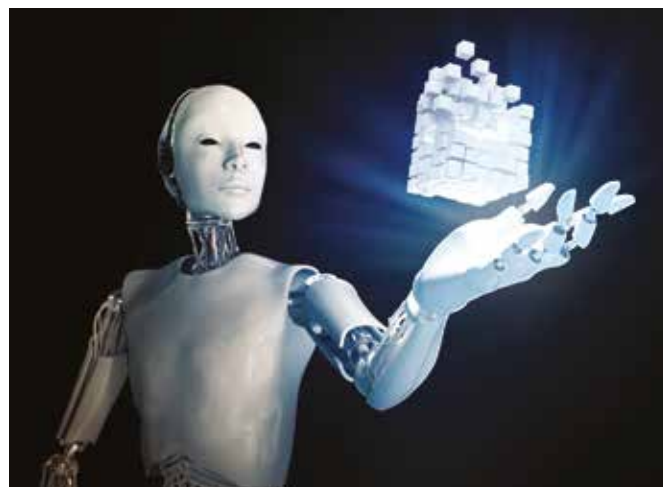


Are robots the future? The prospects of artificial intelligence

The recent death of Alvin Toffler, author of *Future Shock*, which sold a few million copies in the 1970s, reminds us that it was the time when futurology became one of the favorite exercises of scholars and intellectuals. However, the risk of forecasting error is always very high. Even when there are economic and technical conditions ripe for a particular discovery, it is not uncommon to find that laboratories suddenly abandon one subject to focus on another. The reason is almost always economic, as discoveries are generally costly and the choice of a goal can depend on the amount of money available. Although highly motivated by their own interests, scientists often end up discovering what is requested by a lender.

The main factor of technological innovation is war

The factor that has most influenced our existence and which has radically modified our traditions is war. The “patrons” that enable great changes are very often the military policies of governments and armed forces. The development of civil aeronautics would have been much slower if the air force had not, in the two wars of the twentieth century, made great strides. We would not have built the first computers if intelligence services had not needed a large calculator to decrypt codes. We would not have conquered space, with the cascade of resulting inventions, if the missile had



not been a World War II weapon and the Cold War had not channeled resources to space research. We would not have the internet if the U.S. armed forces had not needed an extensive and rapid “command and control” network.

Are there currently other areas in which war can produce equally important contributions? The most interesting areas are automation and artificial intelligence. Since its first appearance in literature and cinema, the robot has stimulated our fantasies and occupied our dreams. Research on the construction of humanoids began several years ago, and one of the most promising laboratories is that of the Italian Institute of Technology in Genoa. There are already products on the market scheduled for relatively simple functions—for example, vacuum cleaners and machines for cleaning swimming pools. However, the next generation’s leap forward will likely be due to the military use of robots. Drones hit enemies from the sky and are vulnerable, but their pilots are situated beyond the ocean and wear a white coat. There is no other weapon that so plastically represents the features of an asymmetrical war in which western power

at the Italian Institute of Technology, write that there is a fundamental difference between man and robot. A man has qualities (elasticity, strength, deformability and relativity) that allow him to “develop strategies to adapt the body, in real time, to its needs, situations and changes, greatly reducing the need to calculate what it needs to do each time.” In the robot, on the other hand, the brain is separated from the body and “an intelligence that directs a body is something very different from a synergistic body and mind.” Alongside the technical problems, there is a need to face legal and moral issues, to write codes that grant the owner of a robot the responsibility for its errors, to change urban planning and to resolve the plight of all those who will be made redundant due to automation. In the late eighteenth century in England, workers destroyed the mechanical structures that were “stealing” their work. The phenomenon was known as Luddism, named after a young man (Ned Ludd) who had set the example, and it recurs regularly on the occasion of other innovations. Will we see Luddism appear against robots? How would we react to the use of police robots to restore order?

should, as far as possible, prevent the deaths of its own soldiers, but which often hits, along with the target, those who are unfortunately nearby. No less controversial is the robot-bomb with which the Dallas police killed an African-American former soldier who had killed 5 policemen, purportedly to revenge the many black youths killed by the American police in previous months.

Automation poses legal and moral issues

The major advances in automation will likely be in the field of communications and transport. The route of an aircraft or ship is already governed by a computer. How much time will be needed before cars will not need a driver? Of course, it will be necessary to prepare the artificial intelligence of a car to deal with all of the situations that may occur along the way. In their book *Umani e Umanoidi: Vivere con i robot* (Humans and Humanoids: Living with Robots”), Roberto Cingolani and Giorgio Metta, scientists

Sergio Romano was Italy's representative to NATO and Ambassador to the Soviet Union from 1985 to 1989. After his diplomatic career, he taught in Italian and foreign universities. He has written books on history and politics, and is a columnist for *Corriere della Sera*.



The geopolitics of energy innovation

Technological innovation in the energy industry is distorting the traditional approach of governments, industry and citizens to energy issues. In the hydrocarbons sector, for example, the unconventional revolution in progress in the United States, the expansion of the LNG market and the progressive globalization and commoditization of natural gas have profound implications for traditional producers—OPEC, first and foremost—and for their relations with consumer countries. However, the bulk of this change is yet to come, and this change will be determined by the rapid and disruptive deployment of renewable energies and low-carbon technologies on a global scale. The acceleration in the fight against climate change detailed in the Paris Agreement is underscored by ambitious strategies and technological innovation processes introduced by major international players (both public and private), innovation capable of distorting the way in which energy is produced, managed and consumed on both the global and local level.

The United States and the unconventional revolution

Within a year and a half, the price of crude oil fell from \$114 per barrel in June 2014 to \$27 per barrel in February 2016. This drop can be mainly attributed to the decision of the Saudi royal family to challenge U.S. shale producers, who, thanks to the introduction and progressive improvement of technologies such as

hydraulic fracking and horizontal drilling, managed to bring U.S. production to over 9 million barrels per day in 2015, almost double that of 2010. Equally in the natural gas sector, the boom in U.S. production, accompanied by the expansion of global liquefaction capacity and the reduction in LNG transport costs, has had a strong impact on regional and global market dynamics. They have contributed to a fall in gas prices, an increasing convergence of costs on the Asian market and in the main European hubs, and a destabilizing impact on the strategies of weaker players and less competitive projects.

China leads the boom in renewables

Despite the collapse in crude oil prices, 2015 was a record year for the development of renewable energies. Global investments in the industry reached \$286 billion, with a growth of 5 percent in 2014 and six times that since 2004. Moreover, for the first time ever, renewables contributed over half the new installed electricity generation capacity worldwide (53 percent), for a total of 118 GW compared to 94 GW the previous year. The emerging economies are the focus of this

phenomenal growth, with total investments amounting to \$156 billion (+19 percent compared with 2014), against the \$130 billion invested by industrialized countries (-8 percent compared with the previous year). China alone contributes over one third (\$103 billion, 36 percent) of the global investments, posting a national annual increase of +17 percent, ahead of India, Brazil, South Africa and Chile, whose combined investments reached almost \$30 billion. Because of the collapse in oil and gas prices, even the main hydrocarbon producers in the Middle East have launched significant reforms in their energy industries. In absolute terms, the figures are low compared with those of the major emerging economies such as China and India. However, in the Middle East/Africa, annual investment growth in renewables has increased 58 percent, the highest global figure. Particularly active are the governments of the Gulf Cooperation Council (GCC) which, distancing themselves from the current economic model based on oil revenues, are promoting ambitious policies both to reduce energy subsidies and to encourage the penetration of renewables such as solar and wind.

Global upheavals

These trends will have significant implications, both internationally and locally. In the hydrocarbons sector, change is related to the redefinition of market fundamentals, the American liberation from Persian Gulf oil, the state of confusion within OPEC, Russia's financial difficulties, and growing European energy security thanks to low gas

prices and the expansion of the LNG market. Even more significant may be the spread of low-carbon technologies at an intra-state level, especially in the oil producing countries of the Middle East and North Africa and the developing countries of Sub-Saharan Africa. Technological progress in the energy industry will not only be a key driving force to promote fair and sustainable economic development in large areas of the globe, but it also has the potential to irreversibly alter power relations and socio-political dynamics.

The massive penetration of technologies for the production, distribution and decentralized consumption of energy can make obsolete the top-down model based on energy supplies ensured by a public authority free from interference by the population. The democratizing effect of the spread of new technologies in the energy industry and the growing activism of private players in an industry that, in the past, was strongly harnessed by public control mechanisms may lead to extraordinary upheavals in the economic, political and social arena, upheavals not foreseen even by the parties involved.

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DAVIDE
TABARELLI

The Internet revolution and the “simple promises” of technology

As is true for other areas, for energy “the connection” is the most profound change in recent years. The technological break brought about by microprocessors, which have become increasingly smaller, has enabled an explosion of information and, at the same time, its exponential diffusion through a network to which everyone is connected. Cell phones have within a few years become mobile computers, workstations from which billions of people share news from an enormous number and a huge variety of sources. However, many positive aspects of this process hide the low scientific reliability of much of the circulating information, as users are willing to navigate the surface without sufficiently analyzing topics that, given their complexity, require more time and effort.

Climate change: Between scientific evidence and conspiracy theories

When people turn on lights, make coffee, take the car, or catch a flight, they usually know that the consumption of energy, especially from fossil sources, pollutes and causes the CO₂ emissions that lead to climate change. The topic is a constant source of news, debate and discussion, communication that often suggests that climate



change, caused by energy, is a planetary emergency. An enormous flow of information circulates on the Internet, but the most commonly found information there is the easiest and most trivial, while the credibility of science is too often questioned. The news that captures attention is negative, certainly not positive, and those who produce it must exaggerate to get clicks on the page where the advertisements are placed and for which the author gets paid. Conspiracy theories, frequently present in debates, spread and gain credibility from those who browse on the surface and are captured by apocalyptic scenarios and simple accusations. Renewables are unfairly contrasted with fossil fuels, as if they are the only solution, forgetting that they themselves will be problematic in the future. The technical difficulties of renewables, their intermittence, unpredictability, and storage difficulties, are

complex issues that require study. People prefer to commit themselves to simple technological “promises”, such as long-lived batteries for the electric car. Answers are promised within a few months, but these promises are constantly postponed.

Responsible finance and the energy market

In the economic arena, the most profound influence is the financialization related to energy. The companies that supply traditional energy are constantly under pressure from the financial community, which, also influenced by the internet, wants change to save humanity's future. Unlike in the past, investors control huge capital stakes which, thanks to technology, move quickly from one company

to another, often based on judgments related to the environmental profile of projects. A responsible finance has grown, one that is sensitive to ethical issues such as sustainability, and one that requires this commitment because investors, connected to the Internet, demand it. Meanwhile, in the U.S., the fracturing of rocks or the processing of huge amounts of data related to the subsoil are technological innovations that are less discussed and often criticized on the internet. Yet these very issues are the ones that enable the global energy supply to grow more than demand and bring needed energy to billions of people at lower prices.

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ROBERTO
DI GIOVAN PAOLO

The Trump enigma and the resurgence of fundamentalism

Donald Trump's Republican nomination seems to replay a film that has already been seen in the race for the U.S. presidency. On one side is Hillary Clinton, who represents the more “governmental” Democratic party and must mediate Bernie Sanders' proposals. On the other side is the champion of the Republicans, who defends the tougher positions of his party which, from an ideological point of view, has its roots in the so-called “Tea Party” and also looks backwards to rural Christian fundamentalism. Most newspapers in recent months have compared the relationship between Trump and the party leadership to the battle between Barry Goldwater and Nelson Rockefeller in 1964 where Goldwater presented a tough vision of U.S. political conservatism. But is this really a valid comparison? Although we are certainly not in the times of Ronald Reagan, with his support from Jerry Falwell and the Moral Majority, “fundamentalism” still has a significant meaning to the Republican ranks, especially for its new international implications which seem a difficult issue for Trump to handle.

An idea of freedom that embraces integralism

It is, in fact, at the international level that “made in the U.S.A.” fundamentalism seems to

represent a new “evil empire” reminiscent of Reagan's critique of the Soviet Union. Trump will have to come to terms with that ironic problem while holding on to the votes of “his” fundamentalists at the same time that fundamentalism is easier for a Democratic and “liberal” candidate to handle, because they don't rely on fundamentalists for their votes. In fact, the episodes of violence that have occurred in the United States, especially those linked to individuals who burst into schools or other public places and shoot wildly, recall fundamentalism of various origins, thereby contributing to cultural and political confusion. The cultural attitudes of Omar Seddiq Mateen, the Islamic fundamentalist who instigated the tragic attacks in Orlando, are comparable to those of ultra-nationalist Christian fundamentalists in the southern United States, rather than something that is foreign to U.S. history and culture. Mateen railed against multiculturalism, LGBT rights, and social policies and civil liberties guaranteed by the Constitution and American law. The fact that he had sworn allegiance to ISIS adds an element of context but does not change the reality that a different cultural background, with its own roots, has managed to integrate itself perfectly with many values of Christian fundamentalism in the southern United States. The challenge now is to determine whether Republican political battles, rather than the typical American roots often referred to, manage to serve as a breeding ground, perhaps unconsciously or involuntarily, for the spread of anti-state sentiment. The

common belief that local land and homes, far from the “sinful” Sodom and Gomorrah called Washington, are more virtuous affects Trump's “anti-caste” and populist policy.

The relationship with fundamentalism has been present in the Republican party since its origin, but its positions were not so important in the country until the 1930s, during the opposition to Roosevelt and the New Deal. In the 1950s and 1960s, the movement provided an organizational structure which exploded with Jerry Falwell during the Reagan period. It became an essential element for the political construction of Reagan's “evil empire” theory, which was applied to communism. The cultural contribution of Christian fundamentalism to politics remained high even after the Reagan presidency, despite the advent of the “Tea Party” as an attempt to steer towards a more presentable, mainly economic, liberal conservatism. Karl Rove, a strategist in the election campaign that saw George W. Bush junior become president, resorted to the key idea of “Salvation and Rebirth”; this applied to a politician considered a non-ideologist, a culturally weak man and one who had a history of problems with many vices such as drugs and alcohol. It was precisely the weakness inherent in the candidate that became the strength of that electoral campaign. Bush's “Axis of Evil” would also signal

a focus on a traditional fundamentalist dichotomy of good/evil.

The crisis of Christian fundamentalism

At present, Christian fundamentalism certainly has a much smaller influence in terms of media presence or self-representation than it did during the Reagan years due to two main factors: the risk of becoming a breeding ground for some sort of “heterodoxy of purpose” and mutual weakening, both in polemics and challenge, with the Tea Party. The result is a Republican candidate who is little inclined to yield to electoral pressure, having been freed by both his distance from values and proclamations and enabled to focus on matters more congenial to him such as major energy choices, or an interest (or lack thereof) in climate treaties. Donald Trump is a free man, despite the coarseness and vulgarity he exhibits, but he is certainly not a classic Republican leader, dependent on religious fundamentalism and values. This “break” can definitely change the Grand Old Party.

Roberto Di Giovan Paolo, a journalist, has written for, among others, ANSA, *Avvenire* and *Famiglia Cristiana*. He was Secretary General of the Italian Association for the Council of European Municipalities and Regions, and he is a lecturer at the University of International Studies of Rome.

MARKET DEVELOPMENTS

Obstacle course for recovery

Prepared by Market Scenarios and Long-Term Strategic Options – Oil (SMOS/OIL) – Eni



OIL PRICES

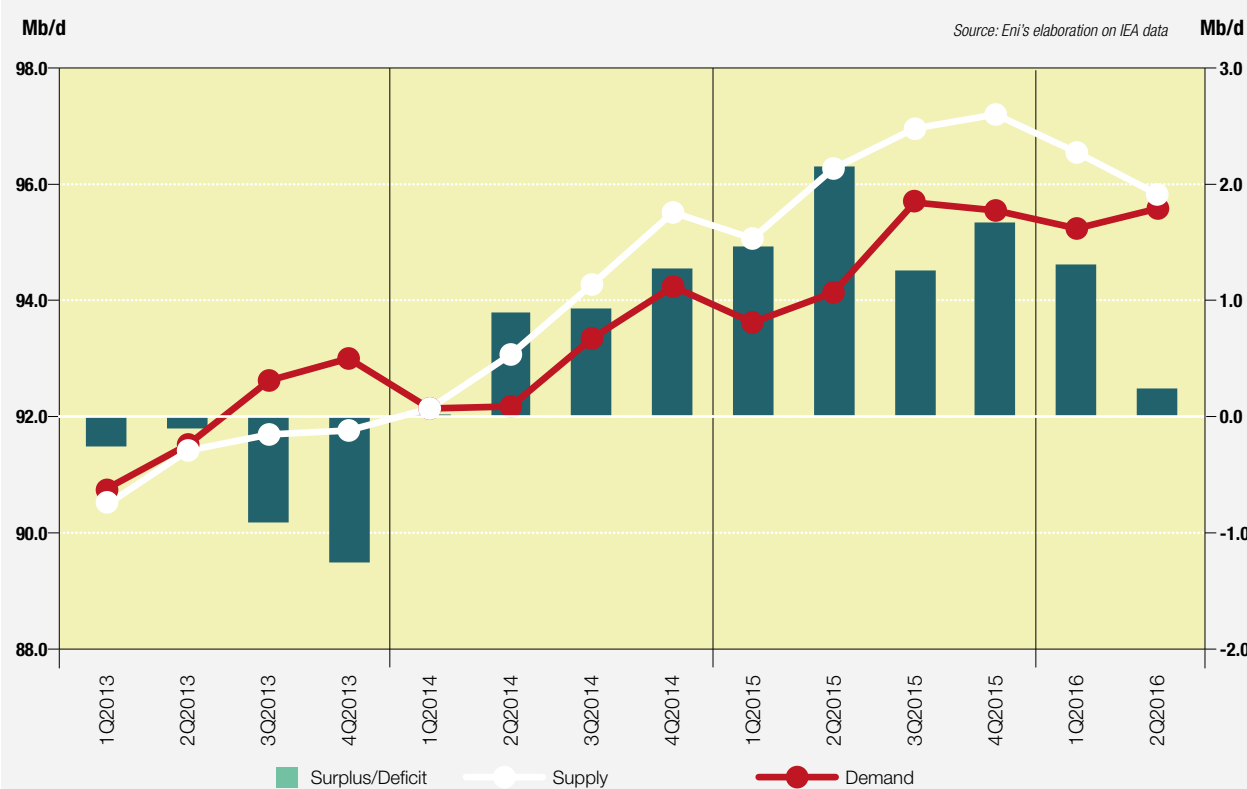
Following an increase to \$50 per barrel due to disruptions, Brexit cools the markets

Brent, having reached its lowest level in the last 12 years in January, is recovering and approaching a \$50 per barrel price, a ceiling that is still difficult to exceed. The meeting in Doha (April 17) that had fueled expectations of an OPEC-non-OPEC agreement to freeze production ended in stalemate. Despite the rebalancing of fundamentals, this price level continues and is accelerated by strong demand in the first part of the year and, especially, by a decisive downsizing in supply. The surplus supply of the last eight quarters is being reabsorbed and, in the second quarter, the surplus settled at just 0.2 Mb/d, partly due to a disruption that in May alone withdrew approximately 1.5 Mb/d from the market. In addition to temporary reductions in supply, the consequences of the capex cut are beginning to emerge, especially for higher-cost non-OPEC production. In July, U.S. tight oil has returned to the lower levels of two years ago, and in June production of Chinese crude oil reached the lowest level of the last three years. This readjustment process could be undermined by a price recovery, although there are factors that do not allow for a rapid regeneration in supply, such as the crisis in Venezuela, which has deep political and economic roots. Financial operators are returning to bet on a price rise; net long positions in ICE Brent are growing, while in May short positions were at their lowest levels for the year. In June, the Brexit effect, the peak in OPEC production and the fear of U.S. tight oil recovery intervened to curb optimism. Operators are freezing their positions and remaining on stand-by. Brexit, in particular, raises uncertainties regarding global economic growth, this shown in recent IMF revisions. Two days after the "leave" victory, Brent lost approximately \$4 per barrel per day, and it continues below the threshold of \$50 per barrel. But analysts agree that the rebalancing process is underway, and the surplus will tend to be reabsorbed by the end of the year, although the rise in prices may be bumpy.

BRENT PRICE



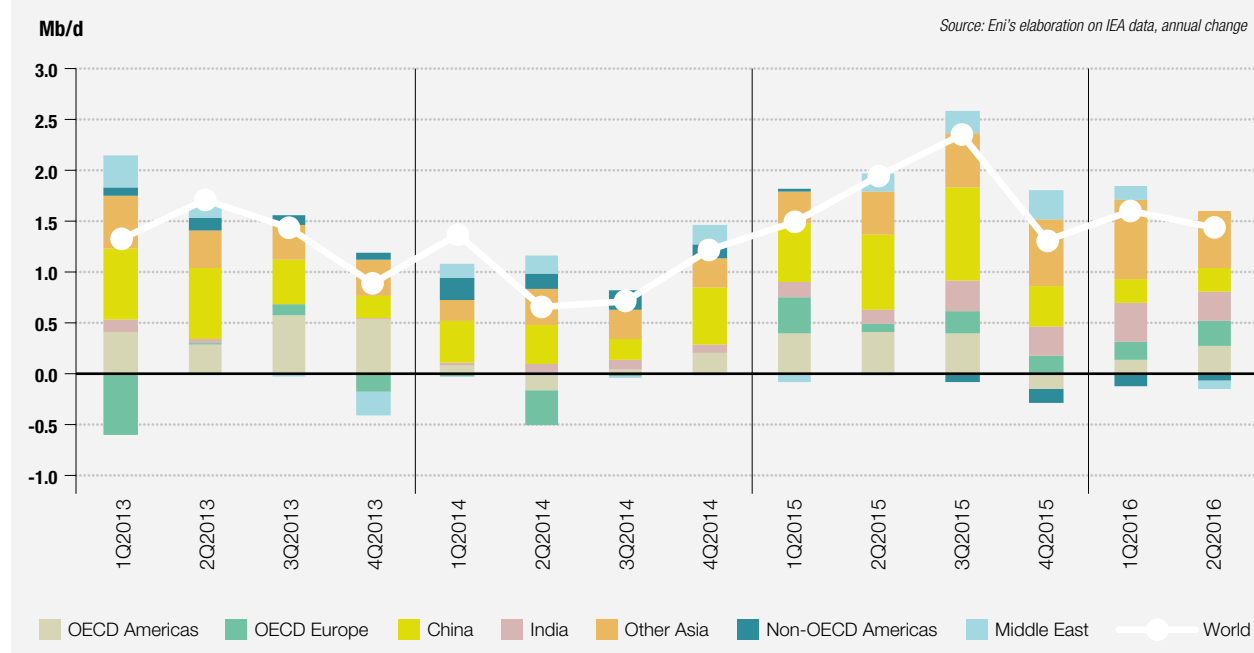
SUPPLY/DEMAND BALANCE



OIL DEMAND

In the first half of 2016, global oil demand showed strong growth (+1.5 Mb/d) encouraged by the sharp fall in prices. Growth remains driven by non-OECD Asia, but in the second quarter, Europe also stands out. Thanks to relatively low prices and the improvement of the macroeconomic context, demand reached 13.8 Mb/d (+0.24 Mb/d), the highest level since Q3 2015. Also increasing is OECD America, thanks to record-high consumption of gasoline in the U.S. (9.7 Mb/d in June) and to the decreased drop in diesel consumption which, in the first quarter, had suffered a collapse due to a mild winter, the weakening of the manufacturing industry and reduced drilling activity in the oil & gas industry. In OECD Asia, weak consumption is mainly linked to decline in Japan, where the displacement of fuel oil for thermoelectric power plants continues due to the reopening of part of nuclear capacity. Non-OECD Asia experienced a slowdown between the first and second quarter (+0.9 Mb/d in Q2 vs +1.4 Mb/d in Q1), one linked to reduced consumption in China and

ANNUAL DEMAND CHANGE BY SELECTED AREAS



Saudi Arabia. Asia remains the area of greatest growth, with +0.8 Mb/d in Q2 (vs +1 Mb/d in Q1) this partly due to India, which became the top country in terms of increased consumption, surpassing China (+0.34 Mb/d in India vs +0.23 Mb/d in China in 1H16). Chinese demand is affected by its reduced economic growth compared to the recent past, with the lowest growth rates

since the recession of 2009. The Chinese economy is in transition from an export-oriented model driven by heavy industry to one more focused on domestic consumption, driven by the services industry, and one with a negative impact on demand, mainly on oil products for industrial use. Oil demand in the Middle East decreased in the second quarter

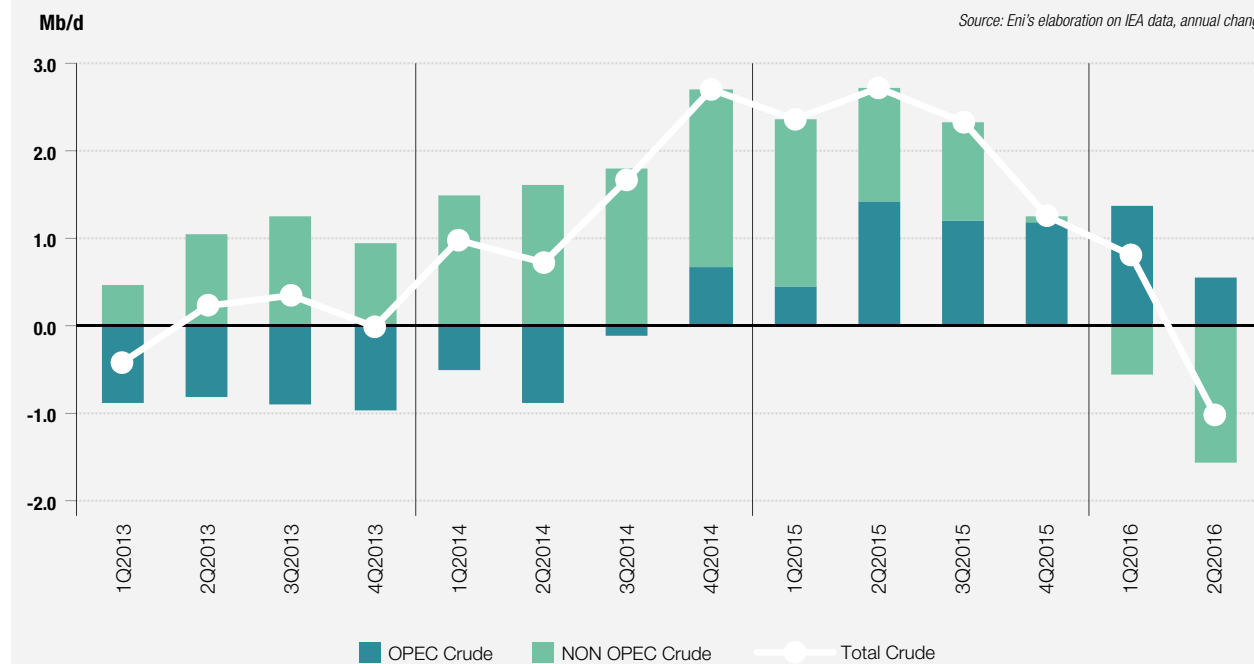
(-0.1 Mb/d vs Q2 2015) while it remained positive in the first quarter (+0.1 Mb/d vs Q1 2015). The removal of fuel subsidies for the transport industry and the negative impact of lower oil revenues on economic growth weighed heavily on oil consumption in Saudi Arabia which, in Q2, recorded the biggest reduction on a quarterly basis in the last three decades.



OIL SUPPLY

In the second quarter of 2016, the global oil supply fell below 96 Mb/d, with a significant cut in production concentrated in the non-OPEC area. After four years of continuous growth, for the first time since 2011, the production of non-OPEC crude oil retreated (-1.5 Mb/d in Q2 vs 2015). In the first half of the year, U.S. production fell by 0.5 Mb/d compared with 2015, a reaction to lower crude oil prices and a sharp decline in the number of oil rigs. In May, a fire in Canada led to the evacuation of many of the oil sands fields in Alberta and a 1.0 Mb/d collapse in output; however, the business should be back up to speed by July. Throughout the first part of the year, Russia totaled over 10.8 Mb/d (0.2 Mb/d vs 2015) due to the fall in costs linked to the devaluation of the ruble; the country, after the failure of Doha, declared that it does not wish to cooperate in any cuts in production. China is affected by the cut in capex implemented by the major companies and average losses in the first six months of over 0.2 Mb/d (vs 2015). Production in Colombia is penalized by continuous rebel attacks. OPEC is not

ANNUAL CRUDE SUPPLY CHANGE



changing its policy following the meeting of June 2. Production in the first half of the year grew by 1 Mb/d vs 2015 led by the Middle East due to the rapid post-embargo recovery of Iran, the increase in Iraqi production and the continuous growth of Saudi Arabia which, in his "Saudi Vision 2030," Prince Mohammed bin Salman sanctions his country's

changing role. On the other hand, some countries are entering a very critical phase. The severe energy crisis in Venezuela is the tip of a deeper problem in the country which, in the second quarter, saw a doubling of the decrease in production. In Libya, despite progress on the political side, production remains at around 0.3 Mb/d. The situation in

Nigeria, however, is even more serious, due to the continuous attacks of the rebel militia in the Niger Delta. In May, output fell to the lowest levels since 1989. In the coming months, supply, although recovering from temporary disruptions, will not have additional capacity to reverse the trend already started.



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