Let’s Not Pursue “Peak Oil”

The Risks to Society of a Global Oil Shortfall Due to Climate Fear

Robert Lyman 9/11/23

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LET'S NOT PURSUE "PEAK OIL"

EXECUTIVE SUMMARY

"Peak Oil" refers to the hypothetical point at which global crude oil production will hit its maximum rate, after which production will start to decline. At the forthcoming COP 28 conference in Dubai, a major agenda item will concern whether all parties to the Framework Convention on Climate Change will commit to curtail financing of new hydrocarbons development, thus aiding to advance the arrival of "peak oil".

The International Energy Agency June 2023 Oil Report projected global oil demand to peak "before the end of the decade".

The exact size of the global oil resource is not definitely known. Experience over many years has shown that initial resource estimates have been continually revised upwards as new discoveries are made, fields are better delineated and new technologies applied. It is important to understand the terminology. Oil reserves are the amount of crude oil a country or region has that can be economically produced with current technology. Oil resources include oil reserves plus the quantities of oil in the ground that are considered either "conventional" (susceptible to development through well bores using minimal stimulation) and "unconventional" (resources whose development also require multistage hydraulic fracturing or other advanced extraction techniques).

Current estimates are that global oil reserves are between 1.4 trillion barrels and 1.73 trillion barrels. The world has a reserve to production (R/P) ratio of somewhere between 38 and 46 (i.e. 38 to 46 years of production at current rates left).

There is a widespread international effort to find and develop more oil. According to a June 2023 report by Energy Monitor, there are now 47 countries with planned new oil and gas fields.

In 2012, the United States Geological Survey assessed undiscovered oil and gas resources. For undiscovered, technically recoverable oil resources, the mean total for the world was 565.3 billion barrels of crude oil. There remains a large potential for increasing oil production from existing fields by improving the recovery factor, or RF (the percentage of initial oil in place that is recovered

through better technologies). The average RF from mature fields around the world is somewhere between 20% and 40%. The means to do this now are a combination of enhanced oil recovery (EOR) and improved oil recovery (IOR). Using combinations of EOR and IOR technologies it has been possible to achieve RF's of 50% and 70% for some fields. In other words, in many cases it is possible to almost double the recovery factor, thus potentially doubling the existing conventional oil reserves.

Estimates of the size of the unconventional oil resource base are more difficult. Using the statistics of the US Geological Survey and the US Department of Energy, the global unconventional oil resource base was 450 billion tonnes (3.3 trillion barrels).

The potential ultimately recoverable oil resources are thus a combination of currently discovered conventional reserves (1.4 trillion-1.73 trillion barrels), plus undiscovered conventional reserves (565 billion barrels) plus unconventional resources (3.3 trillion barrels). The total, which must be regarded as speculative, is in the range of 5.1 trillion to 5.4 trillion barrels. At current rates of consumption, that could supply the world's needs for close to 150 years. From this it is reasonable to conclude that the potential consumption of oil in the world will not soon be resource-constrained.

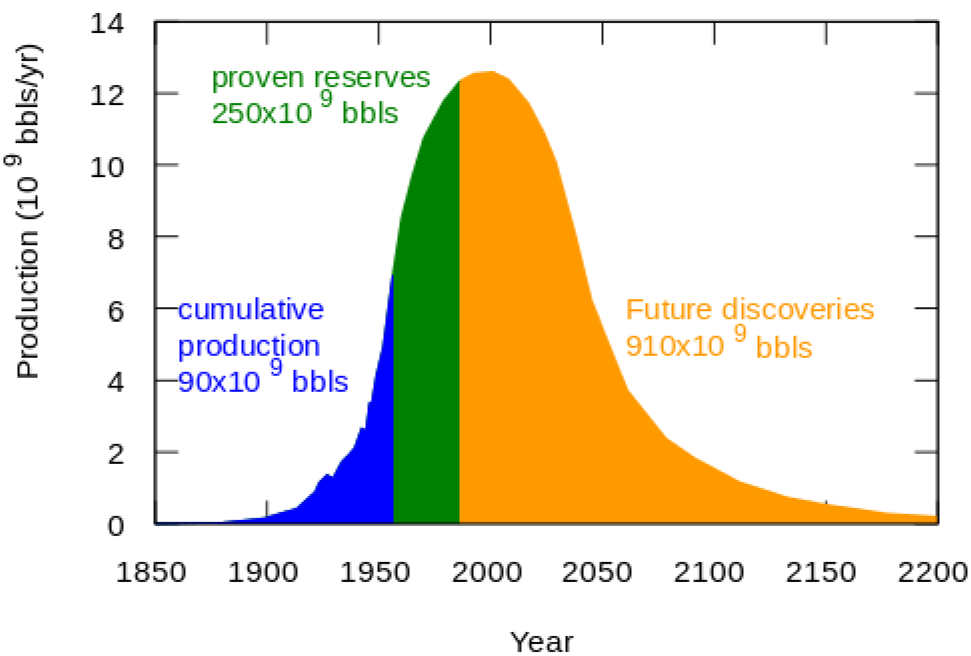
Development of additional oil reserves relies upon a favourable investment climate for oil companies, high enough prices to supply the necessary cashflow, and supportive government policies. The International Energy Agency 2023 report indicated that upstream oil and gas investment rose by 11% in 2022 to over US $450 billion and is expected to rise by 7% to US $500 billion in 2023. However, in 2015, new capital expenditures constituted over 90% of cash flow, but that share steadily declined to less than 50% in 2022. Among the reasons cited by the IEA was "uncertainty about future oil demand", but global oil demand continues to rise at over one million barrels per day per year. A more accurate reason may be companies' concern about the adverse impact of western countries' anti-hydrocarbons climate policies.

Absent intrusive climate policies, the world would inevitably go through a long transition in which increasingly more expensive oil was supplanted by natural gas and a range of other competitively-priced energy sources. Climate policy, however, seeks through taxation, regulation and central planning to control the pace of transition. It also seeks to remove natural gas from the equation as a transitional fuel. In so doing, climate policy risks creating a situation of both dire scarcity and extremely high energy prices that may persist for a long time. It remains to be seen, of course, whether the public in democratically-governed countries will tolerate such a transition.

LET'S NOT PURSUE "PEAK OIL"

THE RISKS OF CHOOSING A "PEAK OIL" OUTCOME

"Peak Oil" refers to the hypothetical point at which global crude oil production will hit its maximum rate, after which production will start to decline. Predictions of when peak oil will happen have a long and failed history, going back more than 70 years. These predictions were usually based on the views of geologists about the likely constraints on oil production posed by the size of the resource and the limitations of extraction technologies. Every one of the past predictions of when peak oil production would occur has been proven wrong.



A 1956 world oil production distribution, showing historical data and future production, proposed by M. King Hubbert – it had a peak of 12.5 billion barrels per year in about the year 2000. As of 2016, the world's oil production was 29.4 billion barrels per year (80.6 Mbbl/day),[1] with an oil glut between 2014 and 2018.

More recently, various expert sources have based predictions of peak oil more on the view that oil demand will soon peak and then decline due to international climate policy. The United Nations now promotes restrictions on oil and gas industry investment. At the COP26 climate conference in Glasgow in 2021, a group of 12 governments (including Quebec but not Canada) formed the Beyond

Oil and Gas Alliance. At the forthcoming COP 28 conference in Dubai, a major agenda item will concern whether all parties to the Framework Convention on Climate Change will commit to curtail financing of new hydrocarbons development, thus aiding to advance the arrival of "peak oil".

This article will seek to place these efforts in the context of the geologic, economic and policy factors that may determine potential future oil production in the absence of, or perhaps despite, policies that seek to thwart it.

How much oil will be available is not the only important public policy issue. Since the 1970's, the OECD countries that, until recently, were the largest oil importers have realized that where oil was produced was probably as important as how much was produced. Heavy reliance on imports from a small number of countries in regions subject to high geopolitical disruptions can pose a major security risk. For this reason, the sections that follow will also describe the geographic distribution of the resources.

These energy security considerations compete with the policy preferences of most OECD governments to achieve a greatly accelerated transition in the global energy system (or, at least, in the OECD economies) from one in which over 80% of energy services are based on hydrocarbons (i.e. oil, natural gas, and coal) to one reliant almost entirely upon renewable energy sources and highly-electrified end-uses.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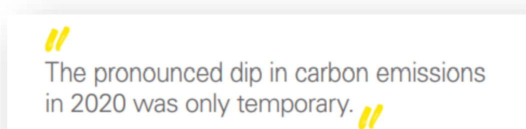
THE CURRENTLY ACCEPTED VIEW

The view of oil supply most often expressed in the media, and therefore accepted by most of the general public, is based on the analysis of the International Energy Agency (IEA). The IEA's World Outlook 2022 report included three different global energy scenarios, the first with oil production peaking in 2035 in its "stated policies" scenario, the second with oil production peaking in 2024 under its "announced pledges" scenario, and a third scenario that oil production had already peaked in 2021 in its "sustainable development" scenario. More recently, the IEA's June 2023 Oil Report projected global oil demand to peak "before the end of the decade".

Much of the analysis of future oil production levels is based upon views of the size of currently proven oil reserves. **Oil reserves are the amount of crude oil a country or region has that can be economically produced with current technology.** It includes crude oil, condensate and natural gas liquids (mainly, ethane, propane, butane and pentane).

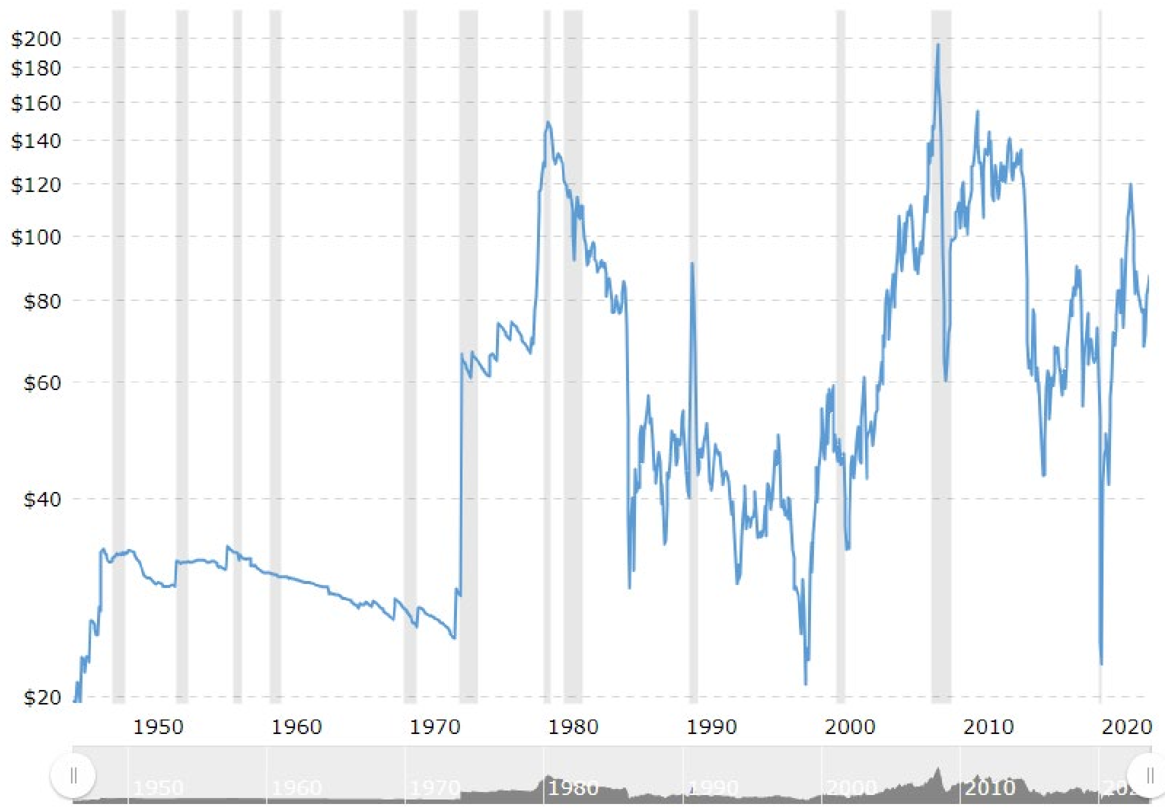
The Energy Institute now publishes the Statistical Review of World Energy. According to its most recent report, at the end of 2020 global oil reserves were 244 billion barrels , equal to 1.73 trillion barrels. The Oil and Gas Journal, in its annual assessment based on information at the end of 2021, reports that "*The world's proven oil reserves total 1,757 billion barrels, up from 1,735 billion barrels a year earlier*." The United States Geological Survey estimates that in 2016 there were 1.65 trillion barrels of oil reserves, but that by now the total is less than 1.4 trillion barrels. Using these three estimates to define a spectrum, at current oil demand of roughly 36.5 billion barrels per year, the world has a reserve to production (R/P) ratio of somewhere between 38 and 46 (i.e. 38 to 46 years of production at current rates left).



R/P ratios never have been a realistic indication of when oil might "run out" or peak. Both production and reserve levels are constantly changing. When the demand for oil temporarily exceeds the available supply (i.e. production plus drawdown from inventories), prices rise, and this provides an incentive over time for the petroleum industry to develop new production capacity and for oil consumers to find ways to reduce oil use. Oil remains a finite resource, of course, but the important questions concern how large that resource really is, and how disruptive the eventual long-term reduction in oil use will be to the world's economies.

OIL RESOURCES FOR THE FUTURE

Notwithstanding the popular view, the exact size of the global oil resource is not definitely known. Experience over many years has shown that initial resource estimates have been continually revised upwards as new discoveries are made, fields are better delineated and new technologies applied. Resource estimation is not an exact science, and the uncertainty and range of possible outcomes is huge. Extrapolation of recent trends of discovery into the future is not reliable. Perhaps most important, proven reserve estimates are directly proportional to the oil price – which is constantly changing – and in many cases the newer, unconventional oil reserves are only recoverable at relatively high oil prices that may not endure for long. Finally, for over a century, the power of new technologies and new ideas has always trumped extrapolation of past trends.



https://www.macrotrends.net/1369/crude-oil-price-history-chart

Proven oil reserves include reserves of both conventional and unconventional oil. Unfortunately, different sources often do not indicate what shares of total reserves are in each category.

The likely additions to reserves in future will come from four sources: exploration and development in conventional oil fields; enhanced oil recovery (EOR), improved oil recovery (IOR) from existing and new conventional oil fields; and increased exploration and development of non-conventional oil resources. All of this will be affected by the size of the resource base, meaning the total of the ultimately recoverable oil in conventional and non-conventional fields. Before exploring these topics, we need to define some terms.

CONVENTIONAL OIL RESOURCES are concentrations that occur in discrete accumulations or pools. Rock formations hosting these pools traditionally have high porosity and permeability. Porosity and permeability are separate but related characteristics of soil and rocks. While porosity is the percent of open spaces or voids within a volume of soil or rock, permeability is the rate of water movement through interconnected pores within soil or rock. Conventional oil pools are developed using vertical well bores and using minimal stimulation (an example of simulation is injection of chemicals to increase pressure in the well).

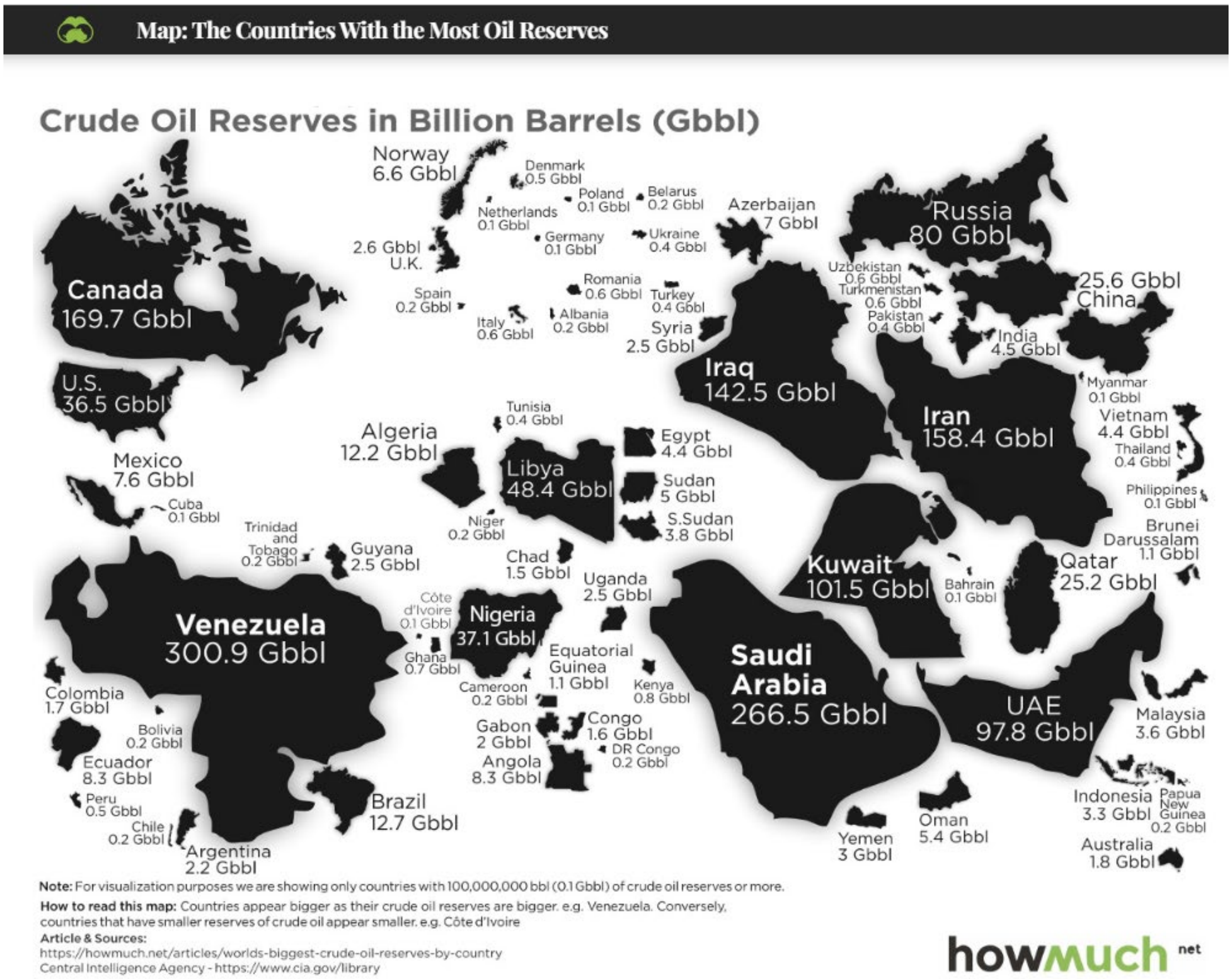
UNCONVENTIONAL OIL RESOURCES are concentrations where the permeability and porosity are so low that the resource cannot be extracted economically through a well bore and instead requires a horizonal well bore followed by multistage hydraulic fracturing to achieve economic production. Unconventional oil resources exist in many different types including oil shale, heavy oil, oil sands, and tight oil.

GROWING OIL RESERVES

As noted previously, the focus of attention of those who believe the world will soon face peak oil supply often has been on the conventional oil reserve to production (R/P) ratio. In 1980, the reserve to production ratio suggested only 32 years of production from existing reserves. However, according to data from the British Petroleum Statistical Review of World Energy, the known oil reserves were 254% larger in 2022 compared to 1980. Reserve additions grew faster than production.

Reserves have grown despite the absence of large field discoveries. The reasons for this are many, as partly explained in a US Geological Survey circular published in the early 2000’s. This included the large number of oil and gas wells drilled, which rose to 73,000 in 2019 before dropping temporarily due to the effects of the pandemic.

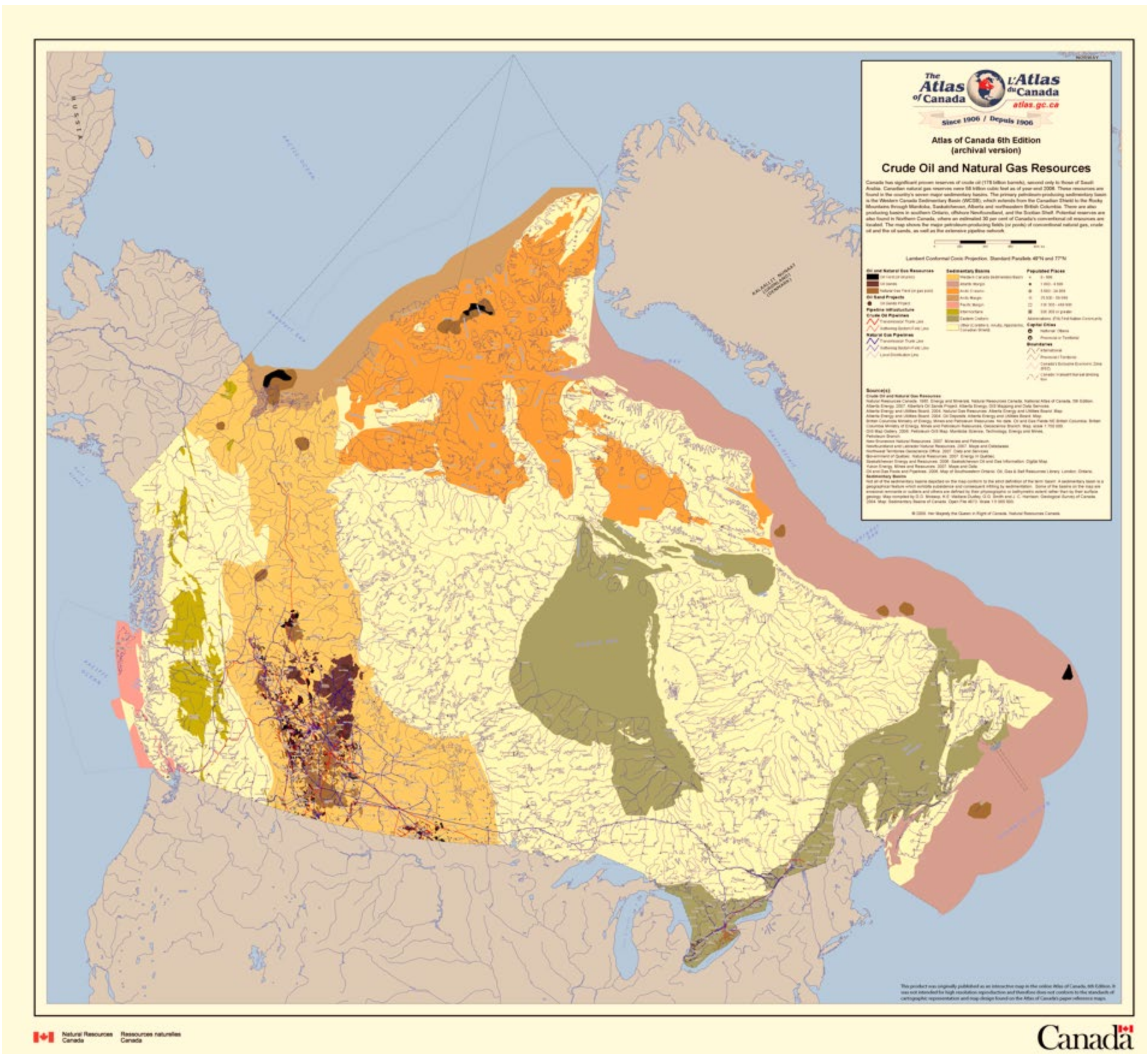
Also important was the increased level of drilling in offshore areas that have higher resource potential. **A total of 12.2 billion barrels of oil equivalent (BOE) was discovered worldwide in 2019, with offshore regions dominating the list of new deposits. In that year, 26 discoveries of more than 100 million BOE were recorded, with oil discoveries in Guyana alone totaling approximately 1.8 billion BOE.**



https://www.visualcapitalist.com/map-countries-most-oil-reserves/#google_vignette

According to Worldometer, 98 countries, or more than half the countries in the world, have some oil reserves. Seventy-five percent of them are in only seven countries, all of which except for Canada are members of the Organization of Petroleum Exporting Countries (OPEC). According to the Energy Institute, the four countries with the largest reserves are Venezuela (304 billion barrels), Saudi Arabia (298 billion barrels), Canada (168 billion barrels) and Iran (158 billion barrels). These have more than half the world's reserves. Russia, with 80 billion barrels, ranks eighth, and it cooperates with OPEC in managing production levels.

In fact, the world's currently economic-to-produce crude oil is located almost entirely in countries that have worked for years to manage supply so as to keep prices higher than they would otherwise be and in regions that habitually experience high levels of geopolitical conflict and uncertainty. Venezuela, the country with the largest reserves, is in such grave political and economic turmoil that it today produces only 73,000 barrels of oil per day, only two percent of the almost 3.5 million barrels per day that it produced at its peak in 1997. Iran remains under severe economic sanctions imposed by the United Nations and the European Union. **Canada's oil reserves are by far the largest source of reliable and secure supply available to the OECD countries.**



https://natural-resources.canada.ca/maps-tools-and-publications/maps/energy-maps/16872

There is a widespread international effort to find and develop more oil. According to a June 2023 report by Energy Monitor, there are now 47 countries with planned new oil and gas fields. The definition of "planned" is that they have already received final investment decisions to develop, and real-world work has been initiated to begin extraction. The top eight countries in terms of the number of new oil and gas fields under development are Russia (undeterred by western sanctions over the war in Ukraine); Brazil (which is already the world's ninth-largest producer of oil and has adopted the goal of increasing oil production by 70% by 2030); Norway (which, despite its aggressive climate policy, has issued as many exploration licences between 2012 and 2022 as it had since it began extracting oil in 1965); the United States (surprisingly still issuing new exploration licences notwithstanding the rhetoric of the Biden Administration); India (developing eleven fields, all of which are small); Australia (mainly focused on natural gas); China (with a major new oil field in the Bohai Sea estimated to contain 680 million barrels of oil); Malaysia (with the largest reserves in southeast Asia); the United Kingdom (where five new fields have received final investment decisions, and more than 900 locations have been approved for oil and gas exploration); and Nigeria, developing eight new fields.

In 2012, the United States Geological Survey published *An Estimate of Undiscovered Conventional Oil and Gas Resources of the World*.[1] In this paper, the USGS assessed undiscovered oil and gas resources in 313 “assessment units” and 171 geologic provinces. For undiscovered, technically recoverable oil resources, the mean total for the world was 565.3 billion barrels of crude oil and 166.7 billion barrels of natural gas liquids. One of the most intriguing findings concerned the geographic locations of the undiscovered oil resources. Table 1 summarizes the findings.

Table 1

Total Undiscovered Conventional Oil Resources by World Region (Mean Estimates)

Region	Resources (Million barrels)
Former Soviet Union	66,211
Middle East/ North Africa	111,201
Asia and Pacific	47,544
Europe	9,868
North America	83,383
South America and Caribbean	125,900
Sub-Saharan Africa	115,333
South Asia	5,855
Total	565,298

Source: US Geological Survey, 2012

[1] https://pubs.usgs.gov/circ/1288/

The points to note from this are that:

- The total undiscovered conventional oil resources were only about half the estimated discovered conventional oil resources. This is one factor that led to increasing concerns that the world was "running out of oil", however slowly.
- The area with the largest undiscovered conventional resources was not the Middle East, but South America and the Caribbean, followed (even more surprisingly) by sub-Saharan Africa.
- North America was estimated to have only 15% of the world's undiscovered conventional oil and Europe less than 2%.

In addition to adding new fields for development, there remains a large potential for increasing oil production from existing fields by improving the recovery factor, or RF (the percentage of initial oil in place that is recovered through better technologies). The average RF from mature fields around the world is somewhere between 20% and 40%. The means to do this now are a combination of enhanced oil recovery (EOR) and improved oil recovery (IOR). To quote a recent report from the British Royal Society:

"*Enhanced oil recovery involves injecting a fluid into an oil reservoir that increases oil recovery over that which would be achieved from just pressure maintenance by water or gas injection. For lighter oils, these processes include miscible gas injection, water alternating gas (WAG) injection, polymer flooding, flow diversion via polymer gels and the use of surfactants. For more heavy oils these processes include steam injection and air injection (leading to in situ combustion). The majority of EOR processes used today were first proposed in the 1970s at a time of relatively high oil prices.*

Improved oil recovery (IOR) is a term that is sometimes used synonymously with EOR although it also applies to improvements in oil recovery achieved via better engineering and project management e.g. identifying volumes of oil that have been bypassed during water of gas injection, using seismic surveying and then drilling new wells to access those oil pockets… Improved computing power enabled engineers to build more complex models and thus estimate the effect of reservoir heterogeneity on flow. Improved seismic algorithms combined with more powerful computers meant that engineers and geoscientists could use 'four-dimensional' seismic surveying, involving the comparison of seismic data taken at different times, in combination with reservoir simulation to identify bypassed volumes of oil on the scale of hundreds of metres horizontally and tens of metres vertically."

Using combinations of EOR and IOR technologies it has been possible to achieve RF's of 50% and 70% for some fields. In other words, in many cases it is possible to almost double the recovery factor, thus potentially doubling the existing conventional oil reserves.

Estimates of the size of the unconventional oil resource base are more difficult to come by, but one seemingly credible source is a paper published in Earth Science Reviews in 2013. Quoting the statistics of the US Geological Survey and the US Department of Energy, **the paper stated that the global unconventional oil resource base was 450 billion tonnes (3.3 trillion barrels).** Recoverable resources of natural bitumen (oil sandstone) were estimated to be 106.67 billion tonnes (782 billion barrels), 81.6% of which are in North America. An updated 2017 edition shows the sum of tight oil, heavy oil, bitumen and shale resources of 412 billion tonnes, equal to 3.2 trillion barrels of oil.

The paper's estimates of the geographical distribution of heavy oil plus natural bitumen are summarized in Table 2.

Table 2

Global Heavy Oil and Bitumen Distribution

Region	Resources (%)
North America	53.6
South America	23.4
Africa	4.7
Europe	0.4
Middle East	6.9
Asia	6.7
Russia	4.4
Total	100.0

Source: Caineng Zou, Unconventional Petroleum Geology, 2017

This distribution of resources demonstrates further the potential, in terms of unconventional oil supplies, for the countries of the Americas to be independent and secure relying on indigenous production – if they so choose.

In addition to heavy oil and bitumen, there are 600 oil-shale deposits in the world, with technically recoverable oil shale resources estimated at about 287 billion barrels[2]. So far, the cost of production is considered far too high for more than negligible production.

THE TOTAL SIZE OF OIL RESOURCES

The potential ultimately recoverable oil resources are thus a combination of currently discovered reserves (1.4 trillion-1.73 trillion barrels), plus undiscovered conventional resources (565 billion barrels) plus some portion of the unconventional resources (3.3 trillion barrels). A problem is that Canada treats its economically-recoverable unconventional oil resources as reserves, whereas other sources may treat these as only part of the "unconventional resources" category. According to Statista, as of the end of 2020, total Canadian proven oil reserves were estimated at 168 billion barrels, of which 161 billion barrels were in Alberta's oil sands and an additional 5.7 billion barrels were in conventional formations.[3] If one deducts Canada's unconventional oil "reserves" from the estimated 3.3 trillion barrels of global unconventional resources, the latter declines to about 3.1 trillion barrels. The total, which must be regarded as speculative, is in the range of 5.1 trillion to 5.4 trillion barrels. **At current rates of consumption, that could supply the world's needs for close to 150 years.**

From this it is reasonable to conclude that the potential consumption of oil in the world is not resource-constrained, regardless of the multitude of "peak oil" claims. Saying that, however, does not address another important question. Will sufficient financing be available to ensure the development of needed oil reserves in future?

TRENDS IN GLOBAL OIL INVESTMENT

The International Energy Agency publishes the most comprehensive annual report on trends in global energy investment. The IEA's 2023 report indicated that upstream oil and gas investment rose by 11% in 2022 to over US $450 billion and is expected to rise by 7% to US $500 billion in 2023.

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[2] https://www.eia.gov/todayinenergy/detail.php?id=11611
[3] https://www.statista.com/statistics/973765/canadian-oil-reserves-by-type/

Perhaps the most striking point in the IEA's report concerned the changes since 2015 in the share of oil companies' cash flow that was devoted to oil and gas capital expenditures. **In 2015, new capital expenditures constituted over 90% of cash flow, but that share steadily declined to less than 50% in 2022.** There has been a large increase in dividends plus stock buybacks and repayment of debt. According to the IEA, companies are seeking investments that are competitive in costs, have short development cycles, and involve acceptable geopolitical risk. There is also a keen awareness of increasing upstream costs due to service companies' higher margins, the higher costs of equipment, labour and electricity and labour shortages in some regions. The IEA also cited "uncertainty about future oil demand", but global oil demand continues to rise at over one million barrels per day per year. **A more accurate reason may be companies' concern about the adverse impact of western countries' anti-hydrocarbons climate policies. In other words, the climate policies imposed by several OECD governments, including Canada, are already placing in peril the availability of secure and affordable oil supplies in future.**


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CONSEQUENCES

If these trends continue, there is good reason for concern that, despite ample resource availability, there will not be sufficient investment in development of new supplies to meet current and projected levels of global oil demand. The inevitable result could be a sustained period of much higher oil prices, which in turn will have important supply and demand effects. Some prominent analysts, including Peter Jackson of Cambridge Energy Research Associates[4], foresee a future in which oil production will reach an "undulating plateau" that may last for several decades before eventually declining. The production profile, in other words, will not resemble a bell curve, but a periodically rising and falling trendline. During the plateau period, the growth in production from unconventional oil will fill any supply gaps, but the result may be prolonged price volatility. **Oil supply will not be constrained by below-ground features but by above-ground political and economic ones.**

The "above ground" features are probably even more difficult than the below-ground ones to predict. They include the major trends in the world's economy, and especially the increases in economic development and middle-class aspirations in the fast-growing Asian economies. They include the trends in oil prices, as these will be important in determining how much money oil companies have to invest in new supply development and whether the level of oil prices to consumers is such as to encourage or destroy demand. Most important from today's perspective will be the effects of climate policies.

This archival news footage from Northeast Historic Film shows scenes of gas stations during the 1979 oil crisis. When operating, the gas stations faced long lines of cars that one customer suggested stretched about a half-mile long. When the stations were closed, signs in front reflected the country's supply shortage at the time—for example, "Our pumps are closed" and "No gas." A station owner explains that regulating hours of operation was necessary to keep stations open throughout the month. An attendant blames "the papers" for causing customers to panic.

https://www.pbslearningmedia.org/resource/bln12.socst.ush.now.oilcrisis/the-oil-crisis-1979/

[4] https://royalsocietypublishing.org/doi/10.1098/rsta.2012.0491

Absent intrusive climate policies, the world would inevitably go through a long transition in which increasingly more expensive oil was supplanted by natural gas and a range of other competitively-priced energy sources. The transition would not necessarily be a smooth one, because the response of consumers to higher prices is always faster than the ability of industry to bring on new supply, so there would inevitably be some periods of volatility. **Climate policy, however, seeks through taxation, regulation and central planning to control the pace of transition. It also seeks to remove natural gas from the equation as a transitional fuel. In so doing, climate policy risks creating a situation of both dire scarcity and extremely high energy prices that may persist for a long time. It remains to be seen, of course, whether the public in democratically-governed countries will tolerate such a transition.**

ABOUT THE AUTHOR

Robert Lyman is an economist with 27 years' experience as an analyst, policy advisor and manager in the Canadian federal government, primarily in the areas of energy, transportation, and environmental policy. He was also a diplomat for 10 years. Subsequently he has worked as a private consultant conducting policy research and analysis on energy and transportation issues as a principal for Entrans Policy Research Group. He is a frequent contributor of articles and reports for Friends of Science, a Calgary-based independent organization concerned about climate change-related issues. He resides in Ottawa, Canada. Full bio.

ABOUT FRIENDS OF SCIENCE SOCIETY

Friends of Science Society is an independent group of earth, atmospheric and solar scientists, engineers, and citizens that is celebrating its 21st year of offering climate science insights. After a thorough review of a broad spectrum of literature on climate change, Friends of Science Society has concluded that the sun is the main driver of climate change, not carbon dioxide (CO_2).

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