The Energy Industry Today

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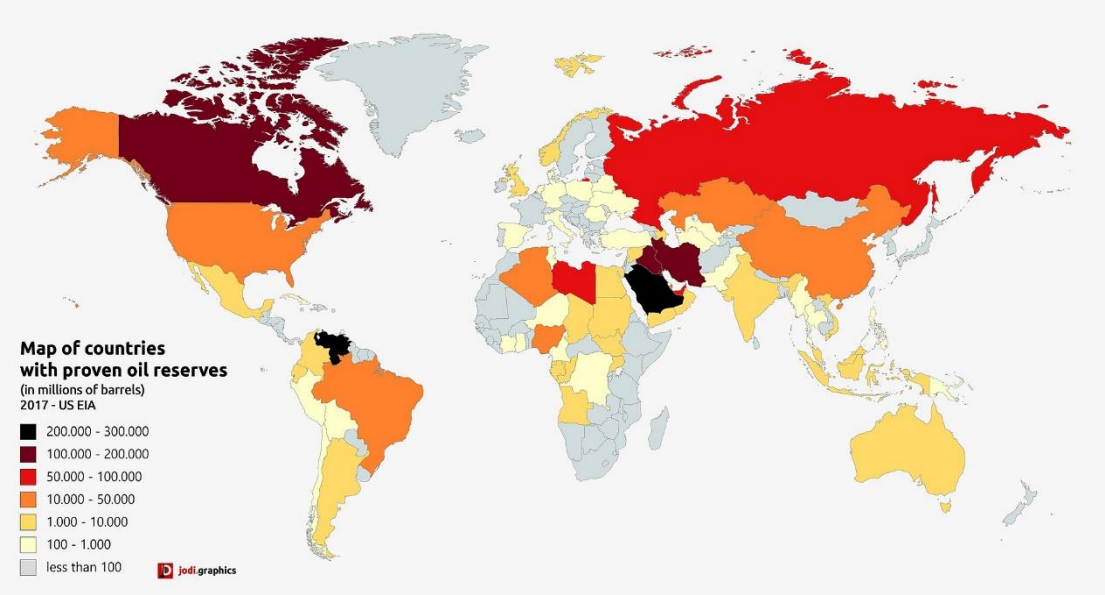
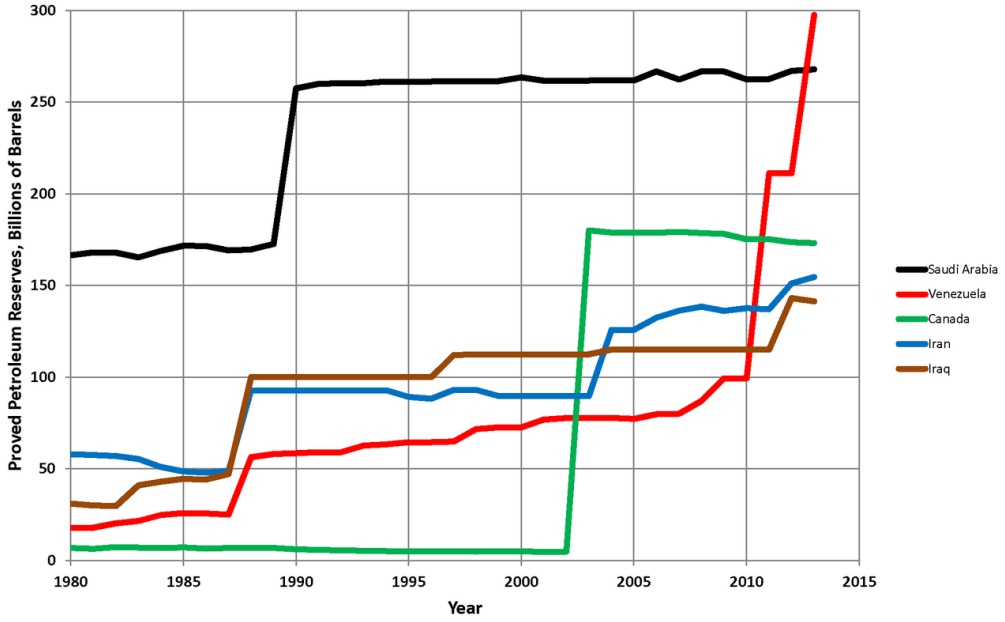
Fossil fuels might arguably have been one of the greatest drivers of economic development, technological progress, and one of the most important factors in influencing international trade and relations for the past century and a half, but as it's own synonymous term "non-renewable energy" states, at the growing rate of consumption by an energy hungry world population, reserves of coal, oil and natural gas are not expected to last much longer. Leaders in the Big Oil – BP, Chevron, Shell, ExxonMobil, Total, ConocoPhilips, Eni – have long considered the need to diversify their production portfolios, as a result of which we have seen a tremendous drive towards technological progress and excellence in the energy industry, with milestones like deepwater drilling, hydraulic fracturing (fracking) of tight oil & gas reservoirs like shale, CBM E&P, directional drilling, enhanced oil recovery techniques such as gas/polymer lift, SAGD, in-situ combustion, and many more. The following map shows a map of proven oil reserves by country, and the historical effect of such progress is seen in the subsequent chart with the dramatic growth proven reserves in the top 5 countries in the past two decades.

Global Proven Crude Reserves (2017)



Source: US EIA Annual report, 2017

Trends in Proven Reserves, Top Five Countries (1980-2013)



Source: US EIA combined data, 1980-2013

However, with such explosive progress comes the increased risk of oversight on critical issues concerning cost-effectiveness and sustainability of operations, environmental impacts, and a growing economic divide between exporters and importers of fossil fuels, not to mention the unimaginable impact of events like the Piper Alpha (1988) and Deepwater Horizon (2010) disasters, Norco refinery explosion (1988), and India's Mumbai High BHN platform disaster (2005). The growing concern with these risks and fallout from such events has encouraged a very serious employee and asset HSSE culture in the industry and significant focus on operational safety, and has given rise to strict environmental regulations on production and disposal operations involving pollutants like waste water, sulphur and nitrogen oxides, gas flares and leakages, groundwater aquifer contamination, and also on offshore safety. The success of these measures, along with fact that a significant portion of the non-energy industry is still heavily dependent on by-products derived from crude oil such as plastics, asphalt and paraffin waxes, petrochemicals & cosmetics, organic reagents and lubricants, paints and varnishes, etc. is why we see the bulk of the industry still following business models that are predominantly fossil-fuel based. However, growing awareness on the depletion of hydrocarbon reserves and on climate change in the past two decades has brought to light that not only is there a global need for non-depletable sustainable energy, but also a silent killer that has been overlooked till very recently – the carbon emissions.

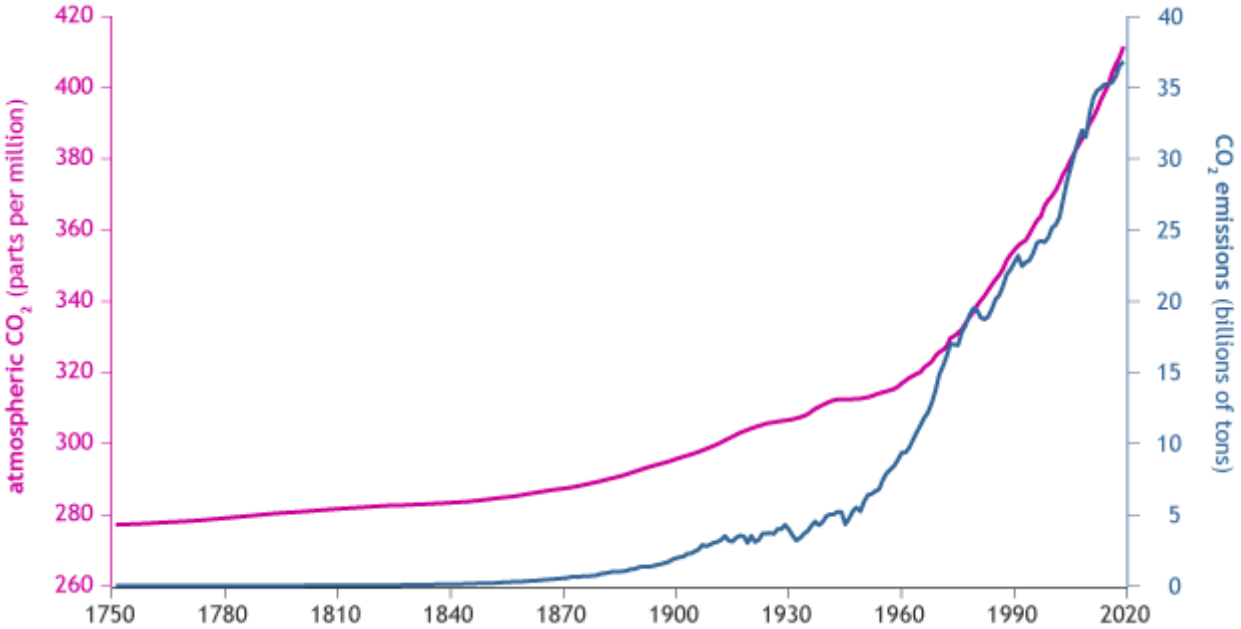
The Global Energy Transition

The energy industry today is facing an unprecedented challenge which involves all participants in the technological chain of energy management, all citizens, and all economic entities – How to transition towards a sustainable clean energy production and distribution system. With global awareness on climate change and consequent pressure towards the necessary corrective measures now mounting, we are seeing the inception of a gradual but clear shift towards alternative sources of sustainable and clean primary energy like solar, wind, nuclear, geothermal energy and carbon-neutral and carbon-negative alternative fuels and energy technologies such as hydrogen fuel, BECCS and DAC.

The Carbon Cycle

Carbon is the most abundant element on the planet. It's unique chemical properties have enabled it be the backbone of not just all life on earth, but also its climate, landscapes, mineralogy, and also our homes, transportation, and almost all else that we exploit for progress and development. Most of the Earth's carbon is stored in rocks and sediments (*lithosphere*), while the rest is located in the ocean (*hydrosphere*), air (*atmosphere*), and in living organisms (*biosphere*). These are the reservoirs, or sinks, through which carbon cycles. Carbon is released back into the atmosphere when organisms die, volcanoes erupt, fires are lit, fossil fuels are burned, and through a variety of other mechanisms. For millennia, the amount of carbon in the atmosphere in the form of the carbon oxides - carbon dioxide and carbon monoxide, which is the driving force behind the regulation of the earth's atmospheric temperature has remained at a fairly consistent concentration till recently, as a result of the increased energy demand due to extensive industrial development. The chart below illustrates this, and as seen, a total of 2900 GT of carbon has been emitted since the late 1800s, since the beginning of hydrocarbon exploration, and is still exponentially increasing, thus causing the global atmospheric carbon to drastically increase.

CO_2 in the atmosphere and annual emissions (1750-2019)



Source: CO_2 emissions, "Our World in Data" NOAA, Global Carbon Project

The Paris Agreement

On 12 December 2015, UN member countries which were party to the UNFCCC reached a historic agreement in Paris to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change with enhanced support to assist developing countries to do so as well. This charts a new course in the global climate effort. There are two main tenets to the Paris Agreement:

- Short Term Goal: Recognizing the current energy scenario, and the prevalent dependency on fossil fuels and their by-products, the first global objective should be to peak carbon emissions to the atmosphere as soon as possible. At this point we would have just reached the peak emission goal; we would still be carbon-positive (*more carbon emitted to the atmosphere than would be removed*)
- Long Term Goal: Achieve carbon-neutrality (*atmospheric carbon emissions from sources = carbon absorbed by sinks*), and eventual carbon-negative balance *(more carbon absorbed into sinks than emitted into the atmosphere*). This is necessary to ensure we do not overshoot our carbon budget (*keeping the emissions below the point to cause 2^o C change in global atmospheric temperature).*

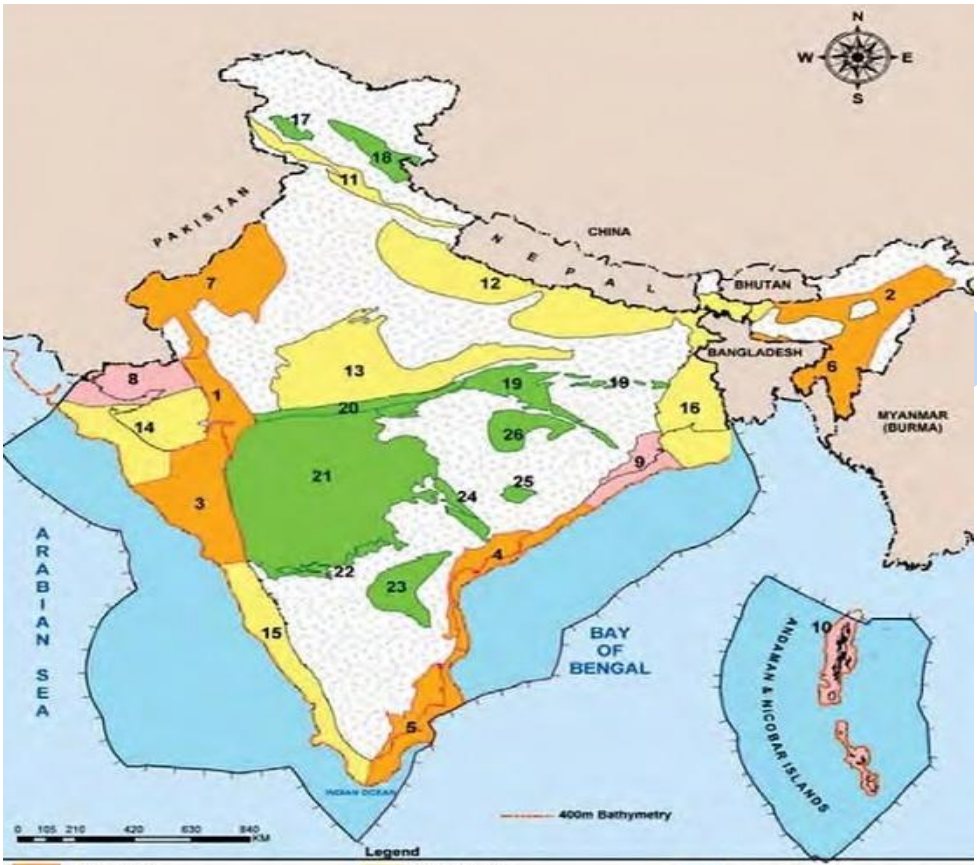
To achieve these goals, it is necessary to understand that while we still may be reliant on fossil fuels as a source of energy and other commodities for centuries more, we must invest in new energy technologies that are carbon-neutral to avoid further accelerated emissions, and also in technologies that act as artificial sinks to capture and store atmospheric carbon and transfer them to the natural sinks for permanent storage. We must also explore methods to de-carbonise the current global energy supply by means of carbon capture at the source. Recent business and R&D focus on such technologies has spurred the movement in the energy industry that has come to be known as the Global Energy Transition.

At the later stages of the energy transition (*the year 2050 as per the Paris Agreement*) the production and transformation of energy, as well as its transport and transmission, distribution, and consumption, will be performed with new technologies and amid new economic relations. All changes will take place within a living system, where not all processes will go in the same direction, which makes process management particularly important, and with the major budget and portfolio re-evaluations in the Big Oil in the wake of the Covid-19 crisis, the transition has been fast-tracked and may come to fruition sooner than we anticipate.

India's Role in the Transition

At present, India is the 3rd largest importer of oil and gas, importing 82.8% of its crude oil and 45.3 % of its natural gas. While India's legacy in hydrocarbon exploration has been ancient, with the first oil well of Asia being drilled in Digboi, Assam in 1866 in the Tinsukia district, and the first refinery being set up in the same place as early as 1901 by what was then the Assam Oil Company, the lack of substantial proven reserves, the monopolization of exploration and production activities by the national producers ONGC and OIL, and the failure to attract private oil majors through initiatives like the NELP has kept India towards the chasing side of the energy race. At present, the country is dependent on the two main proven reserves in India's EEZ – The ONGC operated Mumbai High Field, about 175km offshore in the Gulf of Khambat, and the OIL operated Sylhet-Kopili/Barail-Tipam Composite Basin (also known as the Assam-Arakhan Shelf Basin). These however, are not very high producers *(total of 32 billion Mcf/year for natural gas – 0.8% of worldwide production)* and are not predicted to last very long, and with the growing demand for energy in a developing India, it is essential to plan for more sustainable options.

Proven Crude Reserves in India by Category (2017-18)



Category I	Category II	Category III	Category IV
1. Cambay Basin	8. Kutch Basin	11. Himalayan Foreland	17. Karewa Basin
2. Assam Shelf Basin	9. Mahanadi Basin	12. Ganga Basin	18. Spiti -Zanskar Basin
3. Mumbai Offshore Basin	10. Andaman-Nicobar Basin	13. Vindhyan Basin	19. Satpura-South Rewa-Damodar Basin
4. Krishna -Godavari Basin		14. Saurashtra Basin	20. Narmada Basin
5. Cauvery Basin		15. Kerala -Konkan -Lakshadweep Basin	21. Deccan Syneclise Basin
6. Assam-Arakan Fold Belt		16. Bengal Basin	22. Bhima -Kaladgi Basin
7. Rajasthan Basin			23. Cuddapah Basin
			24. Pranhita- Godavari Basin
			25. Bastar Basin

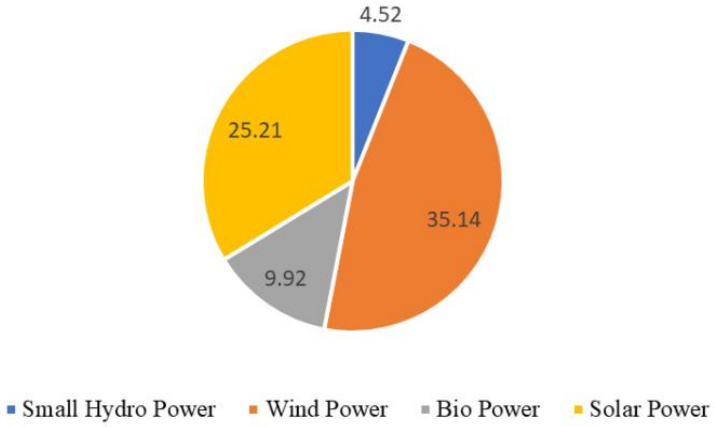
Source: National Data Repository, DGH India

India's Alternative Energy Capacity

India has made significant strides towards sustained operations for already established alternative direct fuel sources such as hydrogen and nuclear power. As of March 2018, India had 22 nuclear reactors in operation in 7 nuclear power plants, with a total installed capacity of 6,780 MW. 7 more reactors are under construction with a combined generation capacity of 4,300 MW. In October 2010, India also drew up a plan to reach a nuclear power capacity of 63 GW in 2032. While India may not have an operable hydrogen generation plant yet, since 2019 national corporations like the NTPC, IOCL and ISRO, in association with Tata Motors, have collaborated to launch hydrogen fuel public buses, and have announced plans to build hydrogen generation and consumption infrastructure in the coming years.

With regard to electricity and the renewable energy sector, India has a competitive advantage, currently being 4th largest in the world in capacity and production. At present, India's renewable energy capacity is estimated to be 377 GW, of which the installed capacity stands at 136 GW (around 36%), by the following breakdown per sector –

India's Total Installed Renewable Energy Capacity by Sector (2018-19)



Source: Ministry of New and Renewable Energy (MNRE), compiled by CSIS

This puts India in the unique position of being a key player in the energy transition, and this has not gone unnoticed, as is clearly seen by the huge investment in the past half-decade in renewable energy exploitation and the future ambitions stated by the MNRE (*175 GW renewable capacity by 2022*). Wind and Solar are the most promising forms of primary energy that India is currently looking to invest in. The Solar Energy Corporation of India (SECI) concluded a tender for 1.2 GW of renewable energy projects with storage that could potentially meet the power demand during morning and evening hours for the major grid hubs. While dependency on coal (*which still provides 75% of the country's electricity*) may not diminish, the hope for a future of new energies in India looks quite promising.

The Path Forward

The Global Energy Transition is in its nascent phase right now, and most of the imagined potential is still uncharted waters for the world. Most of the new energy technologies are novel concepts not in application, and with the technologies that have come into development and operation, the key issue is with the technology required to make the concepts commercially viable for production, storage and distribution. Most of the new energy projects worldwide are concentrated in limited regions having the relevant public/private investment and R&D focus, and only supply to a few cities or a few small districts. Large economies of scale with these technologies have not yet been realized, and more so than production, storage of carbon-neutral primary and secondary energy is a serious challenge. However, this also presents exciting new opportunities in the future of the energy industry for completely new types of business models and new R&D to explore, and as sure as the shift from steam-powered industrial technologies during the industrial revolution to oil and gas powered technologies had taken place over the following half-century since hydrocarbon resources were first discovered, the transition to new energies is inevitable, and we will soon be living in a world where our homes will be powered by renewable energy electricity, our vehicles powered by hydrogen and other zero carbon fuels, and our industries and economies powered by safe, sustainable and clean energy.