

The Critical Role of LNG in the Global Energy Transition and Energy Security

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This presentation provides a global overview of natural gas production, consumption, and availability. We especially focus on the increasingly important role of LNG in the energy transition and its importance in energy security.

Bottom Line Messages

- 1.) Natural gas will be the dominant fuel in the ongoing energy transition creating the need for further exploration and development of natural gas resources.
- 2.) The speed of installing offloading LNG terminals in Germany illustrates that once impossible deadlines for building and developing such projects can be developed at record speeds if the need dictates such action. What Germany achieved in a short time, could be duplicated elsewhere.
- 3.) Similar to the Marshall Plan which accelerated Europe's post- WW II recovery, such action may need to be implemented for providing more global natural gas resources.
- 4.) Expect cost over-runs and delays at LNG projects worldwide including the LNG Canada and other proposed Canadian LNG projects.
- 5.) The recent shift eastwards to a new axis integrating energy between the Gulf states and China and Russia will impact on the global flow of LNG.
- 6.) The rapid downward trajectory of renewables will impact on the demand for gas. The speed of these changes is still uncertain and subject to a wide range of variables.



Figure 1. LNG tanker. From Reuters, January 26, 2024, in Daily Energy News.

Introduction

The world is faced with highly complicated and sometimes bewildering choices of energy consumption and simultaneously needing to urgently deal with the following:

- 1.) Continued world population growth along with continued economic growth and the corresponding increasing need for energy.
- 2.) Increasing CO₂ in the earth's atmosphere and related global warming.
- 3.) Society's determination to decarbonize and lower the earth's CO₂ content.
- 4.) The Russia – Ukraine war is forcing governments worldwide to re-examine the availability of their domestic reserves of oil and gas and their dependence on imported oil and gas.
- 5.) Russia's invasion of Ukraine is turning the public and investors' interest in renewables.

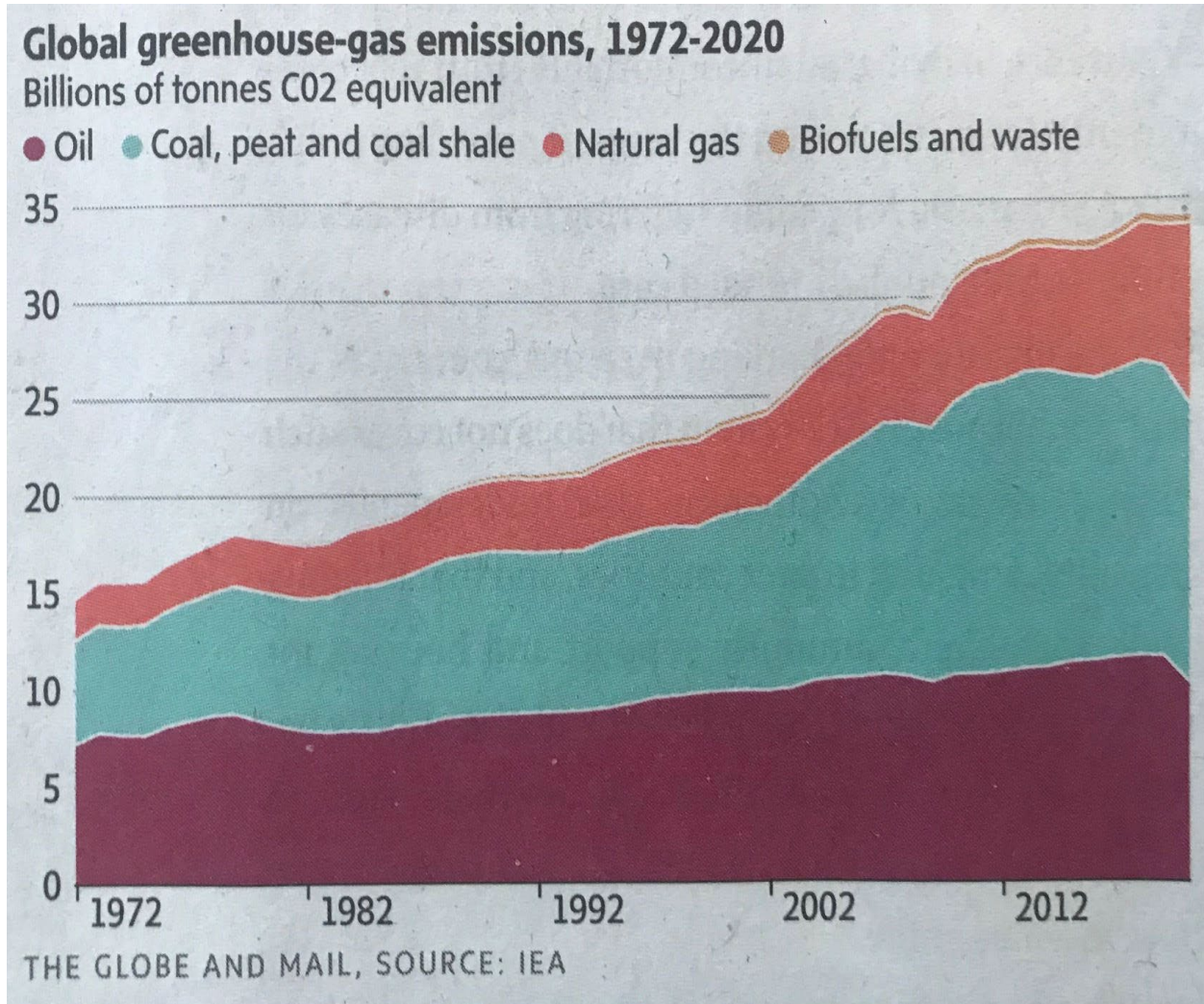


Figure 2. Global greenhouse-gas emissions, 1972 – 2020. From Globe & Mail, Dec 7, 2022.

This presentation provides our view that natural gas will be of critical importance for global energy security. Gas will be equally important in the necessary energy transition.

Undeniably natural gas is a fossil fuel. However, due to gas being the cleanest burning of the fossil fuels and due to its global availability, our view is that there is a sharply increased global focus on gas exploration and development which will assist in flattening and then dampening the curve of atmospheric CO₂. Natural gas thus will become the key “bridging fuel” or the “transition fuel” during the energy transition.

In our presentation, we will review the world’s major gas resources which we believe remain under-explored and under-developed thus creating opportunities for gas-focused international oil companies (IOCs) or state-owned energy companies.

The senior presenter Tako Koning is based in Calgary and provides his views from living in North America (USA, Canada, and Mexico) where the continent’s combined oil production is 16.8 million barrels of oil per day (BOPD) and 10,800 billion of cubic meters of gas per year. North America’s oil and gas production rivals the production from the Middle East which has been traditionally viewed as the world’s most important area to produce oil and gas. Gerard Kreeft is based in The Netherlands and provides a Europe-centric view of global energy markets. He has decades of experience in organizing oil and gas conferences, symposiums, and workshops. He is also an acknowledged authority on the energy transition. More information on the authors is at the end of this abstract.

Oil and Gas Statistics

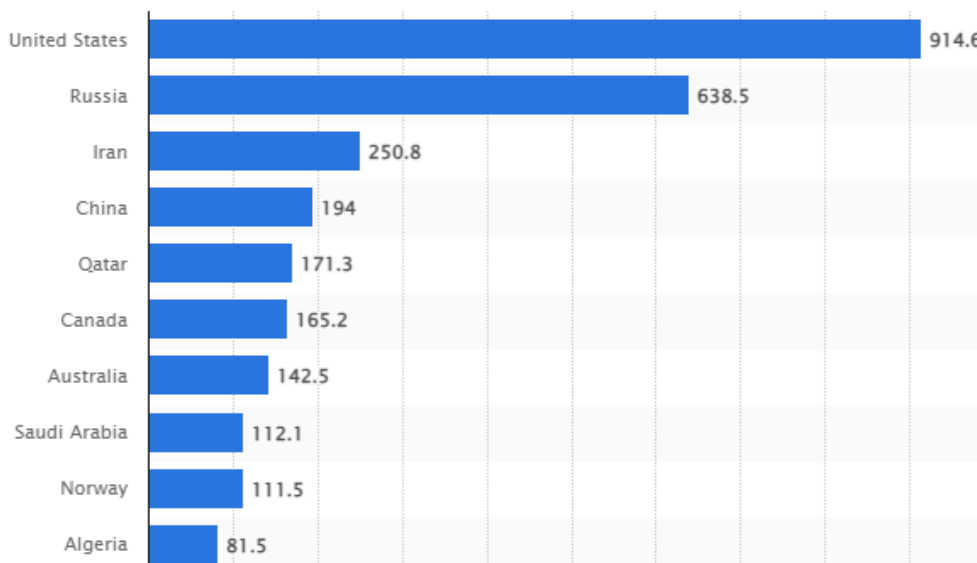


Figure 3. World’s Top Ten natural gas producers in 2022.

Gas in billions of cubic meters. Excludes gas flared or recycled. From Statista, 2022.

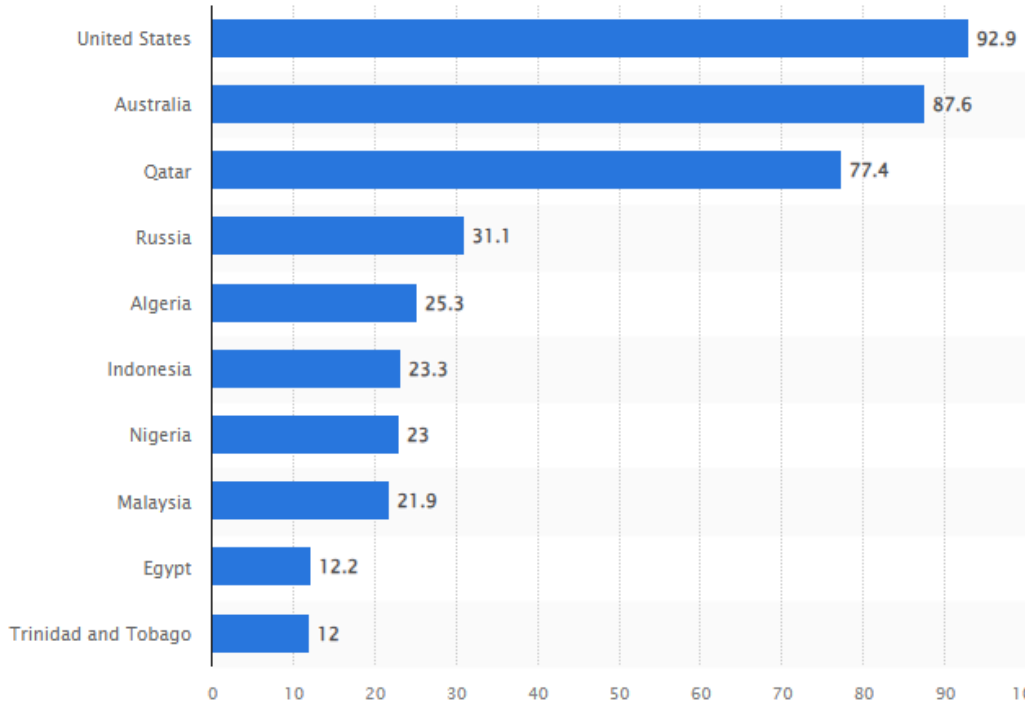


Figure 4. Countries with the largest LNG export capacity in operation worldwide, October 2023, in million metric tons per year. From Statista 2023.

Henry Hub Natural Gas Spot Price

Dollars per Million Btu



Figure 5. Henry Hub natural gas spot price from 1995 – 2024. Prices in US dollars per million BTU. From Thomson Reuters, 2024.

Global Natural Gas Production

As shown on Figure 2, the U.S. is now the world's largest producer of natural gas. The U.S. already has seven LNG export terminals making the U.S. the world's No.1 LNG exporter, with shipments expected to double at the end of this decade even without new terminals. U.S. LNG is exported through Chenier Energy's four LNG plant at Sabine Pass, Louisiana and by Freeport Energy's three liquification plants at Qintana, Texas.

How has the U.S. achieved this position?

- 1.) The U.S. has achieved this position primarily because of its geology consisting of vast and deep sedimentary basins underlying much of the US.
- 2.) In addition, building of LNG terminals to export American gas is relatively simple along the lengthy coast of the Gulf of Mexico. In contrast, Canada's gas required the building of a lengthy pipeline over British Columbia's high and rugged Rocky Mountains to deliver gas to the Canada LNG project, currently under construction at Prince Rupert on the Canadian west coast.
- 3.) Lastly the U.S. is probably one of the world's most "business friendly" countries in the world. Subsequently gas development in the U.S. proceeds relatively quickly as compared to other countries where such activity is highly regulated. For example, much of the natural gas in the U.S. is the result of hydraulic fracturing of shales which faces little opposition as compared to other countries such as the UK, France, and Germany.

USA Natural Gas Prices

When Russia invaded Ukraine on February 22, 2022, gas prices tripled. The world believed that a disastrous energy crisis had begun with large shortages of natural gas which Russia had been delivering to Europe. Nevertheless, two years later, gas prices in the U.S. are at 3 ½ year lows. Natural gas prices in February 2024 fell to an inflation-adjusted 30-year low of \$1.60 per thousand cubic feet, benefitting consumers of the fuel like utilities but hurting gas producers who are now selling at nominal prices as low as they were in the depths of the Covid-19 downturn (Reuters, Feb 21, 2024). In contrast, in 2022 the average price was \$6.50 per million British thermal units due to the impact of Russia's invasion of Ukraine. Now gas prices are less than one third of 2022's average price.

For nearly all the past year, U.S. natural gas producers sharply reduced production as prices fell. But relentless output gains including from oil companies which produce gas as an oil byproduct led to record gas supplies. Associated gas, which is gas produced along with oil in oil wells is an increasingly important component of U.S. gas production. More than one third of all US gas production comes from oil producers according to government estimates. Not surprisingly, as U.S. oil production reached a record level of 13.3 million barrels of oil per day, simultaneously gas prices reached record lows. In the oil versus gas contest, gas producers are losing out. Some are shutting-in wells, cancelling projects, or selling themselves to rivals to avoid losses.

U.S. gas firms last year cut drilling by 22% to stem the output of gas. But the flows continued with 105 billion cubic feet a day of gas this year, up 2.5 billion cubic feet a day from last year op

In summary, in 2024 U.S. gas producers are facing a perfect storm caused by:

- 1.) An exceptionally warm winter caused by the El Nino effect
- 2.) Too much gas supply, including primary and associated gas
- 3.) Uncertainty in the approval for new LNG export permits

US Biden Administration Temporary Pause on LNG Export Approvals

The decision in early 2024 by the Biden Administration to have a temporary pause on LNG export approvals has been met with great concern worldwide. Many Asian countries have expressed concerns about potential disruptions in their energy security and decarbonization.



Figure 6. U.S. President Joe Biden. Photo: WHITE HOUSE

Top U.S. LNG exporter, Chenier Energy announced that despite President Joe Biden's pause on new LNG export approvals, this will not delay the company's trio of planned expansions of its Gulf Coast facilities. The company still intends to file its application with the Federal Energy Regulatory Commission (FERC) later this quarter for an expansion of approximately 20 million tpa at its Sabine Pass terminal in Louisiana. Indeed, with the Sabina Pass terminal and Chenier's LNG exporting plant in Texas, the company plans are for more than 30 million tpa in additional capacity (from Upstream, Feb 23, 2024). Chenier reported strong earnings of \$4.8 billion for 2023. This earning was a drop of 47% compared to 2022 when natural gas prices spiked amid the initial shock of Russia's invasion of Ukraine.

U.S. gas producers have been reluctant to deeply cut output since they also see the prospects of giant new LNG plants opening this decade. LNG exports would drain the excess gas supplies and should return prices to levels that make gas profitable to drill again in 2025. There are four U.S. LNG projects with export permits in the planning stage that would consume 6.3 billion cubic feet

daily. The danger is that this third wave of new LNG plants may be delayed or lost forever, jeopardizing as much as 32 billion cubic feet per day of future consumption.

At the time of writing this abstract for GeoConvention, on February 28, 2024, the Middle East nation of Qatar announced new LNG expansion plans to squeeze out U.S. and other LNG rivals. Qatar's plans could see it control nearly 25% of global markets by 2030 especially if President Biden's pause on approvals of new export permits stays in affect (Gas Processing & LNG News, Feb 28, 2024).

Global Gas Production from Floating Liquefied Natural Gas (FLNG) Facilities

Floating LNG (FLNG) facilities pave the way for opportunities to monetize gas resources from remote, marginal and stranded natural gas fields, which otherwise would be uneconomical to develop via conventional means. FLNG has advantages in areas with small gas reserves, expensive onshore port facilities, and/or constrained engineering, procurement, and construction resources. It can also offer simplified approval processes while avoiding domestic gas commitments and unfavorable taxation (From Rangel, L., Offshore Engineer, June 2016).

Projects in Australia, Malaysia, Mozambique, Cameroon, Congo Brazzaville, and Equatorial Guinea chose FLNG solutions to monetize fields.



Figure 7. Shell-operated Prelude Floating Liquefied Natural Gas (FLNG) Facility, offshore Australia. Prelude is the world's largest floating LNG producer and the biggest maritime vessel ever built. Shell photo, March 2019.

Australia. The world's first FLNG development is Shell's Prelude facility, an offshore development which produces natural gas from a remote gas field 125 km off Australia's northwest coast. Prelude was designed to produce 3.5 million tpa of LNG, 1.3 million tpa of condensate and 0.4 million tpa of liquefied petroleum gas (LPG). Prelude uses one quarter of the size of an equivalent plant on land which would cost \$12 billion (Rangel, June 2016).

Shell laid the keel of Prelude in 2016 and first production of LNG was three years later in 2019.

Malaysia. An example of a smaller FLNG facility is Petronas, Malaysia's state oil company's Satu facility which began construction in 2011 and commenced production in 2016. Satu was designed to produce 1.2 million tpa of LNG and initially produced the Kanowit gas field, offshore Sarawak, Malaysia. The vessel – which has a 20-year design life – will be able to exploit gas fields with up to 20% carbon dioxide in a maximum water depth of 200 meters.

Petronas has never divulged the cost of its FLNG projects, though it maintains the technology offers cost-effective development solutions for certain fields, especially when it negates the need for a pipeline to shore. The use of Satu was reviewed by Petronas as follows. Petronas' VP Adnan Zainal Abidin stated "LNG investments are long-term investments. You cannot make decisions on a short-term basis. For floaters (FLNG), the economics are somewhat different because without the floating facility there are small, marginal, remote fields which have zero economic value. So, it's not straight forward but it must make economic sense at the end of the day. For Petronas, we take into account how much does it cost to drill the wells, the cost of shipping, the cost of refrigeration. It's through the whole value chain" (From: Battersby, A., April 8, 2016, Upstream).

Congo Brazzaville. An example of a moderate-to-large recently built FLNG facility is Congo LNG operated by ENI. Production will commence 1Q 2024 from the \$5 billion project. Congo LNG will eventually have a capacity of 3.0 million tpa. ENI CEO Claudio Decalzi stated that this project provides "additional revenues to the country while contributing to Europe's energy security" (From: Upstream, Feb 28, 2024).

Mozambique. In the past decade, a number of large gas discoveries were made in deep water areas of Mozambique's continental shelf. The first FLNG project to commence production in Mozambique is the ENI-operated Coral South facility. A second FLNG vessel will likely be sanctioned in late 2024 to produce LNG at the Coral North gas field. Coral North is expected to replicate Coral South (From: Upstream, Feb 28, 2024).

ENI's gas production is from Mozambique's Rovuma Basin in approximately 2,000 meters of water. Coral South was designed to process LNG at 3.4 million tpa. The project cost in the order of \$4.7 billion. Export of LNG commenced in 2022. Gas reserves of 16 TCF are estimated for Coral South. Total estimated reserves for ENI-operated Block are in the range of 85 TCF. The partners in Coral South are ENI with 35.7%, ExxonMobil with 35.7%, and China National Petroleum Corporation with 28.6%



Figure 8. ENI operated Coral South FLNG facility. From ENI website, March 2, 2024

Global Oil Production

Although there is a worldwide focus now on the energy transition, it is very important for governments and policy makers to realize that the world is still highly dependent on oil. This summary is provided based on current data. Indeed, before the Covid-19 pandemic struck in 2020, the world was consuming close to a near-record of 102 million barrels of oil per day. Now due to the post-Covid-19 economic recovery, oil consumption has resumed almost back to record high rates of consumption of about 103 million barrels of oil per day.

Top ten oil producers (MMbopd)

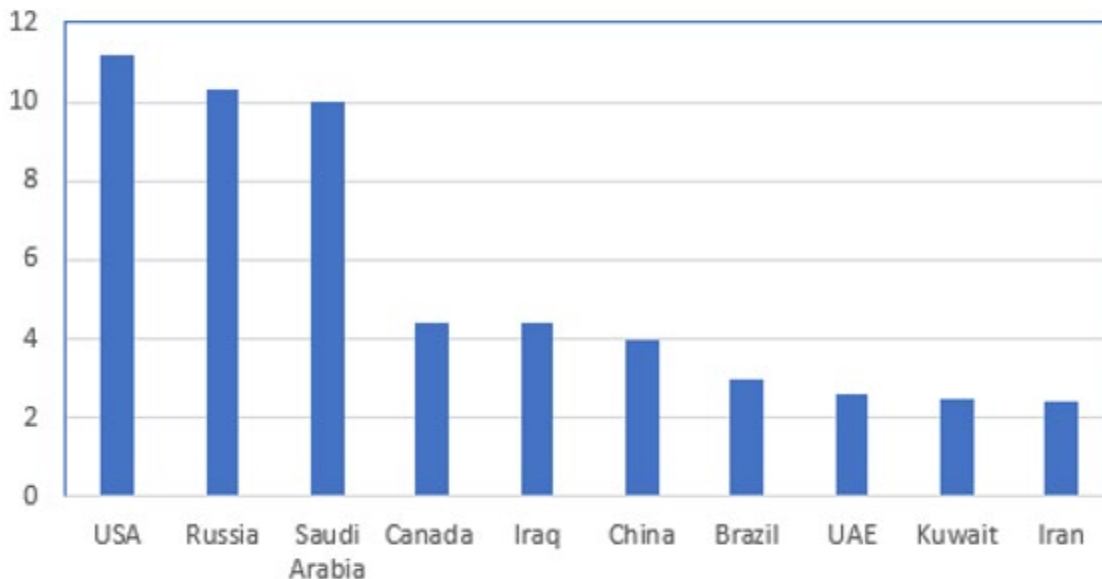


Figure 8. World's Top Ten Oil Producers. From: Statista, 2022.

U.S. Oil Production

U.S. oil production is currently at a record 13.3 million bpd (barrels of oil per day). Average production in 2023 was 12.3 million bpd. Accordingly, current production represents an increase of 8.1% in the past year.

Oil production from U.S. shale basins will rise to 9.7 million bpd in the first quarter of 2024 according to an announcement from the Energy Information Administration (EIA) on Feb 12, 2024. Oil output in the Permian Basin, the largest US shale basin spread across West Texas and New Mexico will rise to 6.1 million bpd. Production from the Eagleford Formation in southeastern Texas will rise to 1.1 million bpd. The Bakken Formation in North Dakota is set to rise to 1.2 million bpd (from Reuters, Feb 12, 2024).

In summary, 73% of the U.S.'s oil production is from shale. Had the technology for hydraulic fracturing of shale not been developed, the U.S. would be much suffering from the need to import vast amounts of oil.

U.S. Oil Consumption

The U.S. is the world's largest consumer of oil at a rate of 20.1 million bpd (2022 data). The transportation sector consumes about 12 million bpd which is 65% of the total. To meet its consumption requirements, the U.S. imports 8.4 million bpd.

In comparison, China is the world's second largest oil consumer at 14.3 million bpd whereas China produces 4.0 million bpd. This has resulted in China needing to import oil at a rate of 10.3 million bpd making it the world's largest importer of crude oil.

International Oil Prices

At the time of writing this abstract on Feb 23, 2024, the global benchmark crude had risen above \$83 per barrel based on the escalation of Red Sea conflict and also hopes of demand recovery

On December 2, 2023, **OPEC** - the Organization of Petroleum Exporting Countries announced that they had increased their voluntary oil production cuts to 2.2 million bpd. Concurrent, **Saudi Arabia** has voluntarily reduced its oil production by 1.0 million bpd. **Russia** is part of OPEC+ and it also has withdrawn 0.3 million bpd from its oil production. The total oil production withheld from global oil markets is 3.5 million bpd. If OPEC, Saudi Arabia, and Russia were to resume full oil production this would ignite a price war which could drop the price of oil to \$20 per barrel or lower. Accordingly, the fact is that OPEC, Saudi Arabia, and Russia have brought stability to global oil markets. Oil producing countries including Canada and the province of Alberta greatly benefit financially from this oil price stability.

Global Gas Futures

- 1.) The oil price collapse in 2014 – 2015 resulted in a dramatic slowdown in exploration and development of oil and especially gas. Hence, gas is perceived by some to be in short supply.
- 2.) The current global concerns about global warming and record temperatures experienced worldwide in the last few years has resulted in a backlash against oil and gas activities. Many pension funds, sovereign funds and institutional lenders have divested their shares in oil and gas companies. Hence this has made it more difficult for these companies to raise capital for oil and gas exploration and development. This has also led to the current concerns about the availability of oil and gas supplies.
- 3.) We live in a global village and the impact of economic activities in one part of the world can directly impact on other parts of the world. Economists have underestimated the rate of economic growth in Asia in the past five years and its impact on the need for energy.
- 4.) Russia's invasion of Ukraine has dramatically raised concerns worldwide about energy security.

Coal

Coal is the most CO₂ emitting of the fossil fuels. On June 2, 2021, the G7 group of industrialized nations hardened its stance on the use of fossil fuels and announced that coal is their first target. The G7 includes the U.S., Canada, Germany, Italy, France, UK, European Union, and Japan. The G7 called for an “absolute” end for any new 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.

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#	Country	Yearly Coal Consumption (MMcf)	World Share	Cubic Feet Per Capita
1	China	4,319,921,826,000	50.5 %	3,081.50
2	India	966,288,692,600	11.3 %	721.85
3	United States	731,071,000,000	8.5 %	2,234.25
4	Germany	257,488,592,900	3.0 %	3,127.46
5	Russia	230,392,143,100	2.7 %	1,587.72
6	Japan	210,559,949,300	2.5 %	1,658.03
7	South Africa	202,298,474,200	2.4 %	3,585.44
8	South Korea	157,124,158,500	1.8 %	3,062.25
9	Poland	148,799,901,400	1.7 %	3,861.71
10	Australia	129,642,679,100	1.5 %	5,358.09

Figure 10. World's top ten consumers of coal. From Worldometer, Feb 23, 2024

The burning of coal provides major supplies of electricity especially in countries like China, India and the U.S. The increased availability of gas is an incentive for countries to transition from coal-burning electricity plants to gas-fired plants with a corresponding major reduction in CO₂.

Qatar Plans to Further Expand the World's Largest Gas Field

QatarEnergy is Qatar's state oil company and in February 2024 it announced it plans to further increase the LNG capacity of its North Field to 142 million tpa before 2030 (Upstream, Feb 25, 2024). This represents an increase of almost 85% compared to current levels. The North Field along with the extended South Pars Field in the Persian Gulf is by far the world's largest non-associated natural gas field, with ownership of the field shared between Qatar and Iran. The company stated that Qatar's gas reserves are now estimated at 2000 TCF and the condensates at 80 billion barrels.

QatarEnergy is partnering with TotalEnergies, Shell, ConocoPhillips, ExxonMobil, Eni, Sinopec and China National Petroleum Corporation for the first two phases of the North Field expansion

project and is expected to add additional partners in subsequent development phases. QatarEnergy said that Qatar’s total hydrocarbon production will exceed 7.3 million barrels of oil equivalent per day when the North Field project is completed.

The View from Norway – a Key Producer of Oil and Gas

Equinor is Norway’s state oil and gas company and is led by CEO Anders Opedal who stated the following at the Oslo Energy Forum, February 13 – 15, 2024. He described the current situation in energy as “A golden opportunity for more investments in energy sources”. Opedal highlighted Norway’s energy transition drive as Norwegian Prime Minister Jonas Gahr Store reiterated the country’s commitment to Europe’s energy security (reference: Upstream Energy Security, Feb 24, 2024, by Zsuzsanna Szabo).



Figure 11. Anders Opedal, CEO Equinor or at the Oslo Energy Forum

Opedal stressed that, while oil and gas remain key contributors to the global economy, long-term value creation and investing in clean energy is vital. He said, “We believe in a balanced energy transition. The world needs oil and gas now to grow economically. Developing oil and gas will be needed while transitioning”.

Norway’s Prime Minister Store set out Norway’s plans for “transitioning out of oil and gas” and what that will mean for the country and Europe. He said “We are not an oil nation; we are an energy nation. Now our attention is focused on solar, wind – offshore and land, and new technologies. But we will continue to remain a stable provider of gas to Europe” (reference Szabo, 2024).

Russia's Exporting of Oil

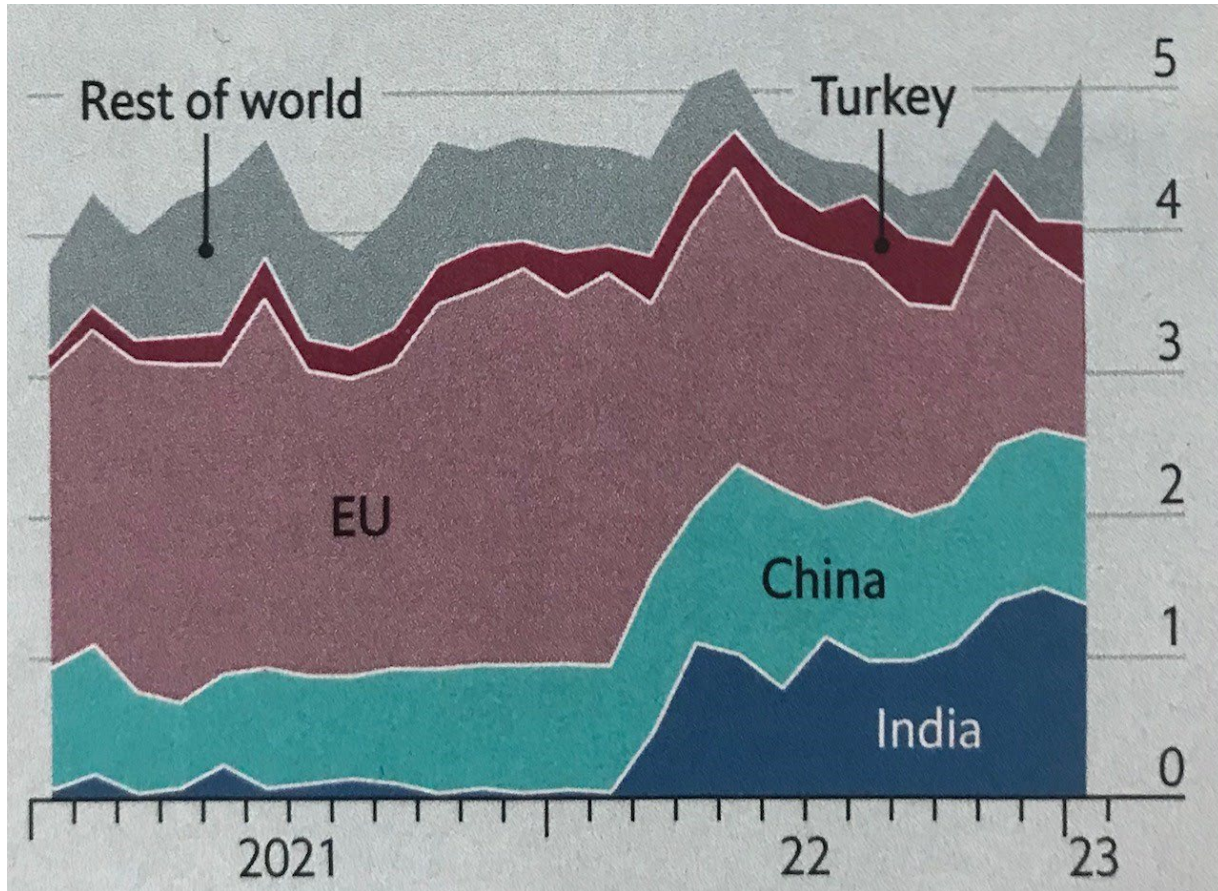


Figure 12. Russia crude oil exports in million barrels of oil per day. Note the decline in exports to the European Union, increase in exports to China and especially a huge increase in exports to India. The oil Russia sells to China and India is sold at a significant price discount. From: Kpler, *The Economist*, February 4, 2023.

Russia's LNG Exports – Set to Hit Record Production Despite Sanctions

The Europe market is still in Russia's focus, but increased gas supplies are expected to flow to Russia's Asian allies. Russia's gas production and LNG exports look certain to hit an all-time high in 2024 follow the completion of extensive maintenance works at the Yamal LNG and Sakhalin 2 developments and expected start -up of the first train of Arctic LNG-2, according to industry analysts. Russia's LNG is expected to flow eastwards rather than westwards.

Russia exported LNG at a rate of 32.3 million tpa in 2023 against 32.9 million tpa in 2022 according to an independent assessment by Kpler based on global movement of gas carriers. As a result, Russian LNG exports to EU countries reached a new high of 15.6 million tpa, up from

1.3 million tpa in 2022. Spain became the largest importer of LNG in Europe and the third largest buyer of Russian LNG, according to Kpler.

Russia's LNG exports to China ended last year at over 6.8 million tonnes, making it Russia's largest gas customer while shipments to India in 2023 were a modest 430,000 tonnes according to Kpler data. China and India are already the two largest buyers of Russian oil. China bought 50% of Russia's oil in 2023 and India was second with about 40% of Russia's oil and oil products (Upstream, Jan 10, 2024).

Asia's Role in the Energy Crisis

China is the world's second biggest consumer of oil. However, China is also the world's 3rd largest consumer of natural gas in the world, consuming 370 billion cubic meters (bcm) in 2021. China's enormous need for oil and gas is due to its population of 1.3 billion people and also due its overall strong economy.

Strong economic growth has been experienced also by Japan, Taiwan, South Korea, Singapore, and India leading to sharply increased need for electricity. Japan has reduced its dependence on nuclear electricity due to the Fukushima nuclear power plant disaster and this has led to Japan increasing importing of LNG.

Germany – An Example of Rapid Energy Response to Russia's Invasion of Ukraine

Germany previously imported about half of its gas from Russia and more than a third of its oil. Russia cut off Germany's gas supply in August 2022 while Germany halted Russia's oil imports in early 2023.

In its race to find alternative sources of energy, Germany has reopened coal-fired power plants, delayed plans to shut down its three remaining nuclear power plants and pushed to increase capacity to store natural gas from other countries such as Norway and the USA. On January 18, 2023, at the World Economic Forum in Davos, Switzerland, Germany's Finance Minister Christian Lindner said that Germany is no longer reliant on Russian energy. He said "Germany has found new sources of energy. Yes, of course, Germany is still dependent on energy imports, but today not from Russian imports but from global markets". Mr. Lindner pointed to the speed with which a new liquefied natural gas terminal had been built in Germany – in a record eight months, he said. More investments were planned, he added. "This is only one example of the enormous change in German policies" he said.

The first full load cargo of LNG for Germany arrived at the LNG terminal in Wilhemshaven in the first week of January 2023. The gas was loaded at a liquefaction plant in Cameron Parish, Louisiana on December 19, 2022 (Oil & Gas Journal, January 9, 2023). The LNG tanker called Maria Energy was loaded to maximum capacity and brought 170,000 cubic meters of LNG to Germany and marked a historic moment as Germany began weaning itself from its dependence

on Russian gas. At the beginning of 2024, three FSRUs (Floating Storage and Regasification Terminals) were operational in Germany (Reuters, Jan 2, 2024). Germany's move away from its dependence on Russian gas is an example of how rapid progress can be achieved by eliminating regulatory delays and policy uncertainty and cutting through bureaucracy and red tape.

A more than 25% slump in this year in northwest Europe's benchmark natural gas price has helped push the price of gas-fired power generation below the cost of coal-fired generation and sets the stage for fuel switching by key regional power producers including Germany.

China: Record Levels of Burning of Coal, Oil & Gas While Record Levels of Renewable Energy

Japan: Re-embraces Nuclear Power – But Risks Underplaying Renewables

The government of Japan is determined to make the country carbon-neutral by 2050. Japan is a country with scant natural resources such as oil, gas and coal. Accordingly, for Japan to become CO₂-neutral as well as to be energy independent, they have a difficult task which requires striking a fine balance between safety, energy security and environmental concerns (Economist, January 14, 2023).

Japan has always been highly dependent on imported oil from the Middle East. The oil crisis of 1973 – 1974 spurred Japan to diversify its sources of energy including expansion of its nuclear plants, LNG receiving plants and also renewable technologies under the banner of the “Sunshine Project”. By 2010 Japan had built 54 reactors producing about 25% of electricity production. The Fukushima disaster ended the plans to continue to build reactors. New laws were passed to stimulate solar power. The share of renewables in electricity generation doubled from 10% in 2010 to over 20% last year. Yet Japan has mainly filled the gap by turning to LNG and coal (see Figure 9. Adding well-regulated nuclear plants in order to phase out coal is sound policy but there is a risk that this will slow or reverse the momentum behind expanding renewables. “The real issue is how to aggressively and rapidly install more solar and wind”, according to the Tokyo-based Institute for Sustainable Energy Policies. They state “Japan is falling behind the global curve. Japan generates about half as much electricity from renewables as its European peers”.

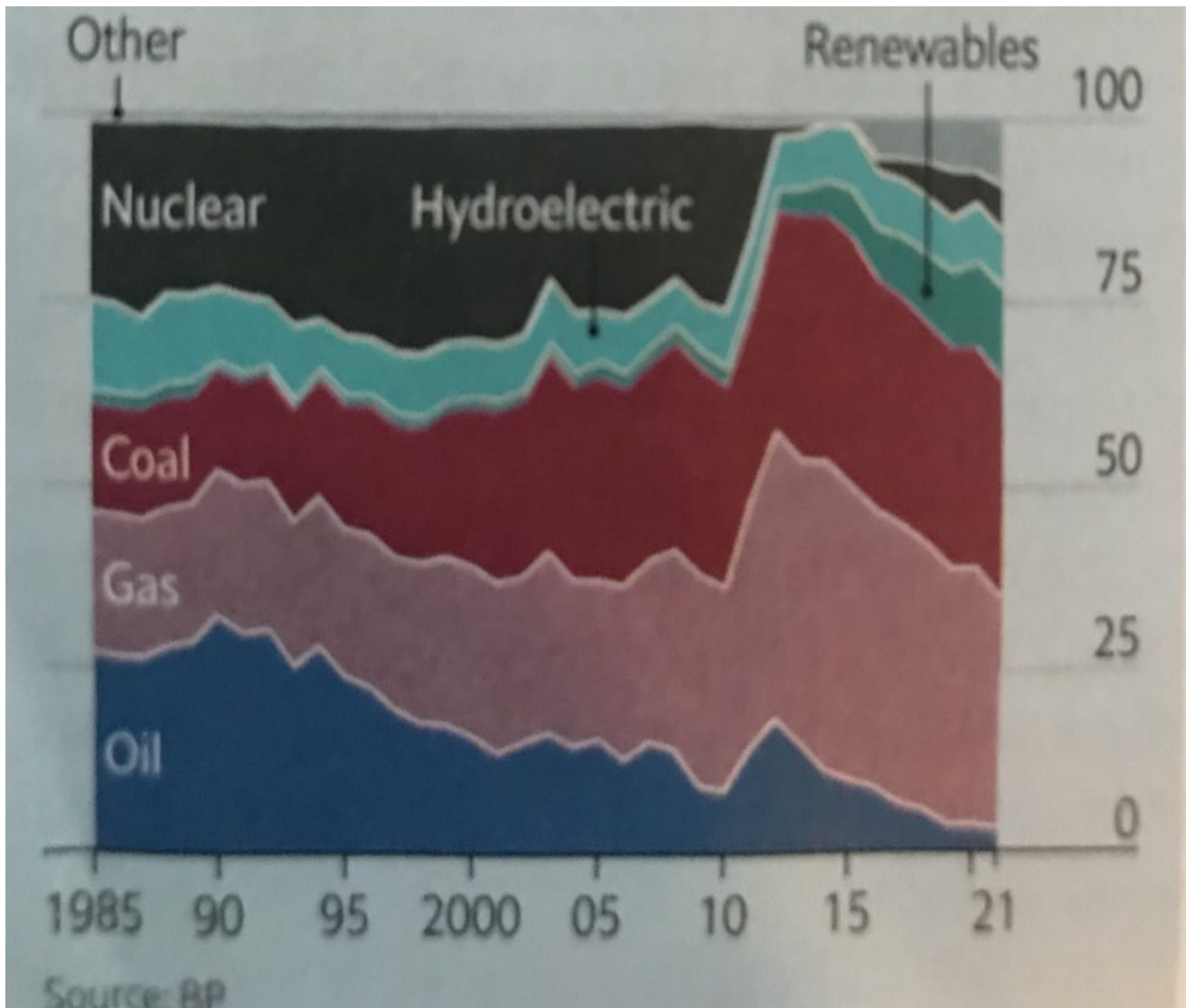


Figure 13. Japan – electricity generation, by source, % of the total.
From: BP, *The Economist*, January 14, 2023.

Canada's Role in the Energy Transition

Most Canadians are not aware that Canada ranks amongst the world's largest oil and gas producers. Nor are they aware of how much the oil and gas industry contributes to Canada's economy. Indeed, CAPP (Canadian Association of Petroleum Producers) estimated that capital investment in the Canadian oil and gas sector will reach Cdn\$40.6 billion in 2024.

Our view is that CO₂ in the atmosphere certainly must be reduced. Canada as a major gas producer can assist in the reduction of the world's burning of coal. To achieve this, Canada needs to expand its export of LNG beyond the LNG plant under construction on near Kitimat, BC.

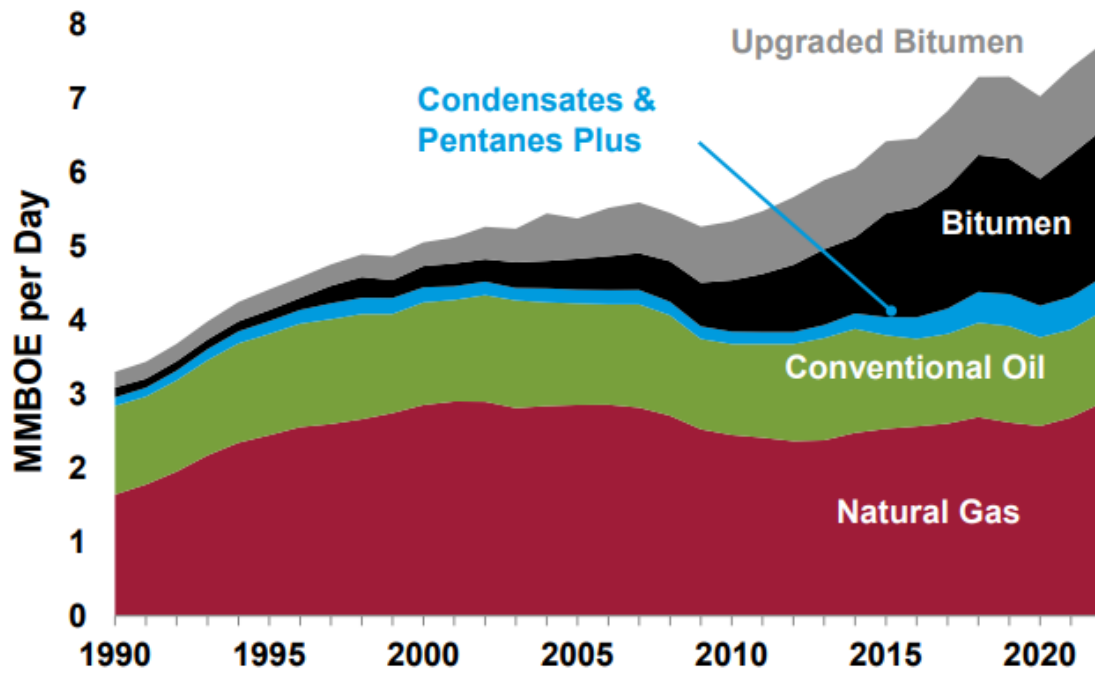


Figure 14. Annual Canadian total hydrocarbon production by type, 1990 – 2022.
Source: CAPP (1990 – 2017), Canada Energy Regulator (2018 – 2022). Oil and gas production continues on an upward trajectory.

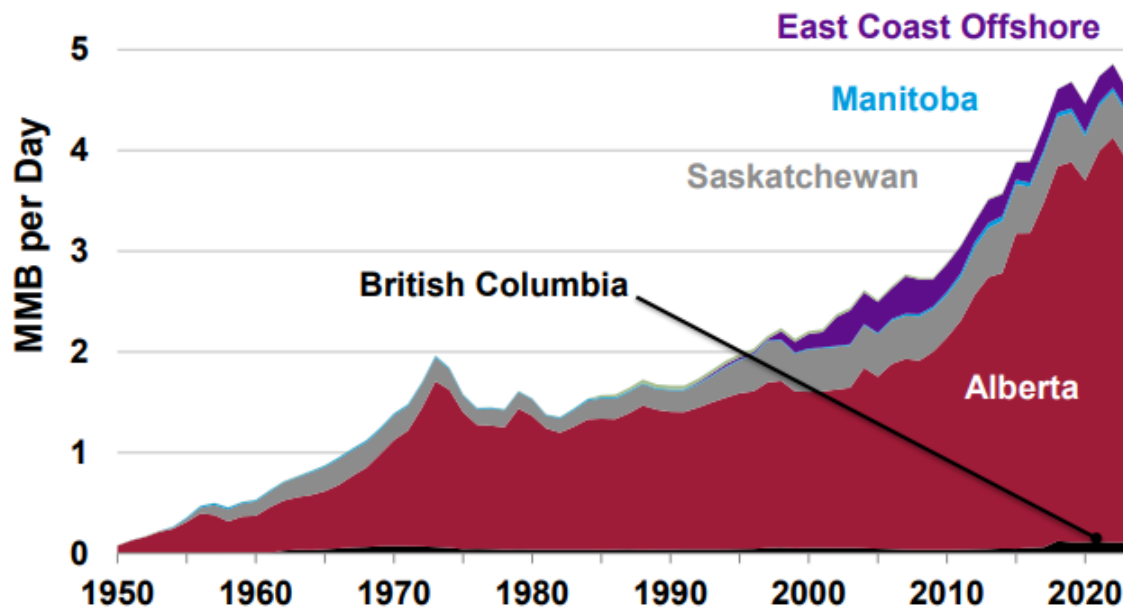


Figure 15. Canada's oil production by province, 1950 – 2022.
From CAPP 1950 – 2017, Canadian Energy Regulator (2018 to current). Oil includes crude oil, condensates and pentanes and does not include NGLs.

Canada's current oil production consists of oil sands at 3.2 million bpd which is 65% of Canada's total production, conventional oil production of 1.4 million bpd which is 30% of total production and 0.2 million bpd from offshore Newfoundland, representing 4% of the total.

Over 200,000 oil and gas wells have been horizontally fractured in Western Canada (The Narwhal, 2022). It is estimated that currently 80% of new oil and gas wells in Western Canada are fracked (CAPP, 2023).

LNG Canada Project, Kitimat, BC

The **Coastal GasLink pipeline** runs from Dawson Creek to Kitimat. This 670 km-long pipeline will transport gas from the northeastern British Columbia's Peace River area to the Shell led LNG plant at Kitimat. Owners of this pipeline are TC Energy Corp, KKR & Co Inc and the Alberta Investment Management Corp. Construction is almost finished. The pipeline had an initial budget of Cdn \$6.6 billion which increased to \$11.2 billion. On February 1, 2023, the operator of the pipeline, TC Energy announced that the final costs are expected to soar to \$14.5 billion. The increased costs are due to: 1.) Higher labour costs (2.) Skilled labour shortages (3.) Environmental protests (4.) Construction delays due to impacts of contractors' underperformance and disputes (5.) Unexpected events like erosion and sediment control challenges.

TC Energy also stated, "Once complete, CoastalGasLink will be Canada's first direct link for LNG deliveries that will further support displacing 60 to 90 million tonnes of CO2 emissions annually – an important step along the energy transition" (reference: Globe & Mail, February 4, 2023).



Figure 16. CoastalGasLink pipeline, 670 km from Dawson Creek to Kitimat. Reference: Reuters, CBC, February 1, 2023.

At Kitimat, the **LNG Canada** plant currently under construction at an estimated cost of \$18 billion will liquify and export the gas to overseas. In January 2023 the plant's operator, London-based Shell PLC announced that the facility will be powered by natural gas rather than by hydroelectricity as originally planned thus adding to the project's carbon footprint.

In addition to Shell PLC are the other co-owners of LNG Canada includes Malaysia-based Petronas, China's PetroChina, Japan's Mitsubishi Corp and South Korea's Kogas. This is the largest investment ever taken in Canada with the current estimated cost of \$32.5 billion for the plant and pipeline. Total costs are forecasted at \$45 billion for the terminal, pipeline and drilling.

Carbon Capture Underground Storage (CCUS)

The Western Canadian Sedimentary Basin has extensive subsurface reservoirs which produced major volumes of oil and gas. These reservoirs had the capacity to store oil and gas for millions of years. These reservoirs can be equally capable of sequestering CO₂. Accordingly, our view is that the geologists, geophysicists, reservoir engineers and energy economists who were involved in previous exploration and development of oil and gas, those skill sets will also be increasingly needed in further exploration and development of natural gas and defining and developing reservoirs for CO₂ capture and storage.

Renewable Energy - 2023 A Record Year

At the end of 2022, the IEA (International Energy Agency) said that the expansion of renewable energy will happen at a much faster rate over the next five years than was though likely a year before and that Russia's war in the Ukraine marks a "turning point" for the transition to clean energy in Europe. It forecasted that renewables as a whole will overtake coal in 2025 to become the biggest source of the world's electricity generation. Half of the renewable's capacity will be in China, predicted the IEA (The Economist, Dec 10, 2022).

Global capacity surged 50 per cent in 2023, driven by large increases in Europe, U.S., and the "extraordinary" growth in solar farms in China, according to the International Energy Agency (Globe & Mail, Jan 12, 2024). We expect this transition to continue, thus complicating predictions regarding the global demand for gas.

Concluding Statements

Global. Due to natural gas' critical role in the energy transition and its ability to contribute to global energy security, we see much increased exploration and development for gas worldwide.

Canada. Since the oil price collapse in 2014 - 2015, Canada's oil industry has been full of doom and gloom. However, the industry has rebounded. The end of Covid-19 has oil and gas demand returning and improved oil and gas prices. Due to the urgent need for gas and LNG, also due to

the need for the world's economies to decarbonize, combined with the concerns about global energy security, we foresee a world of opportunities for Canada's natural gas industry.

Canada is an integral part of the North America oil and gas industry. For example, Calgary-based TC Energy (formerly TransCanada Pipelines Ltd) supplies 30% of North America's gas requirements through over 93,000 km of gas pipelines across Canada, USA and Mexico.

At the same time the Canadian oil industry is committed to reducing its carbon footprint. The Pathways Alliance is committed to reaching net-zero emissions. The companies which are partners in the Pathway Alliance are Canadian Natural Resources, Cenovus, ConocoPhillips Canada, Imperial Oil, MEG Energy and Suncor. They stated in the Globe & Mail, February 18, 2023 QUOTE "We are making clear strides to net zero. Oil sands operations contribute significant carbon emissions in Canada – so the six largest companies are using several pathways to get to net zero. We've teamed up to invest in technology and innovation as part of a robust plan. In the past decade, we've cut our emissions by an average of about 22% per barrel – there is more to come. Part of our plan includes developing a carbon capture and storage network to reduce 10 million tonnes of CO2 emissions annually by 2030. It's one more way we're making progress on the path to net zero. See our plan in action. PathwaysAlliance.ca. UNQUOTE.

The group looks to embark on building a large-scale carbon capture, utilization, and storage (CCUS) network in northeastern Alberta which is estimated to cost \$16.5 billion (Calgary Herald, February 17, 2023). Indeed, this CCUS project is the world's largest (Upstream, Feb 14, 2024).

Biden's LNG pause is a net positive for Canada. The Biden Administration's move to freeze new LNG terminals could provide a much-needed impetus to Canada's economy by accelerating LNG export projects on our West Coast (reference J. Kucharski, Calgary Herald, Feb 24, 2024).

The U.S. has seven LNG exporting terminals whereas Canada has none. LNG exports from North America are essential to maintaining global energy security and affordability because the electricity sectors in many countries depend on natural gas to replace coal-fired generation and back up intermittent renewables. Nowhere is this truer than in the Indo-Pacific region where population and economic growth are driving the demand for energy.

Biden's LNG pause could be used as an opportunity to accelerate some of Canada's LNG projects. Projects which could be affected positively could include the LNG Canada Phase II expansion, Woodfibre LNG, Cedar LNG, Ksi Lisims LNG, and Fortis BC's expansion.

In the electricity sector, the future of renewables is tied to natural gas because it is not yet feasible for any country to have an electricity grid that relies entirely on wind and solar due to intermittent output and the enormous cost of battery storage. The hesitation by the Biden Administration creates an opportunity to become a valued and reliable supplier of LNG to the Indo-Pacific while at the same time generating economic benefits at home (Kucharski, Feb 24, 2024). Biden's hesitation may have handed Canada a golden opportunity which ought not be wasted.

About the Authors

Tako Koning is Holland-born and Alberta-raised. He graduated in 1971 with a B.Sc. in Geology from the University of Alberta and in 1981 with a B.A in Economics (1981) from the University of Calgary. He was employed by Texaco beginning in 1973 for thirty years in Canada, Indonesia, Nigeria, and Angola. He worked in a variety of positions including geologist, assets manager, portfolio manager and vice president exploration. He has also worked in Angola as a consultant for Tullow Oil and the American/British consultancy of Gaffney, Cline & Associates. He is a long-term member of many professional societies including the Canadian Energy Geoscience Association (legacy Canadian Society of Petroleum Geologists), Canadian Society of Exploration Geophysicists, Association of Professional Engineers and Geoscientists of Alberta and the American Association of Petroleum Geologists. He lives in Calgary.

Gerard Kreeft was born in the Netherlands and grew up in the village of Burdett in southern Alberta. He graduated in 1971 with a B.A. from Calvin University, Grand Rapids, Michigan and in 1980 with a M.A. from Carlton University in Ottawa. He is founder of EnergyWise, based in the Netherlands which managed and implemented energy conferences and seminars worldwide. He has Dutch and Canadian citizenship. He writes on a regular basis about the oil industry, energy politics and the energy transition for Lagos, Nigeria-based *Africa Oil + Gas Report (AOGR)* and he also contributes to the Institute for Energy Economics and Financial Analysis (IEEFA), based in Cleveland, Ohio. In 2022 he published a book titled “*The 10 Commandments of the Energy Transition – And Other Essays on How to Power our Society Without Imploding the Economy or Destroying the Planet*”, published by FriesenPress. He continues to live in the Netherlands.

Note: supplementary environmental information below

Supplementary Information on Climate Change

Rising temperatures – the first eight days of February were the hottest on record.

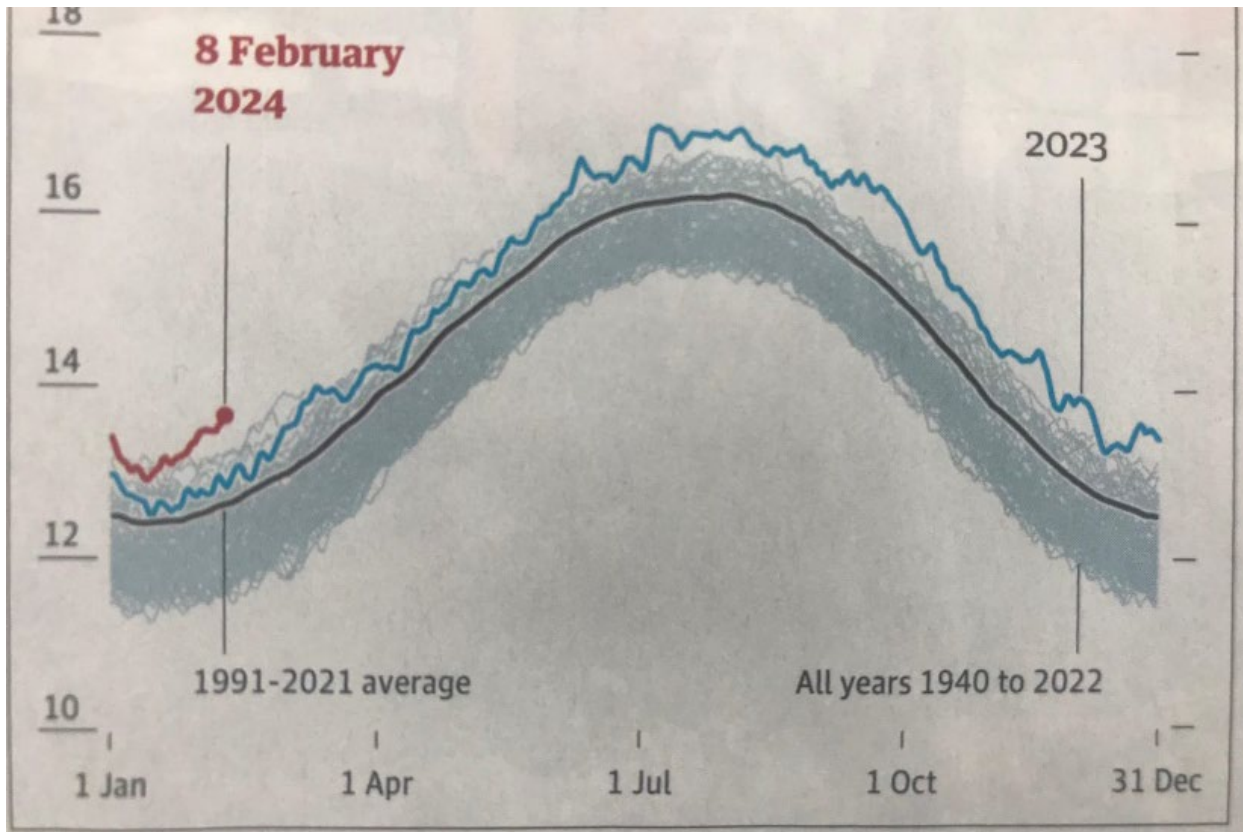


Figure 1S: Daily average global surface temperature, degrees C.
From the Guardian Weekly, February 23, 2024

