

# The global energy transition: challenges and opportunities – a perspective from North America

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**Abstract.** The energy transition from fossil fuels to renewables is dominating the news in North America and other parts of the world. A decade ago, most people would have viewed global warming as an academic subject which did not impact themselves nor warrant serious concern. However, currently many parts of the world are experiencing record temperatures and related environmental impact such as the extensive forest fires being experienced in the western USA and Canada. Accordingly, governments worldwide recognize the need for future economic activity to be carbon-neutral or as is also termed carbon-zero. To achieve the goal of carbon-neutral economies by 2050 will be hugely challenging but economic opportunities will also arise in the major development of solar, wind and geothermal energy.

**Keywords:** Paris climate accord, carbon-neutral economies, renewable energies, carbon capture sequestration and storage

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## Introduction

The past year has been one of upheaval for the world's oil industry. With the onset of the pandemic a year ago, Covid-19 “demand destruction” resulted in global oil demand plummeting from 101 million barrels of oil per day to the current 94 million barrels of oil per day. Prices dropped from US\$60 per barrel to as low as zero last April and now have recovered to the current price of \$70 per barrel (July 23, 2021). A year ago, the world was already seriously discussing the need to transition to a carbon dioxide-zero (carbon-zero) economy. The target is for global economic activity to be carbon-zero by 2050. During this past year, an increasing number of sovereign funds, banks and institutional investors announced their intentions to divest themselves of their investments in oil and gas companies.

Figures 1 to 4 (below) highlight the issues facing today's world in terms of atmospheric CO<sub>2</sub>, rising temperatures, rising CO<sub>2</sub> emissions on a regional basis, and historical population growth.

## The energy transition requires critical thinking

The energy transition is dominating the news media in North America. The current record-breaking high temperatures and vast forest fires in western USA

and Canada is heightening the public's awareness of the urgent need for the world to accelerate the energy transition. People are asking if these temperatures and environmental stress is “the new normal”. However, there are broad philosophical and social justice issues which also must be considered in the energy transition. Scott Tinker is an American geologist, academic public educator, former president of the American Association of Petroleum Geologists and current Director of the Bureau of Economic Geology at the University of Texas, Austin, Texas, USA. He is also a film maker of documentaries on oil, gas and the energy transition. His latest documentary on energy is titled “*Switch-on*”.

Tinker has mentioned the following at many presentations he has made worldwide (Tinker, 2021):

1. Global poverty issues cannot be addressed without adequate energy;
2. One billion people in the world are without electricity and one third of the world is impacted by *energy poverty*;
3. Most of the world's ills including hunger, clothing, shelter, immigration and migration, population growth, healthcare and even empowerment of women can not be addressed with access to *affordable energy*;
4. Accordingly, governments worldwide as they deal with the energy transition must also consider the need of those without energy or those who live with energy poverty.

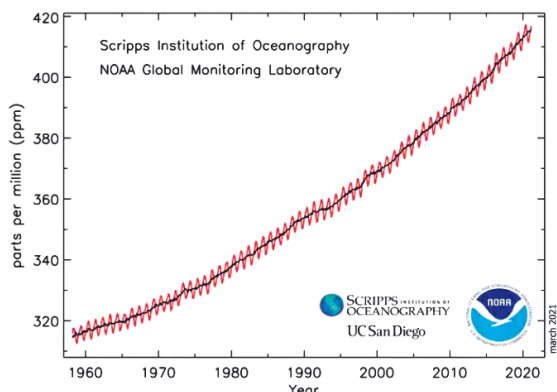


Fig. 1. Atmospheric CO<sub>2</sub> from 1960 to 2020, 60 years at the Mauna Loa Observatory, Hawaii, USA. CO<sub>2</sub> concentration increased from 315 ppm to 415 ppm, a steady increase of 32%. From: Scripps Institute of Oceanography, University of California, 2021.

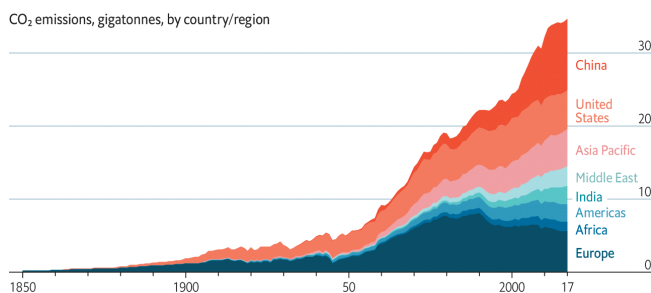


Fig. 3. CO<sub>2</sub> emissions, gigatonnes, by country and region, 1850 to 2017. From: Global Carbon Project, Carbon Dioxide Information Analysis Centre. Published in *The Economist*, 2020.

### Global politics and the energy transition

The election in the United States of President Joe Biden is having a major impact on the oil industry with the Biden administration’s immediate announcement of their intent for the United States to rejoin the Paris Climate Agreement.

Almost all countries signed the Paris Agreement in 1996, whose objective is to limit global warming to well below 2.0 degrees C above what it had been before the Industrial Revolution and preferably keep it below 1.5 degrees C. The importance that the USA now places on the energy transition is the statement of January 28, 2021 by John Kerry, USA Presidential Envoy for Climate that “the United Nations Glasgow Climate Summit to be held November 1 to 12, 2021 is the world’s last best chance to avert the worst environmental consequences for the world”. The USA Department of Energy states that there is no greater challenge facing the USA and the planet than the climate crisis. China, the world’s second largest consumer of oil after the USA which is the largest, is also committed to the energy transition. Earlier this year, China’s President Xi Jinping announced that China will reach peak emissions by 2030 and will be carbon-zero before 2060. Figure 5 highlights the USA and China’s levels of emissions in the past four decades.

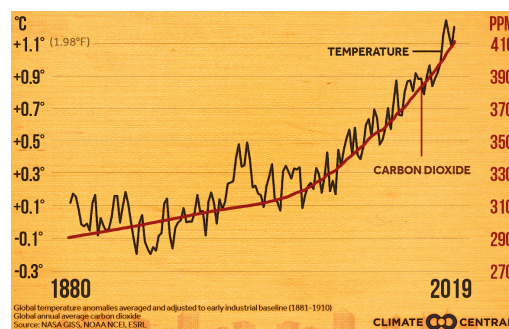


Fig. 2. Global temperatures and carbon dioxide from 1880 to 2019. CO<sub>2</sub> increased by 42% in 139 years. From: Climate Central.

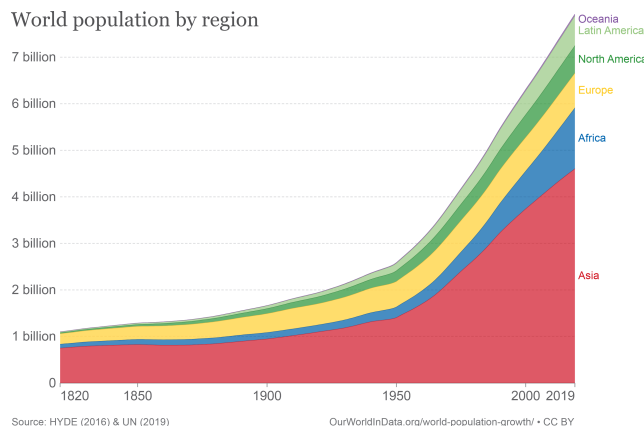


Fig. 4. Human population growth by region, 1820–2019. In 1950 the world had 2 billion people. In 2021 the world has almost 8 billion people. This rapid population growth is not environmentally sustainable. From: United Nations, 2019.

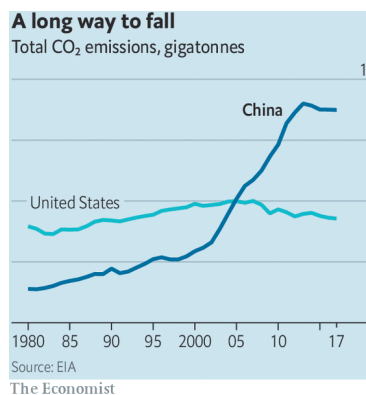


Fig. 5. China and USA CO<sub>2</sub> emissions, 1980–2019. Source: USA Energy Information Agency. Published in *The Economist*, 2020.

### Canada

Regarding my country of Canada, the government of Canada has set a goal of reaching “net zero” greenhouse gas emissions economy-wide by 2050. Although Canada’s total CO<sub>2</sub> emissions is relatively small compared to the USA and China due to our small population of only 35 million people, Canada has the world’s highest level of emissions produced on a per capita basis due to our high standard of living and due to our very cold climate which requires much energy to heat our homes, offices and factories. Furthermore, Canada is the second largest country in the world, after Russia, and due to the great distances between our cities

and towns, Canadians consume much gasoline, diesel and jet fuel in their travels in the country. The burning of thermal coal and natural gas to produce electricity has also impacted on our high level of per capita emissions. Canada's government will raise carbon taxes to \$170 per tonne by 2030. Canadian environmental groups and the government of Canada as well as provincial governments believe that the toll of continued climate change consisting of adverse weather effects like floods and wild fires far outweigh the near-term economic downsides with carbon taxes which is significant losses of employment and Gross Domestic Product (GDP). On the other hand, significant employment will be created by the development of "green energy" which consists of solar, wind power and geothermal energy.

Canada as a major producer of oil and gas is faced with difficult decisions as do major oil and gas producing countries worldwide. From an economic standpoint of view, oil and gas is extremely important for Canada since the export of oil and gas is Canada's largest industry with Cdn \$63 billion of oil and gas in 2020, mainly to the USA. Canada's population continues to increase significantly mainly due to immigration since Canada is viewed as a top destination for immigrants. The increasing population needs increasing energy. The challenge for countries such as Canada is how to increase the production of energy while reducing CO<sub>2</sub> emissions.

While Canada is determined to curb the production of oil and gas due to its associated CO<sub>2</sub> emissions, Canada's production of oil and gas continues strongly. An example of a major gas project underway in Canada is the current construction of a very large Liquefied Natural Gas (LNG) plant being built at Kitimat on the coast of British Columbia. This project is being built by Shell and its partners at Kitimat at a cost of Cdn \$40 billion. Shell's partners include Malaysia's Petronas, Japan's Mitsubishi Corporation, Petrochina and Korean KOGAS. The LNG will be exported primarily to Asian markets.

In other parts of Canada, especially the eastern provinces of Ontario and Quebec which has been described as "the industrial heartland of Canada", the general population is opposed to oil and gas developments. This is viewed as paradoxical by some observers since both these two provinces are the largest consumers of oil in Canada due to the need of gasoline for transportation. The Canadian paradox is illustrated that while a major LNG project is being built on the west coast of Canada, a large proposed LNG project was rejected by the government of Quebec. On July 21, 2021 Quebec's government announced that it would not support the construction of a proposed Cdn \$9 billion LNG plant at Saguenay, Quebec. This project planned to export 11 million tonnes of LNG per year from gas fields in Western Canada to world markets. The Quebec government stated "This project will not come to pass

due to our concerns over its emissions and this project will not support the transition to cleaner energy sources. This project has more disadvantages than advantages". Accordingly, this proposed project has been terminated (Quebec Spurns \$9B LNG Project, 2021).

### **The faces of the global energy transition**

The energy transition has two faces: firstly, the need to develop a global energy road map that will lead countries to becoming carbon neutral by 2050. Secondly, to become carbon neutral a battery of technologies is being rapidly developed: offshore and onshore wind, solar, hydrogen, and carbon capture and storage. Such technologies will be brought to market in a massive scale in the next 25 years. For the global oil and gas industry, the obvious question is what role will oil and gas have in the energy transition?

#### **Petroleum**

Despite the global economic turmoil in the past year, the availability of oil to fuel the world's economies remains critically important. Agencies such as the International Energy Agency (IEA) still forecast that post-pandemic oil consumption will increase to 101 million barrels of oil per day by 2022 and then gradually start to diminish.

The following is a summary of the world's top 10 oil producers in 2020 in millions of barrels of oil per day (MMbopd). This data is sourced from (Xu, Bell, 2021).

1. United States 11.0 MMbopd;
2. Russia 10.8;
3. Saudi Arabia 10.4;
4. Canada 4.7;
5. Iraq 4.6;
6. China 4.0;
7. Brazil 3.0;
8. UAE 2.6;
9. Iran 2.4;
10. Kuwait 2.3;

#### **Natural gas**

In the meantime, the more immediate face of the energy transition – natural gas – will become the bridging fuel. Natural gas is the cleanest burning of the hydrocarbons and is increasingly viewed as a "bridging fuel" or a "transition fuel" needed to transition to the carbon-zero economy. Therefore, in the next decade we can expect to see sharply increased gas-focused exploration and production in the oil industry.

Global consumption of gas remains extremely strong. In 2020, despite the impact of Covid-19, global LNG trade rose to a record volume led by Asia, according to a recent report (12th Annual World LNG Report, 2021) of the International Gas Union (IGU). Indeed, global LNG demand is projected to nearly double by 2040, Royal Dutch Shell reported in its annual LNG market outlook. The importing of LNG by the Asian economies is skyrocketing due to continued strong economic growth in countries such as China and India. Also, China is sharply increasing its imports of LNG for electricity generation as it transitions away from its use of highly polluting coal-fired power stations.

Overall global LNG trade increased to 356.1 million tons in 2020, up by 1.4 million tons or about 0.4% from

2019. The increase would have been much higher had Covid-19 not reduced economic activity. The trade was driven primarily by increased demand from Asia which led to increased exports from the USA and Australia, according to the IGU in its annual report. In 2020 Australia overtook Qatar as the largest LNG exporter in the world, while the USA and Russia remained as the third and fourth largest exporters, respectively, as shown in Figure 6.

Russia has a pivotal role in helping Western Europe, especially the Netherlands and Germany in their energy transition journeys. Both countries are increasing their natural gas imports from Russia – the Netherlands because subsidence and associated earthquakes beneath Groningen, Europe's largest gas field, has ended production from Groningen. Previously the Groningen field provided for much of Europe's consumption of gas including to Germany. Of significant importance is that Germany has instituted a moratorium on nuclear energy and also is reducing its consumption of coal for electricity generation thus its need for gas has escalated. Thus, Russia is helping to alleviate the increasing energy deficit in both Germany and The Netherlands. In the meantime, the Nord Stream 2 gas pipeline is almost complete with just 33 km left to build (as of July 22). Construction will be wholly completed by the end of this year and will allow Russia to export more gas to Western Europe.

At the St Petersburg International Economic Forum, June 2–5, 2021, Rosneft, Russia's largest oil producer announced they signed a cooperative agreement with USA oil field services company Baker Hughes to explore the possibilities for using hydrogen as an alternative fuel for its operations. Rosneft also expects Baker Hughes to provide it with “technologies and equipment” to discover, gauge and reduce greenhouse emissions with the focus on cutting down on methane leaks. Gazprom Neft also announced that its memorandum of understanding with Royal Dutch Shell calls for both companies to explore the possibility of deploying carbon capture, utilization and storage (CCUS) solutions at

their joint ventures in Russia (Russian Oil Giants Pen Carbon-Focused Pacts..., 2021).

### Coal

Coal has been a key component in the economies of the industrialized countries since the Industrial Revolution of 1760–1840. However, coal is also the most CO<sub>2</sub> emitting of the fossil fuels. An example of the importance of coal in the world's economy is that Australia is the world's largest exporter of coking coal used to make steel. Australia is also the second biggest consumer of thermal coal for power generation.

On June 2, 2021 the G7 group of industrialized nations hardened its stance on the usage of fossil fuels and announced that coal is their first target. The G7 includes Canada, France, Germany, Italy, Japan, United Kingdom, USA and the European Union. The G7 called for an “absolute” end for any new direct government support for international generation of electricity by coal by the end of 2021. The G7 also reminded its member countries that any financing of fossil fuels must be in line with the objectives of the Paris Agreement (Wacket, Piper, 2021).

### **International oil prices vs cost of renewables**

The current price of \$70 per barrel is the same on an inflation adjusted basis in comparison to the oil prices of the mid 1970's despite the passage of 45 years of time. Accordingly, the current oil price is very low in view of the major increases in the costs of housing, education, vehicles, food and commodities which have much increased during those 45 years. Therefore “cheap oil” has discouraged the transition to more expensive renewable sources of energy such as solar energy, wind power and geothermal energy. However, now due to technological advances, the costs of renewables continue to decline and is now increasingly much more economically competitive with oil. The net effect is that researchers at institutions such as Imperial College, London have found that renewable energy investments are delivering massively better returns than fossil fuels (Donovan, 2020).

### **Response of the major international oil companies**

The “super-major” oil and gas companies are changing in different ways and at different speeds (Whaley, 2021). They are making the transition from being international oil companies (IOCs) to integrated energy companies (IECs) but in different ways across the Atlantic Ocean.

A few of the major European international oil companies including BP and Total have decided that rather being part of the “carbon problem” they wish to be part of the carbon-free solution and are rapidly transitioning away from being oil companies to energy

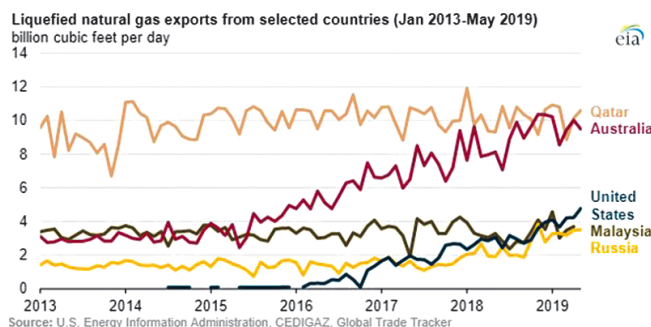


Fig. 6. Global LNG (Liquefied Natural Gas) Exports. Note exports are increasing yearly since 2016. Australia especially is ramping up its LNG exports, primarily to China. From: USA Energy Information Administration, 2020.

companies (Kreeft, 2020). Indeed, Total has already rebranded itself as TotalEnergies.

The Spanish state oil company Repsol is also making significant changes to be net-zero emissions by 2050. This year, it will sell its interests in four exploration blocks in Malaysia and Viet Nam. Repsol has also sold assets in Russia and has stopped oil production in Spain.

A “milestone week” happened during the week of May 23, 2021 when unprecedented changes occurred for three of the world’s largest oil companies. Details are as follows. (1) Royal Dutch Shell. On May 26 a Dutch civil court decision served a stark warning about global warming to Shell and indirectly to the other major international oil companies. On May 26 the court ordered Shell to cut CO<sub>2</sub> emissions more aggressively by net 45% by 2030 compared to 2019 levels. (2) ExxonMobil Corp. Environment-focused activist investors were able to win three seats on USA-based ExxonMobil’s board of directors. (3) Chevron Corp. On May 26 USA-based Chevron’s shareholders voted against the wish of its board of directors and voted in favor of a climate proposal to include emissions from customers’ future burning of fuels as part of Chevron’s future CO<sub>2</sub> reduction targets (Reguly, 2021; Marsh, Quinson, 2021).

Currently a number of major IOC’s including BP, China’s Sinopec, Norway’s Equinor and Shell are looking to hydrogen to help secure demand that otherwise may falter as decarbonization speeds up. They want to utilize existing pipelines, storage tankers and fuel supply to make blue hydrogen, a process that uses natural gas but captures the carbon emissions and stores them. The straightest route to net-zero emissions uses hydrogen produced by renewable electricity – known in the industry as green hydrogen – but the blue variety is expected to be cheaper until at least 2030 as wind and solar power ramp up (Morison, Hurst, 2021).

### **Is net-zero by 2050 achievable?**

The IEA released a report on May 18, 2021 titled “Net Zero by 2050: A Roadmap for the Global Energy Sector” (International Energy Agency, 2021). The IEA report was described by many as “bombshell” and “radical” since it stated the following: (1) If the world wants to effectively end global warming, there is no need for further investments in oil and gas developments. (2) No exploration for oil and gas is necessary other than the oil and gas fields currently being developed. No new oil fields are necessary. (3) The IEA called for a massive clean energy push to reach net zero by 2050.

The reactions to the IEA May 18, 2021 report included the following two examples. The American Petroleum Institute stated: “Any pathway to net zero must include continued innovation and use of natural gas and oil which is displacing coal in developing

nations and enabling renewable energy”. The USA trade organization National Offshore Industries Association stated: “Climate and emissions solutions need to balance the environmental, social, economic and energy needs of society. These needs are correlated. Progress in one cannot come at the expense of another need”.

The following is just one example of one of the issues facing the energy transition. Currently in the USA, 290 million vehicles are on the road with an average age of 12 years. Almost all of these vehicles run on gasoline or diesel. How quickly can these vehicles be converted into electric vehicles? Massive construction of solar, wind and nuclear-powered electricity generating plants throughout the USA will be needed with construction to begin almost immediately. However, will the American population support such enormous changes or will there be “push back” and opposition?

### **Net-zero emissions by 2050? Not without nuclear**

The international media has had extensive articles and discussions on the future role of nuclear power in the energy transition. The overwhelming benefit of nuclear energy is that it does not emit CO<sub>2</sub>. The USA EIA (Energy Information Administration) anticipates a rapid rebound in energy demand and emissions this year (2021). The EIA projects that by 2050, USA energy-related CO<sub>2</sub> emissions will be 5 percent higher than 2020 level (Conca, 2021). On April 22, 2021 President Joe Biden held a virtual Leaders Summit on Climate in Washington which was attended by almost all of the world’s leaders including UK’s Boris Johnson, Russia’s Vladimir Putin, China’s Xi Jinping and Canada’s Justin Trudeau. President Biden declared that in an effort to turn the emissions curve downwards more quickly, the USA aims to cut 2005 level emissions, which peaked at just under 6 billion tons of CO<sub>2</sub>, by half by 2030.

According to various energy research institutions and energy analysts including Conca, J. (Conca, 2021), nuclear power must have a significantly larger role in order to reach net-zero emissions by 2050.

According to the IEA, for 2021 the highest share of nuclear energy in electricity produced by countries is in France at 71.7%, the USA at 19.3%, Russia at 17.9%, Canada at 14.9%, Germany at 11.7%, China at 4.7% and Iran at 2.1% the lowest.

Fossil fuels currently dominate the global electricity grid because the world needs energy as the population continues to grow towards a projected peak of 10 billion people. Access to energy may well be the world’s best environmental protection. The United Nation’s Human Development Index and other studies have shown that 3,000 kilowatt hours per person results in lower birthrates. According to Conca “people become prosperous enough to not depend on their children to

feed them in their old age. You can't save people and the planet without energy".

Nuclear power has made significant progress in the past five decades in safety, efficiency and cost. Global organizations such as the Intergovernmental Panel on Climate Change, the IEA, the United Nations Sustainable Development Solutions Networks and the Global Commission on the Economy and Climate are encouraging tripling of the amount of nuclear energy in the world to stabilize global carbon emissions (Conca, 2021). Concurrently solar, wind and geothermal power will need to ramp up rapidly for the world to reach net-zero.

### Opportunities for the industry and oil & gas professionals

Since this paper is written for the scientific and technical journal *Georesources* which is published in Kazan, Tatarstan which is a major oil producing center in Russia, this paper also addresses how the energy transition will impact on oil industry professionals. These are defined as petroleum engineers (reservoir, drilling and facilities), economists, geoscientists – geologists, geophysicists, geochemists, and also those involved with facilities abandonment and environmental restoration. For oil industry professionals worldwide, all of this turmoil is rather bewildering and problematic but it also creates opportunities (Koning, 2021a, b, c).

The energy transition has the support of the investment community, both in Europe and North America. Most of the energy companies in North America trade on the major stock markets including the New York and Toronto, Canada stock exchanges. As shown in Figure 7, the rate of return from January, 2014 to January 2021 in "clean energy companies" vastly outperformed investments in the traditional oil and gas companies.

The fast-paced energy transition will ensure that exploration and development of gas, domestically and internationally, will remain strong for at least the next couple of decades to satisfy the global demand for gas,

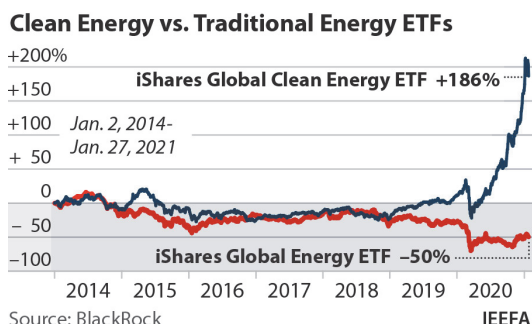


Fig. 7. Stock market investments in "clean energy" in comparison to "traditional energy" from January, 2014 to January, 2021. Traditional energy would include major oil and gas companies such as USA-based ExxonMobil and Chevron and European companies including Royal Dutch Shell and BP and Norway's Equinor. From: BlackRock and the Institute for Energy Economics & Financial Analysis (IEEFA) based in Cleveland, USA.

especially as an energy bridging fuel. The expertise of oil industry professionals will be much needed as sharply increased activity will occur within the area of CCUS – Carbon Capture, Utilization and Storage. They will also be involved in the development of geothermal projects worldwide. Many petroleum engineers have deep expertise in power engineering and can easily switch to such activity in renewable power generation. Accordingly, oil industry professionals will continue to be involved as the world transitions to a carbon-zero and sustainable energy future. However, they will also need to professionally adapt and embrace the new technologies which will evolve with the energy transition.

### Acknowledgments

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