Changing Energy Dynamics And Risks: Where Will Finance Come From?

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New energy game?

Throughout human history energy has always been at the heart of civilisations. In today's world it is even more so. Particularly, in the new "Great Game"2 still in the making, energy figures prominently - alongside food and water - as the most important source of economic life and advancement, but also as a root-cause of conflicts, risks, profits and cross-border collaboration.

Energy and associated sectors also form the backbone of our economies, investment and trade flows, technology innovation and business transactions. It is essential for everything from fuelling our cars to heating our homes to powering the appliances. The term "energy" is very broad and covers a lot of ground, from oil drillers to electric utilities3. Without energy, our lives will become paralysed. It also remains a central component of nearly every global challenge, from universal access to electricity to climate change, from geopolitical tensions to technology discoveries and disruptions4.

The world's energy map is no longer the same as it was over the past two decades. Specifically, with the advent of significant discoveries and oversupply in North America and elsewhere, a new global energy map is emerging - it will change the traditional demand-supply equation, rules and players of the ''game.'' In the new, energy-centric world, the price and availability of oil, gas and electricity dominate our lives. Power will reside in the hands of those who control the global ownership, financing, production, transportation, and marketing of energy.

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[2] The New Geopolitical and Economic Journey: Turkey's Next Ten Years, Mehmet Ogutcu, Bilgesam, October 2018

[3] https://www.fool.com/investing/2018/09/01/investing-in-the-energy-sector-101.aspx

[4] https://www.researchgate.net/publication/233398348_Central_Asia_and_China's_Energy_Security

Power can also be derived from a country's ability to leverage its resources toward economic and political gains, as we see this happening quite often in our recent past. Conversely, dependency on foreign energy restricts policy options, thereby reducing the avenues through which a country can cultivate its national power.

The new dynamics in world energy that are unfolding include, inter alia, greater demand growth over the long term emerging away from the OECD area, continued dominance of fossil fuels, new supply sources beyond the Middle East and former Soviet Union geography, strong growth of unconventional fuels, price volatility, inadequate investment due to uncertainties and global economic downturn, conflictual IOC vs. NOC relationship, geopolitical tensions, and heightened climate change concerns.

Demand for energy resources is increasingly led by growth economies in Asia, unconventional oil and gas production continues to rewrite market forecasts and new production frontiers are emerging. Recent years have also witnessed disruptive events with repercussions for energy policies and prices5.

Sudden shifts in the energy market and overseas political instability may also diminish access to foreign energy sources or dramatically increase the cost of energy imports, further compromising the ability of import-dependent countries to pursue their national objectives6.

The ongoing energy transition, which will be painful and difficult to achieve, stands to benefit those countries that produce clean energy technology and put oil producers at a disadvantage, changing the geopolitical order in the process. As it happens at the end of every cycle, the world is once again going through a major transformation and powershift in this sector.

Progress made to date in ensuring everyone in the world has access to a reliable source of energy has been tremendous, but globally, 2.8 bn people are still cooking on traditional stoves, with firewood, or cattle dung, or some other form of traditional biomass for fuel. More than 670 million people still lack what some developed nations take for granted by 2030. Even when energy is available in the developing world, it is expensive and often unreliable. Unless things change dramatically, there is no way we are going to meet the 2030 goal of universal energy access.

As globalisation lifts millions out of poverty, the demand for energy worldwide will continue to grow, and we risk ending up with a volatile, "beggar thy neighbour" style of competition between countries to control sources of supply,

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[5] The Changing Dynamics of Global Energy Markets: Policy, Investment and Technology, 4 November 2013, https://www.chathamhouse.org/globalenergy

[6] https://chinapower.csis.org/energy-footprint/

especially in the developing world, giving rise to more conflict and confrontation than co-operation and collaboration, which we all aspire.

Energy and geopolitics have always been closely linked. The twentieth century saw access to energy resources become a major factor in determining the winners of wars, oil producers banding together to create new global alliances, and price swings that spurred or deterred the adventurism of superpowers. Now the vast and fast-paced changes in the energy sector in the twenty-first century including advances in renewables are rewriting the relations between the two fields7.

Towards a different world?

Undoubtedly, we and our children will be living in a dramatically different world. The global economy is set to reach new balance of power over the next few decades. On the world scale, the U.S. economy is still the largest in the world at $18 trillion, representing a quarter share of the global economy (24.3 percent)8. China follows, with $11 trillion, or 14.8 percent of the world economy while Japan is in third place with an economy of $4.4 trillion, which represents almost 6 percent of the world economy9. European countries take the next three places on the list: Germany in fourth position, with a $3.3 trillion economy; the U.K. (still counted as a EU country till Brexit gets materialised by March 2019) in fifth with $2.9 trillion; and France in sixth with $2.4 trillion10.

Assuming that the world economy is projected to grow at an average of just over 3 percent per annum in the period 2018-50, it can possibly double in size by 2037 and nearly triple by 2050. The global economic power shift away from the established advanced economies in North America, Western Europe and Japan will continue over the next 32 years. China has already overtaken the U.S. in 2014 to become the largest economy in purchasing power parity terms. In market exchange rate terms, China could overtake the U.S. in 2028 despite its projected growth slowdown11. India has the potential to become the second largest economy in the world by 2050 in PPP terms.

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[7] https://energypolicy.columbia.edu/research/report/new-geopolitics-energy

[8] https://www.weforum.org/agenda/2017/03/worlds-biggest-economies-in-2017/ 111

[9] http://www.cityam.com/231501/world-economic-league-table-uk-could-overtake-germany-and-japan-to-become-worlds-fourth-biggest-economy

[10] India is in seventh place with $2 trillion, and Italy in eighth with an economy of over $1.8 trillion. Ninth place goes to Brazil, with an almost $1.8 trillion economy. And in 10th is Canada, with an economy of over $1.5 trillion. The economy of the U.S. is larger than the combined economies of numbers three to 10 on the list.

[11] "By 2029 China will be safely positioned as the world's largest economy. But its progress in that direction is now likely to be slightly slower than we had expected last year as a result of two factors – slower growth as the country transitions from-export led growth to consumer based growth; and a weaker renminbi as the country adjusts its exchange rate strategy to reflect China's positioning of the renminbi as a reserve currency.

New emerging economies like Mexico and Indonesia could be larger than the U.K. and France by 2030 (again in PPP terms) while Turkey could become larger than Italy. Nigeria and Vietnam could be the fast growing large economies over the period to 2050. Colombia, Poland and Malaysia all possess great potential for sustainable long- term growth in the coming decades.

Central Asia will be the fastest growing region over the next 15 years - achieving a 10 per cent share of the world economy by 2030. In contrast, Western Europe is likely to be the world's slowest-growing region with its share of the world economy falling by 42 per cent over the period leaving countries such as Italy and France likely to fall out of the G-8 and potentially even the G-20 groups.

However, relatively rapid growth is not guaranteed for emerging economies, as indicated by recent problems in Russia, Brazil and Turkey, for example. It requires sustained and effective investment in infrastructure and improving political, economic, legal and social institutions. It also requires remaining open to the free flow of technology, ideas and talented people that are key drivers of economic catch-up growth. Over-dependence on natural resources could also impede long term growth in some countries (e.g. Russia, Nigeria, Kazakhstan, Iraq and Saudi Arabia) unless they can diversify their economies.

The world's major hubs of population, production, trade and finance have gradually shifted to the east. The global energy landscape is following suit. As the "Grand Energy Transition" fast becomes a reality, the minds of global energy leaders are becoming increasingly focused on long term trends that threaten existing economic and business models rather than concerns about short term risks. Issues that will dictate the speed and the breadth of the energy transition include regional integration, climate framework, electric storage, renewables, energy efficiency, electricity prices, economic growth and geopolitical stability12.

Commodity price volatility is a particular issue of importance for all regions but resource-holders and consumers in developing economies show the highest levels of concern. Energy leaders in Asia and Africa, regions heavily dependent on energy imports, reveal this to be the biggest issue in terms of critical uncertainty. Likewise, MENA countries dependent on hydrocarbon exports see the issue as undermining long term economic models. Already, Saudi Arabia has embarked on a what it calls a National Transformation Plan known as "Vision 2030"13 that aims to leverage current oil revenues to provide long term investments necessary for a future beyond oil.

The U.S. recently surpassed Russia and Saudi Arabia to emerge as the top producer of crude oil. This new status could be short-lived, as both its nearest

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12 https://www.worldenergy.org/wp-content/uploads/2017/04/1.-World-Energy- Issues-Monitor-2017-Full-Report.pdf

13 https://vision2030.gov.sa/en

competing nations have ramped up production in recent months to fill a growing void in Iranian production in the wake of re-imposed U.S. sanctions, but the fact that the U.S. arrived at that point at all is an extraordinary achievement14. In 2017, U.S. net imports of crude oil amounted to just 19 percent of the country's daily consumption. Thus, while the country has not become completely energy independent, it has become vastly more energy secure15.

What is fuelling China?

China is a superpower not only in trade and investment, but also increasingly in world energy as a consumer, producer, carbon emitter, technology developer, trader and investor. Decades of rapid economic growth have dramatically expanded China's energy needs. Indeed, China is now the world's largest consumer of energy, the largest producer and consumer of coal, and the largest emitter of carbon dioxide16.

Over the last half century, China's large manufacturing-based economy has primarily been fuelled by coal. From 1990 to 2015, China increased its coal consumption from 1.05 billion tons to 3.97 billion tons. In 2016, coal made up 62 percent of China's energy use. Since 2011, China has consumed more coal than the rest of the world combined17. China's dependence on coal for industrial power generation has significantly contributed to urban air pollution.

China is increasingly looking toward securing its future energy needs with sustainable alternatives. A 2012 white paper on China's energy policy emphasized the need to "vigorously develop new and renewable energy." In accordance with the 2016 Paris Agreement, China has committed to make non-fossil fuel energy 20 percent of its energy supply by 2030.

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[14] A decade ago, the most common phrase used to describe the domestic U.S. oil industry was that "all the whales are gone," with "whales" meaning big, new sources of oil that had the potential of starting a new boom. The Permian Basin was considered a "dead" region, where the biggest potential for increased production lay not in finding new productive formations, but in going into old existing wells and re-working them. The Eagle Ford Shale was known mainly as a nuisance formation from which drillers would get a small kick of gas whenever they drilled into a deeper conventional formation.

[15] https://www.forbes.com/sites/davidblackmon/2018/09/13/the-usas-three-legged-stool-of-energy-dominance/#27a9f6232b7a

[16] https://chinapower.csis.org/energy-footprint/

[17] In 2015, most of China's energy and coal use came from the industrial sector, with 67.9 percent of the country's energy use and 54.2 percent of its coal use due to manufacturing, agriculture, and construction. An additional 41.8 percent of China's coal consumption came from power production activities.

Over the last decade, China's investment in renewable energy and natural gas has surged. In 2017, almost half of global renewable energy investment came from China, totalling $125.9 billion. This is more than double the $53.3 billion that China invested in renewables in 2013. China is becoming the largest market in the world for renewable energy. It is estimated that 1 in every 4 gigawatts of global renewable energy will be generated by China through 2040.

China is likely to overtake OECD Europe as the leading producer of wind power by 2020 or 2025, with the U.S. ranked third. If it so happens, wind power deployment would save up to 4.8 gigatons of CO2 emissions per year by 2050, with China providing by far the largest reductions. The reduction is equivalent to more than the cur- rent E.U.'s annual emissions. Nuclear power generation is already an established part of the world's electricity mix, providing some 11 percent of world electricity of 22,752 TWh.

Renewable revolution

The 21st century promises to usher in the age of renewable energy. The world today is drawing more and more of its power from the sun, wind, water and biomass fuel, as the cost of these sources — down considerably from seven years ago — continues to drop.

The rapid deployment of renewable energy is fundamentally transforming energy supply and power markets, resulting in lower average prices but also more volatile prices. These new market dynamics are causing pain for inflexible generation resources, but also creating significant revenue-enhancing opportunities for flexible resources, particularly in the ancillary services and real-time markets18. The growth of renewables does, however, alter the competitive dynamics of the market and, assuming the trends continue, that shift could become very significant over the next 20 years19.

As renewables are now part of the energy portfolio and are rapidly gaining market share, they bring along benefits such as energy mix diversification, with distributed generation growing at a fast pace worldwide and its installed capacity expected to more than double in the next decade. At the same time, as the energy generation port- folio transitions and diversifies further, new challenges are emerging, which require changes to the electric utility business model and regulatory policies to ensure secure and reliable supply.

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[18] Navigating the new energy market dynamics, 1 March 2018, https://www.risk.net/cutting-edge/energy/5437176/navigating-the-new-energy-market-dynamics

[19] Renewables are changing the dynamics of the energy business, Nick Butler, 12 October 2015, https://www.ft.com/content/50c13709-b006-3882-8bf1-75284d942514

The sun could arguably be the world's largest source of electricity by 2050, ahead of fossil fuels, wind, hydro and nuclear. Globally, it provides 0.5 percent of electricity generation and, in the U.S., only 0.2 percent. Some optimistic IEA roadmaps show how solar photovoltaic systems could generate up to 16 percent of the world's electricity by 2050 while solar thermal electricity from concentrating solar power plants could provide an additional 11 percent. Combined, these solar technologies could possibly prevent the emission of more than 6bn tons of carbon dioxide per year by 2050 - that is more than all current energy-related CO2 emissions from the U.S. or almost all of the direct emissions from the transport sector worldwide today.

It looks as though we are in a better position with wind power, which could possibly generate up to 18 percent of the world's electricity by 2050, compared with 2.6 percent today. The nearly 300 giga- watts of current wind power worldwide will increase eight-to-ten- fold, with the more than $78bn in investment today progressively reaching $150bn per year.

The U.S. is losing the renewable energy race to China, but will be the undisputed leader for oil (an all-time record this year at 11.7 mb/d) and gas in the coming years. The scale of China's clean energy deployment, technology exports and investment makes it a key determinant of momentum behind the overall global low-carbon transition. By 2040, China will have 30 percent of the new wind and solar power capacity and 40 percent of the global investment in electric vehicles20.

Innovation has been a constant companion of the energy system. Recent trends in technical maturity and cost reductions in solar photovoltaics, onshore and offshore wind, battery storage and unconventional fuel extraction have fundamentally altered the global energy balance. Moreover, technologies like smart grids, demand response and blockchain will open up new frontiers for the future energy system by changing the relationship between consumers and suppliers. These new energy market participants demand new set of skills, highlighting the need for human capital development.

Natural gas; no longer a "transition" fuel

Major international oil companies have gradually shifted focus towards gas, to the extent that they are now sometimes referred to as ''Big Gas'' rather than ''Big Oil.'' For companies like Shell or BP, gas now comprises more than 50 percent of their total production. Gas reserves are more accessible and have a wider global distribution. Cleaner gas takes away market share from coal

[20] http://www.businessinsider.com/china-holds-the-keys-to-the-electric-car-revolu- tion-2017-12?IR=T

produced for electricity production and oil in the transport industry, due to environmental concerns.

The share of natural gas in the primary energy mix is rising faster than that of oil and coal and the gas industry is simultaneously undergoing immense changes as new technologies, demand and sup- ply patterns entice new market forces.

In 2011, after the Fukushima nuclear accident, the International En- ergy Agency heralded the arrival of a "golden age" of gas in the period until 2035 due to enormous economic growth in China combined with significant gas consumption, a low share of nuclear energy in the generation of electricity, an increase in the use of gas in the transportation sector, and a boom in unconventional gas production and subsequently lower prices.

Electricity from renewable resources still requires natural gas as a back-up energy source because there is no uninterrupted supply of renewable energy avail- able, at least until technology enabling the high-efficiency storage of electricity is discovered and commercialized21.

Unconventional gas is becoming a real game changer in the U.S. gas market. The widespread adoption of techniques such as hydraulic fracturing and horizontal drilling have made those reserves much more accessible, and, in the case of natural gas, has resulted in a glut that has sent prices plunging. The "shale gale" sweeping across North America the past few years has more than doubled the size of the discovered natural gas resource in North America- enough to satisfy more than 100 years of consumption at current rates, accordIng to a major new analysis of the leading unconventional gas plays in North America by IHS Cambridge Energy Research Associates.

In 2010, 12 bn cubic meters (bcm) of LNG was imported into the U.S.; before this unconventional gas revolution, this number was expected to reach 140 bcm by 2020. Now, the U.S. is a major natural gas exporter, transforming the global gas market.

If the Henry Hub price curve remains near $322, LNG exports of do- mestic production look very competitive at anticipated prices in Europe. If the Henry Hub price curve is raised and a higher price event or set of events happens, such that a $10 spike is tenable, then exports look out of the question. A future price level that could accommodate a $10 price spike also could be more attractive to LNG imports.

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[21] https://www.mckinsey.com/industries/oil-and-gas/our-insights/three-game- changers-for-energy

[22] The price of gas sold by American Henry Hub dropped in 2012 to a level of $2 per million metric British thermal unit (MMBtu), its lowest in the past decade, while the European average spot price and oil-indexed price have fluctuated between $8 and $10, and the Japanese average around $17.

The U.S. success story has inspired many other countries, including Argentina, China, Poland, South Africa and the U.K., to develop their own reserves. Shale development in China, home to the world's largest shale deposits, has been slower than predicted by the government. China may produce 6.5 bcm of shale gas annually by 2015 and has set a target of 60-100 bcm of production annually by 2020, according to China's National Development and Reform Commission.

However, as yet, no country other than the U.S. has what could be termed a shale gas industry -- gas production from tight oil and shale plays is still negligible outside the U.S. Most production increases will only come after 2020, as countries need time to develop the commercial unconventional gas sector due to various geological, logistical and regulatory challenges. The countries where shale gas is presumed to exist in the EU are Germany, Poland, Sweden, France, Austria, Hungary and the U.K.. Warsaw is harbouring major ambitions to develop shale gas, the switch towards which is like "the 21st Century's gold rush"23.

Another development that has and is transforming the landscape of the natural gas industry is the advent of Liquefied Natural Gas (LNG). This mode of transport allows gas-exporting countries to ship their gas over long distances and releases them from the traditional dependence issues associated with pipelines. Pipelines are expensive and once built indefinitely tie producers and consumers while LNG allows both exporting and importing countries to escape this form of captivity. This understandably has both commercial as well as geopolitical consequences.

Despite the rise of LNG, pipelines are still the backbone of the gas industry. Transport by pipeline is not as flexible as by LNG tanker, but is often the cheapest method, depending on the geographical location. Coal, oil and gas will continue to play an important role, particularly natural gas. Abundant, affordable and acceptable – gas is a triple A energy source. It is cleaner than coal; gas-fired generation is relatively quick and cheap to build; and the shale revolution in North America has raised hopes that gas is abundant in geological formations the world over.

Nuclear 'key' to the world's energy future

Another holy grail of alternative energy sources is nuclear fusion, where power is generated by fusing atomic nuclei together in a reaction that releases immense amounts of energy. Fusion is the same reaction powering the Sun. It has the advantage over conventional nuclear fission power in that it is clean

[23] Warsaw is harbouring major ambitions to develop shale gas, the switch towards which is like "the 21st Century's gold rush".

and virtually waste-free – but it only seems to work at the intensely high temperatures found in the Sun, a problem for a reactor on Earth24.

Nuclear power stations have proven to provide a steady "base load" whether the wind is blowing or the sun is shining, and of course, they do not require fossil fuels – although there is the question about continued supplies of uranium and what to do with the nuclear waste.

Despite Japan's Fukushima accident following the tsunami in March 2011, the latest projections by the International Atomic Energy Agency show that the global use of nuclear power will grow significantly in the coming decades. Power produced from nuclear fission is now a mature technology that provides about 16 percent of the world's electricity and almost a third of that in the EU.

Many emerging market governments have committed to a fresh round of building nuclear fission power stations, despite opposition from environmentalists and those concerned about nuclear proliferation Over 30 countries benefit substantially from nuclear energy. In addition to the 400 or so nuclear power plants around the world, many more are to be built over the next 30 years25.

Every time there is an accident, proponents of nuclear power point out that risks are also associated with other forms of energy. Coal mining implies mining disasters, and the pollution from coal combustion results in some ten thousand premature deaths in this country each year. Oil rigs explode, sometimes spectacularly, and so, on occasion, do natural gas pipelines. Moreover, burning any kind of fossil fuel produces carbon-dioxide emissions, which, in addition to changing the world's climate, alter the chemistry of the oceans.

Among those who argue most passionately for nuclear power these days are some environmentalists, who see the uncertain threat that it presents as preferable to the certain harm of climate change. An objective comparison might indeed suggest that a well-designed and vigorously regulated nuclear power plant poses less danger than, say, a coal-fired plant of comparable size.

The global use of nuclear energy is forecast to grow by 1.9 percent per year from 574.0 million toe in 2014 to 859.2 million toe in 2035 this is not actually 50 percent. Nuclear output in the E.U.and North America is expected to decline 29 percent and 13 percent, respectively, as aging reactors are gradually retired and the economic and political challenges of nuclear energy stunt new investments.

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[24] https://www.springer.com/la/book/9783642415951

[25] Over 30 countries benefit substantially from nuclear energy. In addition to the 400 or so nuclear power plants around the world, many more are to be built over the next 30 years.

However, output in China is forecast to increase 11.2 percent annually. Japan's nuclear output will reach 60 percent of its 2010 level by 2020, as reactors restart over the next five years. Other key energy hungry emerging economies are also busy building new nuclear plants to deal with future shortages and to move away from heavy dependence on fossil fuels.

Nuclear energy is no silver bullet for resolving all of the world's energy problems. But it is a crucial part of the global solution of a sustainable and diversified energy mix. And greater diversification of electricity generation technologies means greater security of supply. Hence, nuclear energy must be seen as essential to a com- mon solution, and not as a rival to other technologies. It has already contributed to the development of other, mainly renewable, energy sources.

Technology: a blessing or curse?

"Disruptive" role of energy technologies, in its many forms, is the key to a decarbonised energy future. Artificial intelligence, block- chain, 3-D printing, the Internet of Things, and drones are just some of the emerging technologies that are already transforming our world. In particular, advances in electric storage and renewable energy are key areas that have the potential to dictate the pace and the scale of the energy transition26.

The anticipated improvement in electric storage, notably batteries, has the potential to revolutionise the transport sector as the electric vehicles become a viable alternative to petrol and diesel fuelled cars. The costs of energy storage technologies are likely to be reduced by as much as 70 percent by 2030. Factors that could further dampen the growth in energy demand growth such as energy efficiency and the end to energy subsidies remain high on the agenda of global energy leaders.

Digital disruption is creating new opportunities – but also threats. On the one hand, technology is instrumental for realising intelligent grids and interconnected assets; on the other hand, it introduces new threats such as the possibility of cyberattacks. The increasing interconnectivity and proximity of energy systems means that conflicts can have ripple effects on energy markets and prices. Global inexperience in handling large-scale cyberattacks, combined with the greater capabilities of state and non-state actors, has in- creased the likelihood that future wars and attacks will have a larger cyber component.

Being a leader in energy security today does not mean this competitive advantage will carry through to the future. Tomorrow's winners will be those who successfully manage two key transitions: from a technology standpoint,

[26] https://www.pwc.es/es/digital/assets/pwc-cips-future-of-industries.pdf

their operators must be able to benefit from digital innovation while at the same time building up a solid defence to cyberattacks. From a legal framework standpoint, their structures will have the necessary flexibility to adapt to an ever-changing environment.

Clearly, electric vehicles, robotaxis, and autonomous vehicles sales are at record highs and growing rapidly. Tesla's Model 3 will gain traction this year, and other automakers will introduce more EV models. China is on the way to become the global leader in EV. Vehicle fuel consumption should see a major decline globally as a result, but it won't happen for a couple of decades.

While there are a lot more electric cars, hybrids, and fuel-efficient gasoline-powered cars than a decade ago, sales of pickup trucks, SUVs and crossovers due to low prices have taken away fuel economy gains. We also heard from countries like China, India, France, Great Britain, and Norway—all pledging to ban the sale of fossil fuels to power vehicles on their roads. Electric vehicles could possibly make up 90 percent of all vehicle sales globally by 2050. That would be made up of about one bn battery electric vehicles out on roads worldwide.

Digitalisation has shown remarkable movement by advancing in all three dimensions; uncertainty, impact and urgency. New technologies and replacement of old infrastructure with smarter equipment, along with asset-less activities such as demand response, will have a major impact on the sector in the coming years. Although being a relatively new topic, IoT/Blockchain has gained great attention, being perceived as a potential source of disruption to the sector.

Towards a low-emissions world

No doubt, the world needs to be energized in an affordable, secure, growth-inducing and climate-friendly manner, deploying all available resources, new technologies, policies, institutions and investment dollars. This is critical not only for the needs of today but also for our longer-term future.

The energy industry is coming under increasing pressure (and obligations) on carbon. Simply switching from fossil fuels to renewables alone will not solve the climate change problem. The commitments made at Paris still fall far short of what is required to halt global warming at the 2° C mark, never mind reversing the growth of greenhouse gases in the atmosphere. The simple truth is that the Paris agreement is blind to the fundamental, structural problems that prevent us from decarbonising our economies to the radical extent needed.

There are some hard facts that cannot be ignored. First, the renew- able schemes to date have largely been at the expense of unpopular nuclear installations, while the global share of fossil fuel-generated energy

consumption remains at about 80-85 percent: just where it's been since the early 1970s. Second, the massive amounts of land required for installing gigawatts of solar and wind power will destroy natural habitats and take away valuable farmland27.

As our transition towards achieving lower carbon energy and feeding the energy hungry world continues, a careful, commercially meaningful balance needs to be found between the investments allocated to natural gas and those reserved for renewables, nuclear and advanced technologies.28.

While renewable energy has been growing rapidly29, it is coming from a very low base. The share of electricity that the world's 20 major economies are generating from the sun and the wind has jumped in the space of five years. Whether this breakthrough is sustainable and what it means for the battle against climate change is not clear yet. What's clear, though, is that the growth of renewables and other low-carbon energy sources will not follow a straight line. Investment in ''clean'' energy has been faltering this year after hitting a record high in 2015 (China, alone, had invested over $110 bn).

There are a few dark clouds on the horizon that could upset the banner year for clean energy. The Trump factor is still not well known in terms of which direction it may go, despite the worrisome rhetoric. China's economic troubles could put a dent in investment. The U.S. Federal Reserve raising interest rates, and supporting a strengthening of the U.S. dollar, would increase the cost of capital for new solar and wind projects. And while cheap fossil fuels did not head off the clean energy boom in 2015, persistently low oil and gas prices could prevent much stronger growth. Still, the clean energy sector is now a third-of-a-trillion-dollar industry, with much more room on the upside. The transition to clean energy is already underway, and there is probably no going back.

The climate change accord is already three year old in the works. The realisation will begin to set in that the targets have a high probability of being unachievable – within most countries, and globally as a whole. The biggest

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[27] This is already evident in the way existing biomass production schemes - forests in the U.S. for instance, sugar cane in Brazil, palm oil in Malaysia or wind farms in Turkey - have had serious environmental and social side-effects to the extent that they have been labelled as ''greenwash.'' Third, together with demand from electric vehicle manufacturers, a worldwide renewables boom would rely on a 5 percent to 18 percent annual increase in global production of minerals for the next 40 years. Inexpensive natural gas provides a low-cost transition path from higher-carbon-content fuels such as coal and petroleum.

[28] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Turning_to_renewables_2017.pdf

[29] Renewables, including hydro, accounted for just 5 percent of global daily energy supply. That is increasing — solar photovoltaic capacity grew by 50 per cent in 2016 — but to make a real difference the industry needs a period of expansion comparable in scale to the growth of personal computing and mobile phones in the 1990s and 2000s.

unknown to energy markets is what the world governing bodies will do after waking up to this realisation.

A radical change will be necessary to make the industry global and capable of competing on the scale necessary to displace coal and natural gas. Falling costs, Chinese dominance and competition in battery technology are some of the main developments to monitor.

New geopolitics of energy

Much has been written about the effect of fossil fuels on geopolitics. The world's highly concentrated deposits of oil, natural gas and coal have helped determine the global balance of power over the past century, giving a small number of energy-rich states, many of them in the Middle East, tremendous influence. Since World War II, the U.S. has acted as guarantor of global energy security, protecting its own national interests in the process. Washington formed alliances — most significantly with the Gulf Arab states — to stabilize global energy flows and has been the leader in safeguarding maritime choke points in the Middle East and Asia. The result is a globalised oil, coal and natural gas market and an international oil trade conducted in U.S. dollars — a major boon for the U.S..

Geopolitics, including the threat of expanding conflicts in the Middle East, East Asia, Caucasus and Africa could possibly replace oil supply cuts by OPEC and non-OPEC countries as the biggest driver of energy prices in the coming years. Diplomatic relations between Europe and Russia, for instance, supplier and importer of gas and oil respectively, are fragile. Around the world, threats to stability abound, from the economic shock of oil prices to the rise of extremism and terrorism. Global supply outages averaged 2.7 mb/d and 2 mb/d in 2016 and 2017, respectively. Supply outages from Libya, Venezuela, Iran, and Iraq could increase in 2018 due to new geopolitical tensions.

Renewable energy does not lend itself to the same kinds of international oligopolies. For one thing, renewable energy sources are practically universal: Few places in the world lack wind, sunlight, water and bioenergy of any kind. (That said, however, the renewables industry currently depends on a few critical materials, such as lithium, available and accessible in only a handful of countries worldwide.) Plants for generating wind, solar and hydropower, the predominant renewable energy sources, moreover, require no fuel — and, by extension, no fuel shipments — to operate once commissioned.

In addition, renewable energy generation is by its very nature intermittent. The sun shines, the wind blows and rivers flow fully only some of the time, regardless of geography, further evening the geopolitical playing field. And

compared with more traditional fuels such as natural gas and coal, renewable energies have a much higher potential for decentralised generation.

The global transition to renewable energy will put electricity center stage since renewable energy overwhelmingly takes that form in supply and in usage. To reduce costs and to prevent shortages in the event of a still or overcast day, countries will probably opt to integrate their electricity grids regionally. As a result, today's globalised energy world will gradually become more regionally focused, though global trade will continue.

For some of those who imagine America's burgeoning energy wealth will spur it to retreat from global politics, there is concern a U.S. exit from the Middle East may augur crisis, conflict or even war between nations in the region. But the U.S. has already become less dependent on Middle East crude and has not pulled back troops. There is really no threat to energy supplies. Certainly there is no threat that could not be countered by increased production elsewhere in the world.

Some countries will fare better than others in the course of the energy transition. Germany and the U.S., for instance, are well-positioned to take advantage of the rise of renewables, thanks to their leadership in the field — and the sheer size of the U.S. market. But China is even better off[30].

In the past decade, China has raced ahead to become the world's unrivalled leader in the manufacture of clean energy products, including solar cells and batteries — of which it makes more than half of the global supply. It is also the world's biggest miner and supplier of rare earth materials, biggest deployer of renewable energy capacity and biggest market for electric vehicles. The country has acquired substantial lithium and cobalt mines abroad to power its push toward renewable energy, while also investing in electric utilities around the world, including in Europe, Africa and South America. More recently, it has proposed an ambitious initiative to integrate electricity markets throughout Asia with up to 3,000 kilometers of long-distance, high-voltage transmission lines.

These projects combined could make China the main provider of energy products, services and technology to much of the world. Even so, the U.S. can preserve its traditional importance in the energy sphere with innovation. The growth of renewable energy will demand new solutions in finance, technology

[30] The energy corridors from Central Asia to China, Russia to South Asia and to Europe and the Gulf countries could eventually position the “Middle Kingdom” at the centre of a “Pan-Asian Global Energy Bridge” that will connect existing and potential suppliers to Asia (i.e., the Middle East, Central Asia, and Russia) with the key consumers (China, Japan and Korea). If successfully implemented, such linkages will not only largely improve the energy security of China, but also will enhance its geopolitical influence and trade in this geography as well as boosting the global energy security.

and systems to fund clean energy products, reduce costs and boost efficiency, and improve grid integration.

Though they stand to benefit the most from the global shift toward renewable energy, China, Germany and the U.S. will not be the only winners. India, for example, may be able to stake its claim to the renewable energy market. The country does not have much of a domestic renewables industry, compared with China, the U.S. or Germany. On the other hand, it boasts one of the world's largest markets for renewable energy.

Hoping to carve out a global role for itself in the renewables realm, India has launched a joint initiative with France for the International Solar Alliance, aimed at building and financing affordable solar power infrastructure in developing countries, including states in sub-Saharan Africa. The project, if successful, will enable India to increase its sway among the world's poorer countries[31].

For other states, however, the rise of renewables will be a loss. Traditional oil exporters such as Venezuela, Kazakhstan and the Gulf Cooperation Council states will be among the countries hardest hit by the gradual transition away from fossil fuels. While states like Saudi Arabia will harness their abundant sunshine to become major solar power producers, this status will not confer the same geopolitical prominence that they enjoyed in the oil-dominated world of the past century. Russia, likewise, will lose some of its clout in the renewables-rich world of the future — though not all of it if enough states turn to nuclear energy to combat climate change. Furthermore, the country will remain a significant exporter of natural gas to markets in Europe and Asia for decades to come.

Along with the changes it will cause to the geopolitical order, the rise of renewable energy may well change the face of war. Fossil fuels, particularly oil, have set off several conflicts since World War II, including coups, civil wars and military interventions. Renewable energy — because of its comparative abundance and potential for decentralisation — probably will not have the same power to spark large-scale military confrontations, especially in the Middle East. In fact, renewable energies may even inspire increased co-operation among states by encouraging regional grid integration. Electric grids, after all, are harder to use as a political weapon than are natural gas pipelines, for example.

Still, that does not mean renewables will not cause their share of international strife. As electric grids become smarter and more interconnected, they will

[31] Smaller countries such as Sweden, Denmark, Uruguay, Nicaragua, Morocco and Kenya, meanwhile, could gain outsize regional influence as a result of the transition, thanks to their potential for exporting renewable energy and technology.

make prime targets for cyberattacks by hostile states and terrorist organizations alike. (Decentralizing electricity grids will mitigate this risk.) The supply security of clean tech minerals also will be an area of contention, though interruptions in shipments of materials for new wind turbines, for instance, won't carry the same immediate consequences as disruptions in fuel supplies needed for daily power generation.

And unlike oil, renewable energy technologies are rife with opportunities for innovation to use more commonplace materials in power generation. That means that in time, the commodities that clean tech currently depends on — namely rare earth metals, cobalt and lithium — will become less relevant.

Yes, but where will money come from?

The world energy industry needs around $37 trillion dollars over the next two decades for new greenfield projects and upgrading energy existing infrastructure. How will these projects be financed at a time when domestic sources of funding are dwindling, international conventional finance has become extremely difficult to attract and political uncertainties and commercial risks abound in the world.

Capital is not the issue – there are so much money flowing in the market. It is to find the right projects with long-term stability and good rates of return with minimum risk. Creating alternative funding models via non-traditional investors is one of the ways including insurance companies, pension funds, sovereign wealth funds, private equity and Islamic finance institutions.

Global energy investment totalled $1.8 trillion in 2017, a slight decline in real terms from the previous year. More than $750 billion went to the electricity sector while $715 billion was spent on oil and gas supply globally. The electricity sector attracted the largest share of energy investments in 2017, sustained by robust spending on grids, exceeding the oil and gas industry for the second year in row, as the energy sector moves toward greater electrification, according to the International Energy Agency32.

State-backed investments are accounting for a rising share of global energy investment, as state-owned enterprises have remained more resilient in oil and gas and thermal power compared with private actors. The share of global energy investment driven by state-owned enterprises increased over the past five years to over 40 percent in 2017.

[32] https://www.iea.org/newsroom/news/2018/july/global-energy-investment-in-2017-.html

Overall, more than twice as much money was spent on renewables than on coal and gas-fired power generation in 2018. For the first time, emerging economies outspent richer nations in the green energy race, with China accounting for a third of the global total. China remained the world's biggest investor in energy worldwide, with $315bn spent, despite a slowing in the pace of its headlong economic growth33. The oil and gas companies are now starting to use clean-energy investments to hedge their bets that markets for oil and gas will exist decades from now. They have invested in wind farms, electric battery stor- age systems and carbon capture and storage.

Divestment – the decision to voluntarily reduce one's fossil fuel investments – has been a hot button topic of discussion since 2011. Divestment arguments have often focused on the morality of investments, but the economic value of divestment has recently become hard to ignore. With the value of fossil fuel holdings plummeting and the profitability of renewables growing, investors and companies are increasingly looking to sustainable investments for good long term bets34.

When Prudential Capital Group provided $121 million in financing for an Arizona solar power project in early 2018, and General Electric hit the $1.4 billion mark in solar energy projects it has invested in cumulatively, they were not speculating in risky, early-stage technology ventures. They were investing in core infrastructure projects with high gross margins and revenues fixed for 20 to 25 years; "power plants with no fuel costs35".

Typically, investors such as Prudential, Google and GE come in when virtually all the risk has been structured out through long-term agreements with large utilities that agree to purchase the power generated by these renewable energy generation projects. These projects offer stable, low double-digit rate of returns while generally paying out an annual yield in the range of 6-8 percent.

The U.S. shale industry is at turning point after a long period of operating on a fragile financial basis. The industry appears on track to achieve positive free cash flow for the first time ever this year, turning into a more mature and financially solid industry while production is growing at its fastest pace ever. The improved prospects for shale sector contrast with the rest of the upstream oil and gas industry. Investment in conventional oil projects, which are responsible for the bulk of global supply, remains subdued. Investment in new conventional capacity is set to plunge in 2018 to about

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33 Towards a low-emissions world, Mehmet Öğütçü, Chairman of Global Resources Partnership and Executive Chair of The Bosphorus Energy Club, 16 December 2016, https://www.aboutenergy.com/en_IT/topics/Otugtu-Oil33-eng.shtml#

34 https://www.theguardian.com/sustainable-business/2016/feb/13/renewable-energy-investment-fossil-fuel-divestment-investor-summit-climate-change

35 https://www.forbes.com/sites/mindylubber/2012/03/20/investors-are-making-money-on-renewable-energy/#6731d7cb1516

one-third of the total, a multi-year low raising concerns about the long-term adequacy of supply.

Policy messages: Energy dreams and realities

Let's make no mistake: This is not the first time that the energy sector has faced a series of such risks and uncertainties as today if you recall the oil shocks of the 1970s and 1980s, and the natural gas crisis emanating from the Russian-Ukraine disputes as well as nuclear accidents. Nonetheless, it is at its height now. Uncertainties are particularly dangerous in a sector where investments are long- lived and take a long lead-time to pay off.

New realities are emerging for us to consider for government and business decisions. The challenge from renewables will be focused on natural gas and expensive new nuclear. Apart from the U.S., where indigenous shale gas continues to push out coal, gas is vulnerable to renewables as costs fall and as regulations in Germany and elsewhere protect the share of wind and solar in a declining market squeezed by anaemic economic growth and gains in efficiency.

Despite the rhetorical claims about the imminent "golden age of gas", demand in Europe is down by 20 per cent over the last decade. The problem for gas producers is that extracting and transporting it to market is expensive. LNG facilities take years to build and require billions in investment capital. So, of course, do new nuclear facilities.

The fundamental fact is that renewables add to supply at a time when there is no shortage of any of the alternatives. Protection and subsidies have given them a basic position in the market. Once in place, most of the costs of turbines and panels and grid connections have been accounted for. Operating costs tend to be very low (sunshine is the cheapest of inputs) which gives owners every incentive to keep producing even if subsidies fall.

On top of that there are numerous potential technical gains that would translate into lower costs. All this means that the growth of renewables will put serious downward pressure on energy prices. Also, they mean less geopolitical tensions. Natural gas would become increasingly important in the power sector, replacing much coal-burning both in the U.S. and abroad. also, possible scientific breakthroughs for building lighter, cheaper and faster-charging batteries for cars; biological breakthroughs to make biofuel production more economical; and even advances in the development of hydrogen fuel cells to run electric motors on cars, resulting in emissions of only water vapour. But, commercialization of any of the possible breakthroughs would take at least another decade.

Commodity prices, volatility and capital needs which has a massive impact on energy markets, energy technologies in terms of renewables and electric storage. Those countries heavily dependent on energy imports or exports are seriously affected by the ups and downs in energy prices36.

Energy access and affordability are surprisingly not seen as an urgent global action priority. 100 percent of high income world citizens have access to electricity while only 35 percent of the low income does. Technology and decentralisation is expected to address this continued divide. As fast as the world is embracing technology and decentralisation, several countries with a total population of over one billion people are still working towards universal electricity access delivered reliably and affordably.

At today's stage of the transition, however, concerns are much more focused on the impact of subsidies and electricity prices as new technologies are being added to the mix, and as traditional and new energy resources redefine their space in the global energy economy.

It is important to see how OECD and non-OECD countries are defining differently their respective energy transition agendas and the underlying issues involved. For example, within the energy security dimension, the level of impact of digitalisation and cyber threats are perceived as substantial among OECD countries, whilst it is not a priority for non-OECD. Among the latter, economic growth is higher on the agenda and is strongly associated with energy security concerns37.

It looks as though trade will continue to be a source of conflict among states. The growing market for renewables will give rise to more battles over issues such as intellectual property theft, dumping and domestic content requirements. These disputes could undermine the global trading regime if they become heated enough. The slow but accelerating drift from fossil fuels toward renewable energy sources will change life on Earth within the next few decades, redefining how countries interact with one another.

As non-OECD countries develop, digitalisation and cyber threats will increase in impact for this group as well. This already creates new opportunities for cooperation around strategic learning about these 'future' issues, which can positively impact the transition by reducing the learning time for the non-OECD and contributing to further accelerate energy development38.

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[36] The evolution of oil markets, with the extension of the OPEC deal and increased competition due to the US shale offering, induces significant concerns for the months to come. Climate framework emerges as a new action priority with growth in both urgency and impact over the previous year. The climate framework is a key element to the energy transition and to the transformation of the energy sector.

[37] Definition of energy sustainability is based on three core dimensions – energy security, energy equity, and environmental sustainability.

38 https://www.worldenergy.org/wp-content/uploads/2018/05/Issues-Monitor-2018-HQ-Final.pdf

Much of the future of energy will depend on government policy, of course, and several major decisions are coming soon. Massive amounts of capital are now tied up in the industry - they are held hostage to a single issue: price. The shakeup of capital markets is inflicting opaque, collateral disruption to the energy business too. Financial technologies are altering fund flows, market liquidity and access to capital.

For some of the established companies and their investors these are uncomfortable trends and conclusions. In the future, the companies might call themselves ‘’energy’’ companies rather than oil, gas, wind, solar or nuclear groups, though each has a distinct business model and involves different challenges and opportunities. It will be fascinating to see which of the international energy companies and governments will be the first to grasp what is happening and to set out a convincing strategy for a geopolitical and business world beyond the status quo.