

Forum: United Nations Environmental Programme

Issue: The Question of Environmental Degradation Due to Increased Demand in Petrochemicals

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Introduction

The industry of [petrochemicals](#) is one of great perplexity. Even with multiple obstacles such as the coronavirus and reduction in the oil prices, the demand for petrochemicals has been ever rising in the past couple of years. According to the International Energy Agency, “petrochemicals are set to account for nearly a third of the growth in oil demand to 2030, and nearly half to 2050, ahead of trucks, aviation, and shipping.” The oil industry in general is one of the most profitable industries for worldwide governments seeing as it makes transportation possible worldwide. To understand why this is true, it is important to analyze the different oil-based economies around the world. Being Saudi Arabia’s main exporter of oil, Aramco holds the record for the largest public listing in the world with the value of the company hitting \$2 trillion on the second day of launch. Standard and Poor’s, a renowned consulting agency, also forecasted that GCC states will accrue \$490 billion dollars in deficits by 2023 because of forecasted reduction in oil revenue of \$200 billion by the end of 2020 due to the Covid-19 pandemic.

These facts and statistics all lead to the conclusion that the world functions on oil; everything from aviation, public transport, cooking and more relies on oil. However, the opportunity cost arises when one takes a look at the alarming numbers of environmental degradation. Oil spills have accounted for the loss of 5.73 million tons of oil from 1970 to 2016, oil pollution has the ability to harm ecosystems at large, and it can prevent photosynthesis in plants.

Knowing all of these consequences, countries around the world are still extremely keen to invest in the petrochemicals market because these chemicals extracted from refining petroleum are used in products like cosmetics, plastic, electronics, solar panels, and wind

turbines. This, in turn, has the ability to create millions of jobs and open companies up to several investment opportunities that can be used for economic benefit. Weighing all the positives and negatives, the question of whether petrochemicals should continue to be used is still debatable, but it can be stated with absolute certainty that it can have disastrous effects on the environment and its ecosystems.

Definition of Key Terms

Petrochemicals

Also known as petroleum distillates, petrochemicals are the chemicals that are derived from refined or partially refined chemical fraction. They can also be obtained through other fossil fuels such as natural gas and coal as well as renewable sources such as maize and sugar cane.

Carbon Capture, Utilization, and Storage

This is a process through which carbon can be “recycled.” It does this by injecting gas into the grounds in which the oil rigs operate which can reduce the overall carbon emissions and increase oil/heat recovery.

Clean Technology Scenario

This is an ideal scenario which “lays out an energy system pathway and a CO₂ emissions trajectory in which carbon emissions related to the energy sector are reduced by around three-quarters from today’s levels by 2060” according to the International Energy Agency.

Climate Change

Climate change refers to the changes that occur in the weather of the Earth over a long period of time and is affected by several factors such as global warming which is caused by carbon emissions and general pollution. Mathematically, it refers to the difference of the Earth’s global climate over time.

Carcinogens

Carcinogens are the substances that encourage the formation of cancer cells within a living body by damaging the genomes or disrupting metabolic processes.

Key Issues

Increased Economic Growth in the Petrochemicals Industry

The fact that a lot of economic growth comes from the export, import, and domestic use of petrochemicals is very advantageous, however, the reason that this is a growing issue is due to the fact that on the contrary, it causes many harmful environmental effects. The world has increased its carbon emissions marginally every year except for 2020 due to the COVID-19 pandemic and reduced industrial activity. According to octopus.energy, “if we continue to use these fossil fuels at the current rate without finding any additional reserves, it is expected that coal and natural gas will run out by 2060.” Coming back to petrochemicals, the IEA predicts that there will be a 25% spike in oil consumption by 2023 meaning that severe environmental hazards will be noticed such as the ones mentioned below.

Economically speaking, the petrochemical sector has maintained a 41% market share in the new project announcements and has attained the top spot in new project announcement since 2016. According to a statement by the Construction Boxscore Database, these projects are worth around USD 510 billion worldwide led by the Middle Eastern, Asian-Pacific, and American regions.

Petrochemical Products are Not Biodegradable

Many of the products that are made from petrochemicals are types of plastics. Specifically, olefins (ethylene and propylene) are the types of petrochemicals used in plastic. These types of chemicals also act as artificial preservatives and lengthen the lifespan of the product. As a result of this, plastic takes 1000 years to decompose. Since plastic is common for the usage of bags, cosmetics, and packaging, it causes mass pollution on an everyday basis. This is because the chemicals, including [carcinogens](#), that are used in the production process are released over a short period of time which in turn pollutes the atmosphere and marine life.

Moreover, chlorinated plastic releases harmful chemicals into the soil which can then be absorbed by rivers, underground outlets, and the general surface of the Earth acting as a contributing factor towards environmental degradation. Additionally, by digging for coal and oil

through the extraction process to obtain petrochemicals, salts rise to the surface of the water which can cause harm to natural ecosystems and put habitats at risk.

Air Pollutive Petrochemicals Lead to Negative Health Externalities

The root cause of severe air pollution in the petrochemical extraction process is the release of carcinogens. According to environmental impact assessment (a study that measures the quantitative impact of emissions on the environment), “unsafe emissions may be due to improper production process, poor maintenance practices, and internal operations problems.” When the production process in the United States was observed by the Environmental Protection Agency, it was noted that production releases 150-300 mg/m³ of chemicals such as benzene and bromomethane into the atmosphere which proved to be particularly dangerous for infants and children. In terms of the health effects due to this air pollution, research shows that it can cause acute respiratory problems, ulcers, allergic dermatitis, tubular necrosis, and liver damage.

It is important to note that most countries in the world are aware of these chemical leaks however refuse to take action. For example, the Indian government doesn't even have a database on the EIA (environmental impact assessment) due to which they cannot take any action to combat it. The reason being that certain standards require governments to insure equipment like PPE (personal protection equipment) and enforce the worker's compensation law which puts an additional premium on the cost of environment-saving technologies. Governments consider the premium too much of an opportunity cost however, research by the EIA shows that 80% of all environmental catastrophes can be prevented through safety devices.

Major Parties Involved and Their Views

Saudi Arabia

Saudi Arabia has the second biggest oil reserves in the world after the United States of America. It plays a huge role in the oil economy and has bolstered its own through oil revenue with a 42% GDP contribution. With companies like Aramco hitting a \$2 trillion market capitalization on the second day of trading, it has truly made its mark in the environmental society. Moreover, the nation is extremely active in the petrochemical field with companies like SABIC leading the worldwide industry. Analyst reports indicate the oil in Saudi Arabia is

expected to last for 90 years. This may seem like a short period of time however; Saudi Arabia is not worried about low oil reserves because it wants to drive the attention away from oil. Just recently, women were permitted to drive, and the country expanded its tourism sector through projects like the Kingdom Tower and more.

However, Saudi's fossil fuel consumption has increased in the past few years which is why the nation has developed a range of environmental issues such as the ones caused by urbanization and increased standards of living. On the contrary, environmental action is quite common and this can be seen especially through the renewable energy industry in the nation. One example of which would be the fact that the overconsumption of oil has pushed policy and legislation towards renewable energy; Saudi Aramco recently announced its interests to invest in the solar energy sector with the target of implementing 41 Gigawatts of renewable energy plants.

Organization of Petroleum Exporting Countries

OPEC is a cartel headquartered in Vienna, Austria that brings petroleum nations together in order to regulate the supply and demand of oil in the market. Theoretically, if there wasn't a cap on the amount of oil that could be produced, oil prices would be as low as ever and reserves would burn out way quicker. The creation of OPEC ensured to create fake scarcity in the market which regulated the price of oil for investors and the quantity of it for producers and consumers.

Moreover, the fact the OPEC exists already serves as a sort of limit for petrochemical refineries as the chemical compounds are derived from the refining of oil which is a great regulatory step.

Russia

The reason that Russia is so popular in the modern oil market is that it has the third-largest reserves in the world and because it was involved in an oil price war with Saudi Arabia. This occurred when Russia failed to come to a consensus with OPEC about reducing oil production levels which resulted in both parties increasing their output due to competition. The end result was a drop in oil prices during the Covid-19 pandemic and an excess supply of oil in the market. This had quite an adverse effect on refineries like Sibur Holdings, TAIF, Rosneft, and more as their profit margins had dropped in the first economic quarter.

"We have already witnessed climate change effects this summer and we need to prepare for more damage to come," says Anton Kulbachevsky, the head of Moscow city's environmental committee. He says that climate-related economic damage in the Moscow region, home to 20 million people, is expected to reach \$4.3 billion a year by 2025. Russia's approach to [climate change](#) and environmental degradation is quite unconventional. This is because they don't want to stop or prevent climate change from occurring, they just want to reduce the impacts caused by climate change through some small adaptations which would indirectly have a positive environmental effect.

For example, in 2010, summer temperatures touched a record high and Moscow witnessed more deaths of elderly people due to multiple heat waves and low immunity; their response was to modernize hospitals, ensuring free water supply, and making sure that all households that have a senior citizen present have access to air conditioning.

China

Petrochemicals are used in many of the products around the world today and many of the refineries are located in China. The problem that China is facing right now due to the Covid-19 pandemic is that of economic instability which took a toll on its primary and secondary sectors. This is evident by the fact that many transnational corporations around the world are shifting their production from China to India who is welcoming them with open arms. As of last year, China had a GDP of over \$14 trillion and was forecasted to overtake the USA in 10 years' time, however, due to the current situation, this is a dream of the past for the nation and has been forced to adopt innovation and more solutions are required on this matter.

On a rather opposite note, the COVID-19 pandemic has caused a reduction in the annual carbon emissions for the first time in decades. Additionally, in 2018, the Chinese government announced that it had achieved its Copenhagen emission targets for 2020 which was to reduce fossil fuel intensity by 45% and increasing renewable energy usage by 15%. Even with all of these conservation efforts, China will still face problems regarding environmental degradation down the line; this is because of its ever-increasing population. In the past, China attempted a 'one-child policy' in the country as well as several other birth control methods which were all unsuccessful.

Gulf Cooperation Council

One of the main reasons that all the Gulf countries need to be considered when dealing with the petrochemical industry is because they are suffering the most from the Covid-19 pandemic. Their deficits from foreign countries are expected to reach up to \$180 billion dollars just this year implying a slow-down in their economic growth. This is especially important because these deficits have been racked up due to a reduction in oil prices and oil revenue.

This is the reason why GCC countries want to start looking at alternative sources of revenue in the coming years and want to produce efficiently as they cannot afford a further reduction in oil prices. Solutions are still needed for how GCC countries can recover from the pandemic in a sustainable way.

Development of Issue/Timeline

Date	Event	Outcome
1835	Polyvinyl Chloride (PVC) was first discovered by Henri Victor after accidentally leaving vinyl chloride in the sun	This was marked as the start of the plastic era and a new form of income for businesses was discovered. PVC was also used in healthcare and several other goods on the market.
1859	Oil was discovered when a well was drilled near Titusville, Pennsylvania.	Oil started to become popular and was used as a commodity in the US in which annual oil production output was 2000 barrels.
1862	John D. Rockefeller started monetizing off oil and started his own oil refinery	This led to a chain of events where multiple firms and individuals found oil to be beneficial and to have a variety of use cases

1909	The discovery of Bakelite is announced	Bakelite was considered the world's first plastic and it helped to transform the radio industry forever. It was used to create aesthetic looking radios for which people were willing to pay a significant amount of money. It was later used in many other products around the world
1914-1918	Germany's enemies cut off their access to natural rubber	This resulted in transportation difficulties because rubber was used in tires. Thus, Germany started mass manufacturing of synthetic rubber and its implications were later questioned after the war.
1920-1940	An era began known as the "Petrochemical boom"	After high-pressure hydrogen processes were discovered along with many other technological advances, this time became a hotspot for the petrochemical's era. Petrochemicals such as nylon, acrylics, and several other plastics became useful in clothing, sports gear, parachutes, plexiglass, and industrial equipment
1929	Starting of the mass production of polystyrene	In 1929, scientists at BASF used previous research and

		figured out how to mass-produce polystyrene. As of the modern-day, polystyrene is used in packaging, electronics, and laboratory ware.
1937	Anti-freeze developments	Petrochemicals started becoming very prominent in everyday life and within these boundaries was anti-freeze which was used mainly in the medical industry. It played a key role in reversing the effects of poison and preventing permanent organ damage. In 1937, these treatments were enhanced by replacing Methanol with Ethylene Glycol as the anti-freeze agent.
1939-1945	Increase in weaponry and aviation supplies during World War II	The United States supplied 80% of aviation gasoline as well as other petrochemical-based military supplies. As known, this led to many deaths around the world and partly because of such supplies from various sources. This is when countries decided that regulation was required.

1960	The Organization of Petroleum Exporting Countries was founded	During World War II, there was an absurd amount of oil and natural gas being transported across the globe. Neutral parties questioned the ethical practices of such an act which is why OPEC was formed to regulate production and output of oil in petroleum exporting countries like Saudi Arabia and Russia. This created a fake scarcity in the market which allowed the cartel to regulate the prices of oil as well in order to maintain economic stability in the industry.
1940-1970	Environmentalists suggested that several industries including oil and petrochemicals led to the unnatural cooling of the Earth	Although many people would think that this may have been natural and reversed climate change processes, there is another underlying reason for this phenomenon. Between 1940 and 1970, the average temperature of the Earth dropped. Research shows that this was due to the massive output of aerosols from powerplants and the petrochemicals industry was a contributing factor.

2006	Increase in carbon emissions due to the petrochemicals sector	According to a report by the International Energy Agency, the petrochemicals sector was responsible for 18% of global emissions in 2006 which only increased from then.
2014	Low-cost gas feedstocks led to business-based advantages	Oil producers took advantage of the low-cost natural gas as opposed to expensive crude oil which allowed them to reduce their business costs drastically. Moreover, this was mainly beneficial to producers in the Middle East and North America. This is an example of how monetization through oil and petrochemicals has developed over the past century.
2016	An extraordinary rise in the demand for petrochemicals	Annual ethylene production rose from around 100 million metric tons in 2000 to 150 million metric tons in 2016 combined with a compound increase in value generation of these petrochemical-based products of 4% annually. According to McKinsey, petrochemical stocks performed well in comparison to other stocks in the past three years and there is promising value generation

		and return on investment for investors.
2020	The coronavirus pandemic starts to have slight effects on the petrochemical industry	The Covid-19 pandemic hasn't had much of an impact on the petrochemical industry. In fact, oil producers are now showing more interest in the petrochemical sector. The reason for this is because the use of petrochemicals is mainly in the primary and secondary sectors and they haven't been affected as badly as the tertiary sector taking into consideration China as an exception. Moreover, this is evident by Aramco's recent acquisition of SABIC which is a natural gas and refinery company.

Previous Attempts to Solve the Issue

Carbon Capture, Utilization, and Storage

[CCUS](#) has been described below as a method for capturing carbon and storing it for further use meaning that it is extremely economical and feasible. It has been used in many nations that are serious about their production of oil and chemicals as the main source of country revenue. An example of such nations are Saudi Arabia and China. In 2014, Saudi launched the Uthmaniya Demonstration project which succeeded in capturing 0.8 million tons of CO₂ from the atmosphere. This is an absolute necessity for nations like Saudi due to the fact that it is home to the second most valuable company in the world which happens to be an oil

company and oil is a scarce resource meaning that all conservation efforts need to be put in place.

On an opposite and rather ironic note, China is rapidly increasing its industrial development which in turn is bolstering its economy. This is why the country is able to implement such technologies with low cost and while it lasts, China wants to focus on energy conservation as much as possible especially with the Covid-19 pandemic having an adverse impact on the nation. Additionally, many more countries will start to consider CCUS as the pandemic has caused structural ramifications. An example of such would be India welcoming dozens of companies moving their manufacturing units from China. India's biggest oil exporter, Reliance has overtaken Exxon as the second biggest energy company in the world with a share spike of 43% due to various foreign investments. All of the nations mentioned above are MEDCs meaning that third-world nations will find it quite expensive to implement such technologies. This is the primary failing point that governments need to combat because countries like Bangladesh that have one of the highest carbon footprint and population density in the world are not able to combat it with the available machinery and equipment meaning that alternatives need to be proposed for such third-world nations.

Enforcing the National Ambient Air Quality Standards through the Environmental Protection Agency

The NAAQS standards are essentially a table of 6 chemicals, elements, and compounds that have a pollutant limit due to health and environmental hazards. These consist of sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone pollutant, particulate matter, and total suspended particles. Each of these has been given a limit to which producers have to adhere to in order to reduce the consequences of such compounds some of which being smog, acid rain, and other health hazards.

This was enforced by the Environmental Protection Agency under the Clean Air Act of the United States. Many other nations have similar acts such as the Prevention and Control of Pollution act in India which focus on limiting the amount of pollution caused by pollutant chemicals and compounds. NAAS standards are primarily aimed at the United States of America and most of the states in the nation succeeded in complying with the rules and regulations put forth by the Environmental Protection Agency, however, the EPA reported 7 instances where states failed to adhere to the pollutant limit and submit a transcript summarizing respective carbon footprints. Moreover, a failure lies in the false reporting issue

where numbers are being made up just to artificially comply with these standards when in reality, all firms want to do is increase their economic output. To fix this gap in regulation and legislation, political solutions need to be proposed.

Implementation of the Clean Technology Scenario through the International Energy Agency

The IEA is an agency dedicated to reducing carbon emissions, pollution, and generally making the world a cleaner place to live in. Similar to the United Nations Sustainable Development Goals, the [Clean Technology Scenario](#) is a mission set out by the IEA which aims to target multiple sectors of the economy and lead them towards environmental efficiency. The broad aim is to reduce carbon emissions by three-quarters by the end of 2060.

All of the members of the International Energy Agency are required to adopt this mission and several countries have already started doing so. An example would be the Clean Air Act by the United States that was referenced previously. In addition to the CTS, the IEA has also implemented the Reference Technology Scenario; the difference being that the CTS focuses on carbon emissions while the RTS focuses on clean energy solutions as required by the Paris agreement. It is quite difficult to analyze the failures and successes of this act by the IEA however it can be clearly identified that many countries have made substantial progress towards this act. Germany, for example, has heavily subsidized electric car production in the last 5 years; India has banned plastic bags and products while in Norway, 98% of the current energy consumption comes from renewable sources.

Possible Solutions

Tax the Production Process of Petrochemical-Based Products

In regions where pollution is excessive, an eco-tax is levied on manufacturers and producers to reduce the negative externalities caused by pollution. This should be considered on all levels of petrochemical manufacturing as the leaks caused by the refineries can have detrimental consequences. This would work by quantifying the negative effects caused by the pollution and apply a tax based on the amount quantified; this means that if a higher amount of pollution is recorded, a higher tax amount will be imposed. It was previously stated that certain governments are quite careless about the safety procedures in such refineries due to the

additional costs; this solution is a great way to incentivize all firms to implement certain safety methods and increase the quality of their production as to reduce the tax amount.

The opportunity cost of such an act would be the fact that the EBIT (earnings before interest and taxes) margin for the more careless firms would decrease by a small margin, however, they would also have to understand that these safety systems are a one-time investment meaning that they could expect it to increase in the consecutive year. Another road that firms could take would be to consider a merger or a takeover in the industry. This is an extremely popular option especially in times of the Covid-19 pandemic as seen from ARAMCO's acquisition of the Saudi Basic Industries Corporation (SABIC). In terms of the details of the acquisition, Aramco acquired 70% of SABIC from the public investment fund of Saudi Arabia however most economists would question the feasibility of a petrochemical company acquisition in times of the pandemic where oil prices even turned negative. All one has to do to answer this question would be to understand the financial performance of Aramco; its profits dropped 25% whilst other rigs and refineries went bankrupt and needed bailouts. This is why this is a great solution for both stakeholders: governments and petrochemical refineries.

Subsidize Eco-Friendly, Substitute Products of Petrochemical Goods and Implement More Conserving Technologies

Taxing the production process is one side of the equation; the other is how to promote substitute goods and services as opposed to petrochemicals. One of the main ways in which nations can achieve this is by subsidizing eco-friendly goods and services, an example of which would be Germany. According to Bloomberg, Germany provided an ample number of subsidies to electric car manufacturers such as Renault that the price of the car dropped below the price of a mobile phone contract. Statistically speaking, Germany has 305,787 plug-in vehicles in operation.

Moreover, in addition to subsidizing eco-friendly goods, it is important to adopt conserving technologies. This refers to when the pollution can be lowered as output is increased. A typical example would be Carbon Capture, Utilization, and Storage which is the process of removing CO₂ from the atmosphere and storing it for future purposes. Moreover, CCUS can be implemented for as cheap as \$15 - \$20 per ton of CO₂ which makes it extremely economical. On the contrary, technologies like CCUS are only useful postproduction and consumption however it is important to focus on prevention as well. This is why it is also important for nations to subsidize safety systems for their oil rigs, petrochemical refineries, and

chemical manufacturers. This can be done under the supervision of the American Petroleum Institute keeping in mind EPA regulations.

Adopt Processes of the Waste-to-Energy System in Countries with Relatively High Population Density

Singapore is ranked 19/59 for its air quality and is generally one of the cleanest energy nations in the world. The reason for such a statistic is because it is an extremely small nation who wants to utilize all of their space in an efficient way meaning that it cannot afford big landfills, high rates of pollution, and chemical leaks. The main method that the nation is using to discard their garbage is the waste-to-energy system. As the name implies, it is essentially a cycle where waste is processed, burned, and the heat energy is then used for production and electricity in many homes. The residue ash is then taken to an island where it is deposited with some soil so that birds and insects can come to pollinate the plants giving birth to new ecosystems.

Singapore is home to four such waste-to-energy plants and was just recently given the go-ahead for a \$1.5 billion plant in the country. If implemented in countries around the world that have a high population density, this will be extremely advantageous in terms of its value for the waste industry. Linking this to chemical usage, it is known that plastics and petrochemical products end up in landfills which then release the chemicals used into the atmosphere after a certain amount of time. The ramifications of such pollution acts can be reduced significantly through the waste-to-energy system and it can allow for innovation and development in most nations that implement it.

Encourage the Use of Organic Fertilizers as Opposed to Nitrogen, Phosphorus, and Potassium-Based Fertilizers

Fertilizers play the role of a contributing factor in eco-system damage. The main contents of fertilizer are nitrogen, phosphorus, potassium, and other such chemicals meaning that they result in a process known as eutrophication as they enter water bodies. This means that when water bodies such as rivers, lakes, and streams absorb these nutrients, it causes an algal bloom leading to a depreciation in the oxygen levels. This can result in completely anoxic waters and a dead zone leading to aquatic animal deaths and habitat destruction.

By using organic fertilizers that are based out of animal manure instead of such chemicals, this process of aquatic deprivation is being stopped. Admittedly, this means that the rate of plant growth will slow down, however, this is where governments can intervene and provide grants, subsidies and more to focus on increasing the quantity of agricultural output.

Bibliography

- "Bloomberg - Are You A Robot?". *Bloomberg.Com*, 2020,
<https://www.bloomberg.com/news/articles/2020-07-15/electric-car-subsidies-have-rendered-renaults-free-in-germany>.
- Dharni, Aishwarya. "What Singapore Does With Its Garbage Is A Lesson For The World In How To Save The Planet". *Scoopwhoop.Com*, 2020,
<https://www.scoopwhoop.com/singapore-trash-island/>.
- Greenhouse Gas Emissions From New Petrochemical Plants*. Iadb, 2020,
<https://publications.iadb.org/publications/english/document/Greenhouse-Gas-Emissions-from-New-Petrochemical-Plants-Background-Information-Paper-for-the-Elaboration-of-Technical-Notes-and-Guidelines-for-IDB-Projects.pdf>. Accessed 3 Aug 2020.
- Iea.Blob.Core.Windows.Net*, 2020,
<https://iea.blob.core.windows.net/assets/86080042-1c55-4c37-9c20-d3390aa5e182/English-Future-Petrochemicals-ES.pdf>
- "NAAQS Table | US EPA". *US EPA*, 2020,
<https://www.epa.gov/criteria-air-pollutants/naaqs-table>.
- "Petrochemical - Energy Education". *Energyeducation.Ca*, 2020,
<https://energyeducation.ca/encyclopedia/Petrochemical>.
- Petrochemicals*. 2020,
http://www.world-petroleum.org/docs/docs/publications/petrochemicals/wpc-guide2_layout_lo-res.pdf. Accessed 3 Aug 2020.
- "Petrochemicals 2030: Reinventing The Way To Win In A Changing Industry". *Mckinsey*, 2020,
<https://www.mckinsey.com/industries/chemicals/our-insights/petrochemicals-2030-reinventing-the-way-to-win-in-a-changing-industry#>. Accessed 3 Aug 2020.
- "Refinery & Plant Safety". *Api.Org*, 2020,
<https://www.api.org/oil-and-natural-gas/health-and-safety/refinery-and-plant-safety>.

- "Synthetic Rubber - Ohio History Central". *Ohiohistorycentral.Org*, 2020,
https://ohiohistorycentral.org/w/Synthetic_Rubber#:~:text=Germany%20manufactured%20synthetic%20rubber%20during,to%20justify%20its%20continued%20production.
- Systems, Pollution. "Petrochemical Processing Pollution Systems | Pollution Systems". *Pollutionsystems.Com*, 2020,
<https://www.pollutionsystems.com/petrochemical-processing.html>.
- "The Harmful Effects Of Petrochemicals On The Environment". *Sciencing*, 2020,
<https://sciencing.com/harmful-effects-petrochemicals-environment-8771898.html>.
- "Transforming Industry Through CCUS – Analysis - IEA". *IEA*, 2020,
<https://www.iea.org/reports/transforming-industry-through-ccus>.
- "Unsafe Petrochemical Refinery Air Pollution And Its Environmental Impact Assessment". *Research Gate*, 2020,
https://www.researchgate.net/publication/305659081_Unsafe_Petrochemical_Refinery_Air_Pollution_and_its_Environmental_Impact_Assessment. Accessed 3 Aug 2020.
- "When Will Fossil Fuels Run Out?". *Octopus Energy*, 2020,
<https://octopus.energy/blog/when-will-fossil-fuels-run-out/#:~:text=Coal%20and%20natural%20gas%20are,gas%20will%20last%20until%202060>.
<https://www.hydrocarbonprocessing.com/magazine/2019/march-2019/trends-resources/business-trends-petrochemicals-2025-three-regions-to-dominate-the-surge-in-petrochemical-capacity-growth>.