

Global Climate Change and Its Consequences: Revisiting Our Energy Future

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Abstract

The paper looks at the issue of realization of global climate change, deglaciation of the Arctic Ocean and frequent hurricanes, and use of alternative fuels versus petroleum. Current statements of scientists and how they are viewed by the public are discussed. Future of oil is debated under the light of current global climate change. The author is aiming to underline different approaches to climate change and how it will affect the humanity in the near future.

Keywords: Global climate change, greenhouse gases, peak oil, deglaciation, sea level rise, future of oil

1. Introduction

A hot topic for the whole world is global climate change. It is a statement accepted by the vast majority of scientists in the whole world. Yet, there are few outspoken sides which deny it. The planet is going through many changes both climatically and demographically, and it is important to address the severity of the problem. After the ozone layer damage was realized CFCs were banned. In order to keep the anthropogenic CO₂ levels under control international attempts were brought, such as the Kyoto Protocol.

There are reports and essays written on the topic of global climate change. To begin with, World Economic Forum published an open letter written by UN Climate Commissioner Christiana Figueres, the physicist Stefan Rahmstorf and four more scientists. The letter strongly claims that the humanity has only three years to save the planet. The irrevocable threshold for greenhouse gases may still not be passed if we strictly reduce our emissions by the year 2020. On the other hand, if this threshold is passed, then the humanity will witness a rapid deforestation, floods caused by the fast-rising ocean levels, and devastating unpredictable weather conditions that will rampage the coastal areas and farm lands (Wright, *We Have 3 Years to Save the Planet From Climate Disaster, Experts Warn*). Figueres and Rahmstorf have a road map for the year 2020.

- a. 30% increment in use of renewable energy
- b. Providing \$300 billion annually to cities and states to make them stray from fossil fuels by 2050
- c. Making sure that 15% of the new vehicles sold run on electricity
- d. Reducing net gas emissions caused by deforestation
- e. Introducing a new plan by 2050 in order to half gas emissions caused by deforestation
- f. Encouraging the finance sector to introduce more green bonds (Garfield, 07 Jul 2017).

Note: Green bonds are bonds just like other bonds, yet, they direct their income to financing green-friendly projects such as clean water supply, renewable energy production, energy efficiency, and habitat reclamation (Kenny, *What Are Green Bonds?*).

International Energy Agency (IEA) published their report in March 2017 that in 2016 CO₂ levels stagnated just like in 2014 and 2015. Economic growth was considered to be directly proportional to CO₂ level increases yet the last three years' figures showed otherwise (iea.org, 17.3.2017). The same report suggests that the increasing use of renewable energy, shifting from coal to natural gas, improvements in energy efficiency, and structural reforms in the global economy caused the stagnation in the CO₂ emissions.

IEA's *World Energy Outlook* points out that in the year 2016, hydropower made up for a quarter of the growing energy demand while renewable energy resources' contribution was for the half of this demand. There was an 11% decrease in coal demand and generation of electricity from nuclear

power made a peak since 1993. USA, China, South Korea, India, Russia, and Pakistan put into use their new nuclear reactors. The mentioned states host almost half of the global population. In the same report, it is predicted that USA may see an opportunity of exporting home-extracted shale gas to the growing Asian and European markets (iea.org, 17.3.2017).

In general, there are two sides of a claim and both claiming parties have their own strongholds to defend their hypotheses. However, when it comes to global climate change, 97 out of 100 articles accept that there is a global climate change. Also, they add that this is a big problem for the planet. The latter 3% is sometimes seen as the Galileo of the current time who are not afraid to stand up for what they believe in. However, Theoretical and Applied Climatology magazine claims that those modern day so-called Galileo people are wrong. Climatologist Katharine Hayhoe from Texas Tech University and her team reevaluated 38 papers from the last 10 years. The team adds that there was an error in all of these papers. Either their methodologies, their pre-assumptions or their analyses were defective. Once the errors were fixed and the computations were re-run it was found that those gave similar results to the generally accepted side (Foley, 11.9.2017).

Rasmus Benestad of the team (Dana Nuccitelli, Stephan Lewandowsky, Hans Olav Hygen, Rob van Dorland, and John Cook are the other members of the team) prepared a new software to test the results. Benestad reports that the test results were not repeatable, he also adds that these authors only picked the set of data that were useful for them (Foley, 5.9.2017).

Another researcher, Dana Nuccitelli, speaks that this 3%-group cannot bring an alternative theory. Some papers hold the Sun as the responsible and some of them claim wobbles in the Earth's orbit and changing ocean currents are the reason why we are experiencing extreme weather conditions (The Guardian, 25.8.2015).

The author aims to put together different aspects of global climate change and its affects on humanity's lives. The paper not only looks at the temperature difference *Homo sapiens* is going to experience, yet, how different it will be for all of us with different navigation paths, fuel process changes, city life alterations and their consequences. Data is gathered through different sources both academic and the press. It is seen that the academia's approach is not hitherto understood by the public. The input from the press is therefore added to the paper to show how chaotic the situation is observed by the people who actually experience the countereffects of the global climate change. Current situation and data, alterations in weather patterns and deglaciation of the arctic ocean, frequent and devastating hurricanes, and use of vehicles not running on hydrocarbons will be discussed in the paper.

2. Current Situation and Data

Still, we have not faced a worldwide catastrophe due to the global climate change. In the last 20 years the pace of sea level rise grew by 50% and the previous three years were record high

temperature years.

Humanity is experiencing hurricanes and dissimilar precipitation schemes throughout the entire planet. Yet, these new sets events not only challenge the weather, they also encounter our energy future. Alterations in weather patterns and deglaciation of the Arctic Ocean, frequent and devastating hurricanes, and use of vehicles not running on hydrocarbons will play important parts in our energy future.

As Figure 1 shows, a hurricane can cause major disruptions in oil supplies. Hurricane Katrina caused disruptions nearing what was caused by major wars in the Middle East. As extreme weather is becoming more frequent more disruptions are likely to occur.

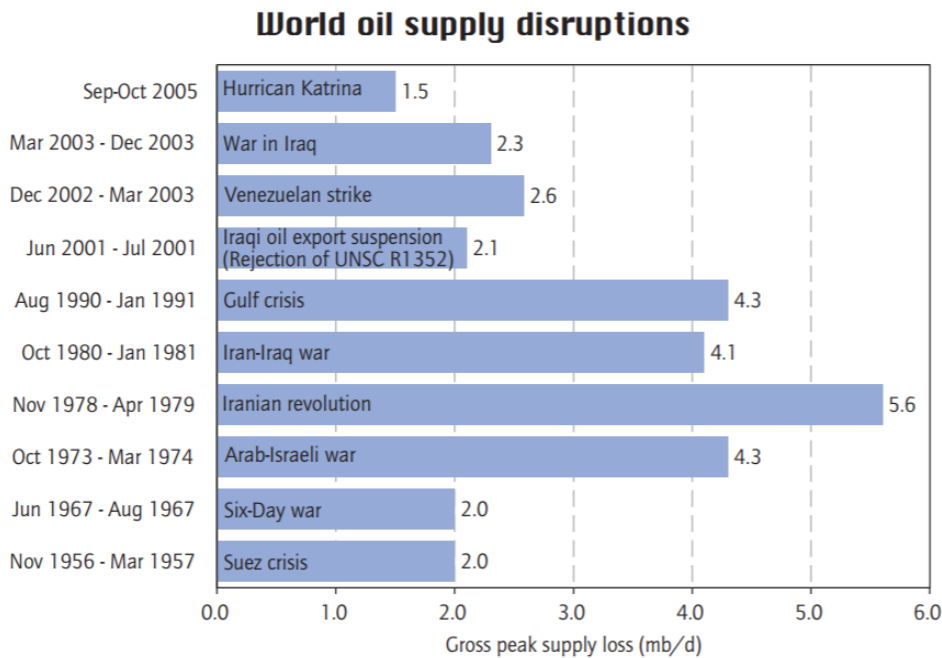


Figure 1: World oil supply disruptions (IEA, Energy Security and Climate Policy)

The last three years saw a CO₂ emission level of 32 gigatons. The two largest economies of the world, i.e. USA and China, lowered their emissions. The relative recession in the EU played part in the stagnation of emissions. While the world economy grew by more than 3%, in the last year USA grew by 1.6% and still managed to lower CO₂ emissions by 3%. Director Dr. Fatih Birol from IEA warns that CO₂ emissions may still have not reached its peak (iea.org, 17.3.2017).

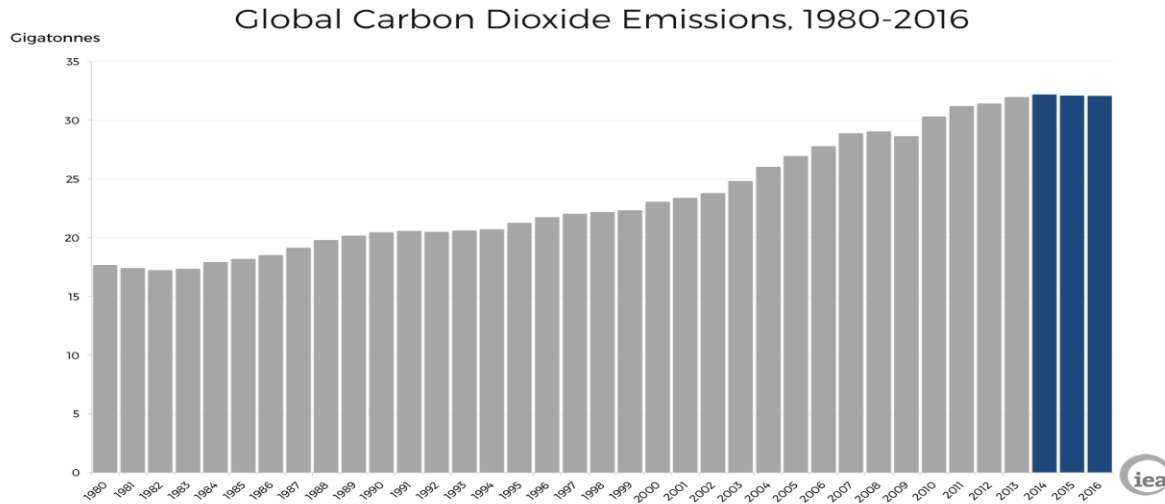


Figure 2: Global CO₂ emissions, 1980-2016 (iea.org, 17.3.2017)

Focusing on the second largest global economy, i.e. China, the air pollution is the biggest threat to human health in the country. Figure 3 shows how drastic the situation is. However, the government managed to grow the economy by 7% yet still succeeded in bringing down CO₂ emissions down by 1%. China's measures were switching coal with natural gas and making a better use of nuclear power. Furthermore, the country covered two thirds of the growing energy demand by wind power plants, hydroelectricity, and nuclear power (iea.org, 17 March 2017). IEA director Dr. Fatih Birol further adds that natural gas produces 25% of world's energy but China and India produce 6% and 5% of their energy from this source, respectively, pointing out that there is still a big potential on switching to natural gas bringing down air pollution. In the EU the demand for natural gas grew by 8% and it dropped by 10% for coal and in the UK, with the natural gas prices going down the shift from coal to natural gas happened faster.



Figure 3: Orange Level Alarm for Air Pollution in the Capital of China (freshnewsasia.com, 2.1.2017)

3. Alterations in Weather Patterns and Deglaciation of the Arctic Ocean

As seen in Figure 4, the Arctic is losing its ice rapidly. A report by The Arctic Council suggests that by 2040 there may be an ice-free ocean in the north. In the last 30 years the minimum ice extent dropped by half and the ice volume fell by 75%.

Of course, the changing boreal ice extent is bearing new outcomes. Figure 5 shows a possible passage way shortening the trip from Asia to Europe via the Arctic Ocean. The northern passage is not feasible at the moment due to extreme climatic conditions and floating glaciers. Yet, the melting process will relatively tame this wild area.



Figure 4: Arctic sea-ice extent (economist.com, 29.4.2017)



Figure 5: Arctic sea-ice extent (economist.com, 29.4.2017)

The Arctic Ocean is reserved as a valuable possession by the shoring nations. The Russians put their flag on the continental shelf in a submarine. Then, the Canadians gave a passport to Santa Claus (a.k.a. Father Noël) that they believe to be residing in the North Pole. This latter gesture is surely not a naïve attempt, underneath, Canada holds their claim to the North. The Economist article shows the possible future of trade in the above illustration.

It is a fact that the polar ice is diminishing as decades pass and the melting ice cools down the entire oceanic hydrosystem. This will affect ocean currents such as Jet Stream, when this current system dies, global climate change will gain acceleration. The Indian subcontinent will suffer from changing monsoons and El Niño will not be like in the old times (Breene, 17.5.2017).

4. Frequent and Devastating Hurricanes

President Trump kept his promise and withdrew his nation from Paris Climate Agreement. This withdrawal not only affects USA but the whole planet. USA emits $16.4 \text{ m}^3 \text{ CO}_2$ per capita (worldbank.org, 2013) which totals to 15% of the global emissions. In the background, Trump defends his position by saying that 6.5 million people working in polluting industries are going to lose their jobs (ntv.com.tr, 2.6.2017). Syria and Nicaragua found a new partner to their side in the Paris Climate Agreement. USA will be the third country not joining the other signing parties. Syria is being torn down by the civil war, so, this agreement is not her top priority. Nicaragua, on the other hand, is demanding a stricter agreement and finds the current one weak.

The New York Times article “The Stakes in the Paris Climate Deal: What Might Other Countries Do?” (Lee and Pearce, 2017) states that we might see emissions equivalent to 69 gigaton CO₂ in the year 2030 if the current trend continues. The signing states agreed on decreasing the emissions down to 56 gigatons.

Nevertheless, China is still willing to keep her promise even if other states wish to pull out. The EU is also staying onboard. The third biggest CO₂ emitter is India and if the top emitter is leaving the agreement, the developing countries who only cause a small fraction of the greenhouse gases may aspire to abandon their promises as well.

Promisingly, even though USA is leaving the agreement as a country, on the state-level there are hopeful steps taken. State of California declared their interest in investing more in greener energies. These studies make up of 5% of what USA promised in Paris (The New York Times, 8.12.2016).

5. Use of Vehicles Not Running on Hydrocarbons

Data from European ethanol producers show 2/3 savings of greenhouse gas emissions with respect to fossil fuel usage (alcoenergy.com, 2017) as seen in Figure 6 above.

The passion for energy in the industry kept going down since the energy crisis of 1970s. In the past years, industry usually experienced a 1% improvement in energy efficiency each year. There is still room for improvement in this area.

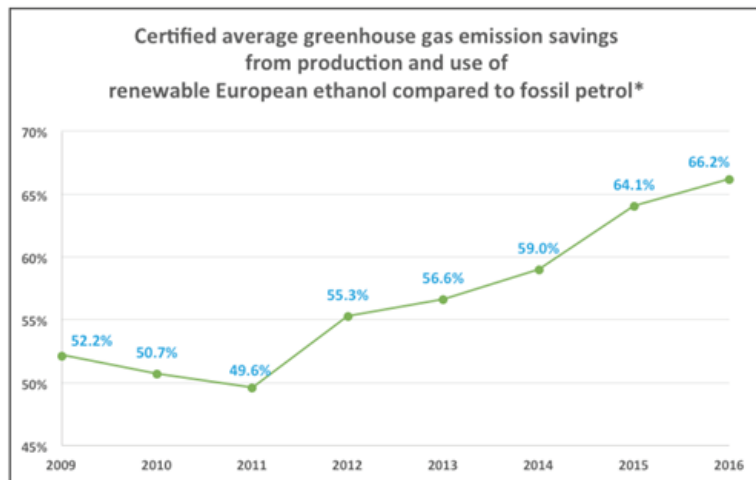


Figure 6: Greenhouse gas emission savings by using ethanol (alcoenergy.com, 2017)

There are more than 700 refineries in the globe. These plants use 1/7 to 1/5 of the energy in crude oil, in other figures, 1/20 to 1/14 of the total global energy (Eidt, 2004). Next, if refineries follow

an energy mitigation plan they can lower their energy consumption by 1/10 or even 1/5 (Worrell et al., 2009). Between 1974 and 1999, Exxon Mobil informed the public that they reduced their energy usage by more than 1/3. Also, Chevron testified an energy usage drop of almost 1/4 between 1992 and 2004.

Then, 1/4 of CO₂ emissions are caused by transportation and discharge is still increasing. New alternative fuel resources are being sought (Chapman, 2007). In Figure 7 below, it is shown that almost completely transportation is dependent on oil (a) and road transport makes up 4/5 of the total carrying (b). Renewables are almost non-existent in the bigger picture. This can be seen as a potential prone to a great growth area.

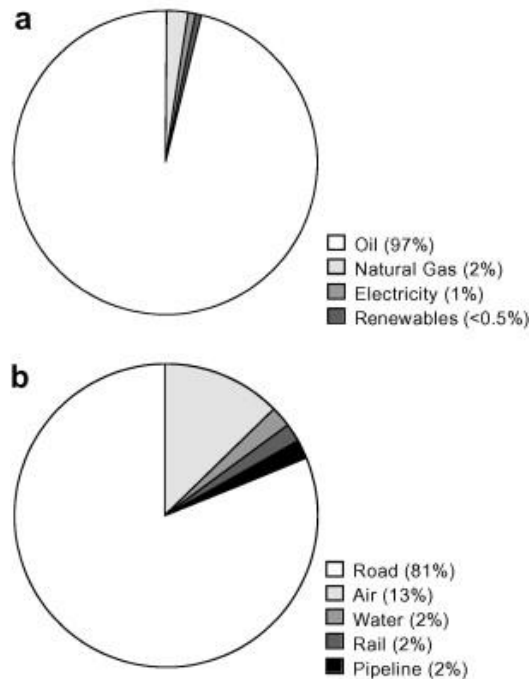


Figure 7: Fuel usage for transport in OECD countries (a) and percentages of transportation means (b) (IEA, 2002)

Then, in the following graph in Figure 8 it is shown that energy production makes up of the lion share in CO₂ emissions which is followed by transportation (a). Afterwards, road transportation caused 2/3 of the CO₂ emissions within the whole transportation.

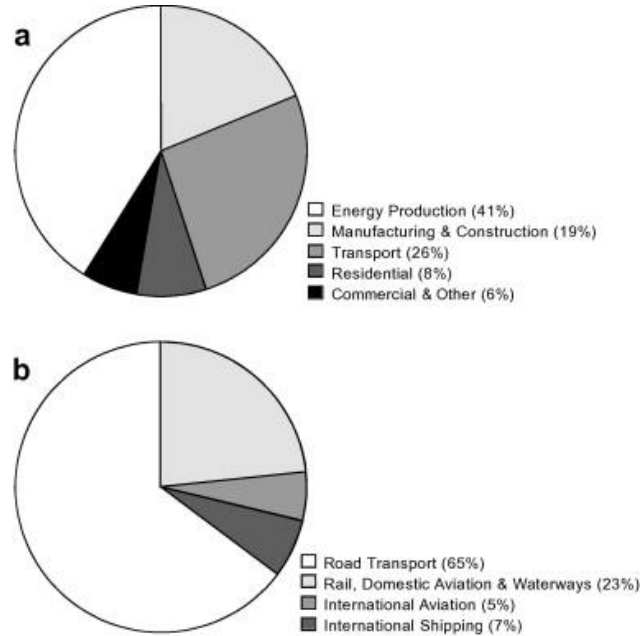


Figure 8: CO₂ emissions by sector (a) and by transport sector (b) (IEA, 2000)

Fuel cell electric vehicles use hydrogen which is the most copious element in the entire universe. However, generation of hydrogen by electrolyzing water takes up energy. This process is made up of steam reformation of methane. Electrolysis is only 51% efficient (Hammerschlag and Mazza, 2005). Alternative electric cars are increasing especially with the trendy Tesla-brand cars that reach attention of millions. Yet, electric cars are just a trivial minority for the time being. Currently, developing countries are not fully dependent on cars. However, current figures of 20 cars per 1000 people is expected to reach 140 cars per 1000 people by 2030 in China (Harvey and Pilgrim, 2011). So, it is easy to realize that the petroleum need in developing countries are rapidly growing. Tesla Company is building its electric trucks, as well. This may help greenhouse emissions down for freight carriage.

India is the second largest country in population. The number of car owners per 1000 citizens are similar to that in China. With these two nations becoming more developed and the citizens becoming wealthier, Indian car owners will increase, too. The Indian motor company Tata introduced their one-lakh car. Lakh is the word for 100,000 and is used when money is the topic. Thus, the car Tata Nano costs around ₹5,900 (\$1,550) making it available to millions of lower income citizens in the subcontinent. Tata's competitors are willing to get larger shares in the Indian market, too, that will bring more greenhouse gases and more oil dependency.

New advancements in transportation technology can lower our dependency on oil, as well. Hyperloop One project is aiming to increase speed of transportation significantly over long distances. The company claims their final system will be emission free and energy efficient with a small energy footprint (hyperlooptech.com, 2017).

Land is a limited resource and land is used for food production, energy generation, material demand etc. In Figure 9 below the schematics of interactions is depicted. As the energy demand is growing the race for land usage will be more significant. Biofuels demand land use, so does food production. Our century will witness a competition between the two.

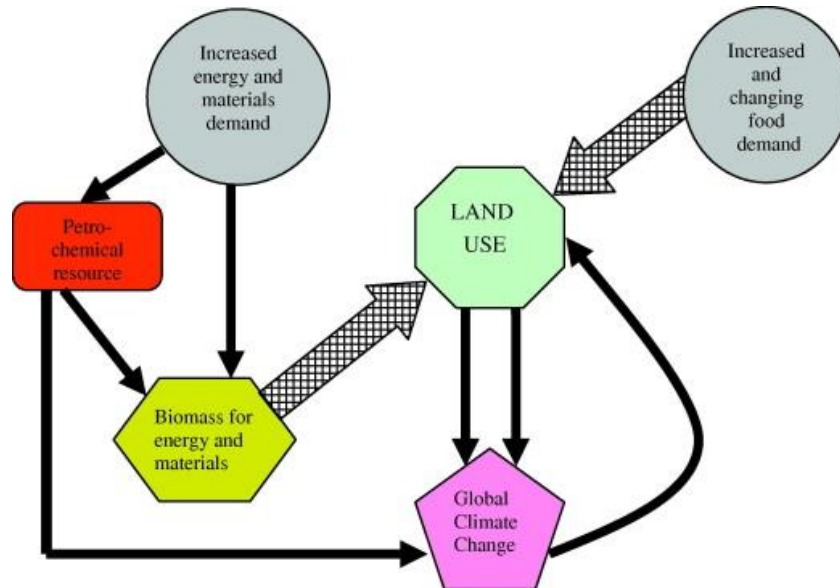


Figure 9: Schematic of interactions of land use (Harvey and Pilgrim, 2011)

Parties that assume oil prices will keep going up rely on the fact that hydrocarbon is a limited commodity. Oil and gas resources deplete continuously. These resources will become less available and will cost more to extract. Alternative fuels, such as biofuels, may be used in road transportation and in the industry. However, aviation still needs petroleum products to fly. Noting that, modern industrialized agriculture itself is oil-dependent as well.

World population growth scenarios predict different numbers till the end of 21st century. In Figure 10, two scenarios show a peaking population in 2050s that starts falling down afterwards. SSP2 and SSP4 predict a zenith in 2070s, and lastly, an ever-growing population scenario of SSP3 is shown. Considering the median estimates, the humanity is going to reach 9.2 billion people by the year 2050.

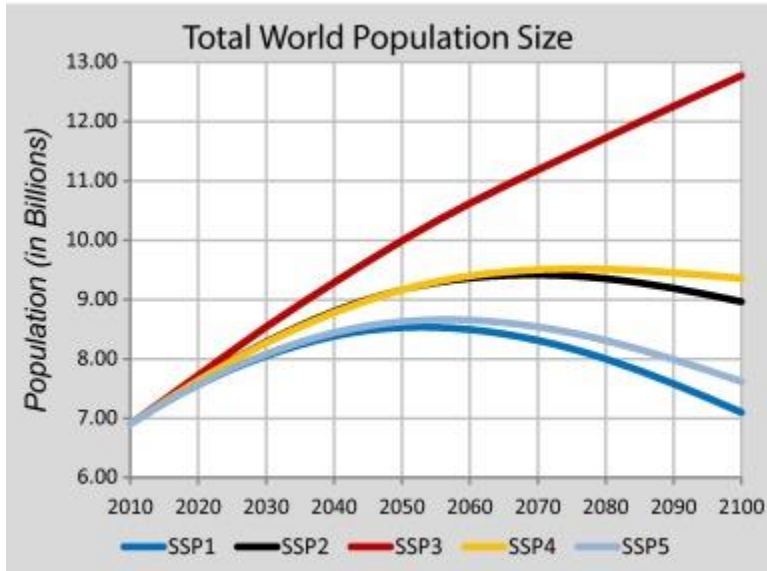


Figure 10: Total world population size scenarios (KC and Lutz, 2017)

Even when we consider the median scenarios, we are yet to experience a 2 billion increase in the global population. This will bring more struggle for food, energy, land use, etc. The demand for fossil fuels is expected to increase. A finite source of hydrocarbons is challenged by a growing world population and their demand for energy and food. Fossil energy problem and the climate change are interlocked (Höök and Tang, 2013). The world population was still under 1 billion in the year 1800, and it became 2 billion in 1920s, and 4 billion in 1970s. The following graph in Figure 11 clearly signifies how fossil fuel energy consumption was raised exponentially as the population burst.

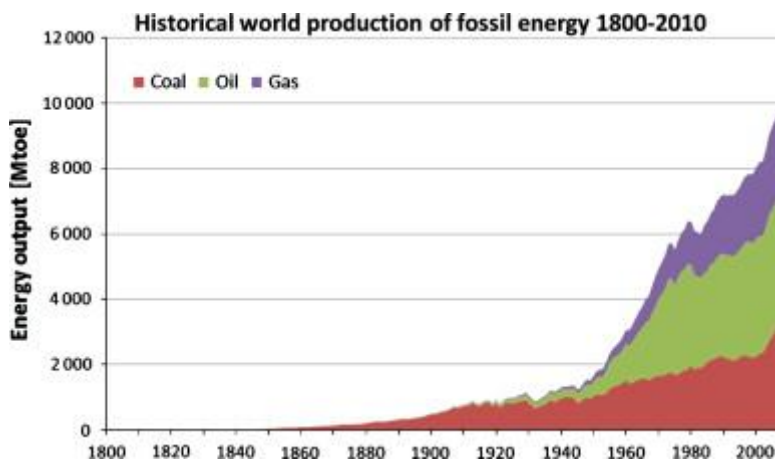


Figure 11: Historical world production of fossil energy (Höök and Tang, 2013)

The USA has seen its peak oil in 1970s. Practical observations display that almost 60 countries are now going downhill since they have surpassed their peak oil. The world is still in debate whether this will happen shortly (as early as in 2030s) or in the next century. There are papers that claim there are many more hydrocarbon resources awaiting to be explored. On the other hand, the discussion continues on whether those future resources will be geologically or economically reachable and feasible, respectively. If we cannot develop these unconventional new resources it will be pointless for the new coming end-of-oil scenarios. Besides, the countries shoring the Persian Gulf are the main producers of oil and 3/5 of oil produced comes from a few hundred enormous oil fields when there are in fact tens of thousands of oil fields (Höök and Tang, 2013). In the same paper, Höök and Tang also note that there is a correlation between recessions and oil prices. The USA went through 12 recessions since the World War II and 11 of them were before oil price increments. With the oil production going lower, this will pull the prices higher, and eventually new recessions may be pending. This may require humanity to pass onto new energy sources.

6. Conclusion

As the petroleum depletes and becomes more expensive, the world is going to perceive a peak in globalization. Freight and transport will become more expensive, goods and people would require more money to be transferred from one place to another. This future issue will cut down on greenhouse gas emissions. Oppositely, when temperatures rise, people will need more hydrocarbons to generate energy for refrigeration and air conditioning. Continuing, rising sea waters will be flooding shores of many countries including the Gulf of Mexico which hosts USA's oil fields, more frequent hurricanes will put the production into danger, more often heavy rain fall will make things more difficult in the region. This may lower oil production in the area (Curtis, 2009). These results will definitely affect global greenhouse emissions. With the addition of policies regarding global climate change, these new incentives may even worsen the pressure on petroleum product prices causing them to rise even further (Curtis, 2009). Inflation, recession, and localization may follow those future events.

Following, as the global temperature rises and heat waves become more frequent, the efficiency of vehicle engines will be lower than of today's. This will increase costs of transportation. Even planes will suffer from the consequences, they would need longer runways and lighter cargo. Hotter weather will cause derailments as the rail tracks expand. The roads and pavements will become softer. This will cause slower traffic and more petroleum consumption (Curtis, 2009).

The EU has taken incentives to produce more biofuels to lower greenhouse gas emissions. In Europe, the cheapest bioethanol is derived from starchy produce, meanwhile, the cheapest in the world comes from Brazilian sugarcane (Ryan et al., 2006). Ryan et al.'s paper also states that use of bioethanol and biodiesel in Europe saves on CO₂ emissions. EU's goals also include energy

safety and rural development while promoting biofuels.

References

Alco Energy, *Renewable European Ethanol Delivered Higher Greenhouse Gas Savings Than Ever Before In 2016*, 7.6.2017, <http://www.alcoenergy.com/en/european-ethanol-higher-greenhouse-gas-savings/>, retrieved on 6.11.2017.

Breene, K., *The Arctic is now expected to be ice-free by 2040*, World Economic Forum, 17 May 2017, <https://www.weforum.org/agenda/2017/05/the-arctic-could-be-ice-free-by-2040/>, retrieved on 12.9.2017.

Chapman, L., *Transport and climate change: a review*, Journal of Transport Geography Volume 15, Issue 5, September 2007, Pages 354-367.

Curtis, F., *Peak globalization: Climate change, oil depletion and global trade*, Ecological Economics Volume 69, Issue 2, 15 December 2009, Pages 427-434.

Eidt, B. (2004). *Cogeneration opportunities - Global Energy Management System*. Presented at the 3rd API/DOE Conference on Voluntary Actions by the Oil and Gas Industry to Address Climate Change, September 29–30, 2004, Arlington, Virginia, www.api.org/ehs/climate/response/upload/3rd_ConferenceSynopsis.pdf.

Foley, K. E., *The 3% of scientific papers that deny climate change? They're all flawed*, 11 Sep 2017, <https://www.weforum.org/agenda/2017/09/the-3-of-scientific-papers-that-deny-climate-change-theyre-all-flawed-fae19159-228d-4ff3-b658-08113fce4723>, retrieved on 12.9.2017.

Foley, K. E., *Those 3% of scientific papers that deny climate change? A review found them all flawed*, September 05, 2017, <https://qz.com/1069298/the-3-of-scientific-papers-that-deny-climate-change-are-all-flawed/>, retrieved on 12.9.2017.

Fresh News, *Beijing maintains orange alert for air pollution*, 02.01.2017, <http://en.freshnewsasia.com/index.php/3051-beijing-maintains-orange-alert-for-air-pollution>, retrieved on 2.11.2017.

Garfield, L., *These experts say we have three years to save the planet from irreversible destruction*, 07 Jul 2017, <https://www.weforum.org/agenda/2017/07/these-experts-say-we-have-three-years-to-save-the-planet-from-irreversible-destruction>, retrieved on 12.9.2017.

Hammerschlag, H., and Mazza, P., *Questioning hydrogen*, Energy Policy, 33 (2005), pp. 2039-2043.

Harvey, M. and Pilgrim, S., *The new competition for land: Food, energy, and climate change*, Food Policy Volume 36, Supplement 1, January 2011, Pages S40-S51.

Höök, M., and Tang, X., *Depletion of fossil fuels and anthropogenic climate change—A review*,

Energy Policy Volume 52, January 2013, Pages 797-809.

Hyperloop One, *Introducing XP-1 The first-generation vehicle of the Hyperloop One system*, <https://hyperlooptech.com>, retrieved on 14.11.2017.

IEA, 2000. International Energy Agency. *CO₂ Emissions From Fuel Combustions 1971–1998. 2000 Edition*. OECD, Paris.

IEA, 2002. International Energy Agency. *Transportation Energy*. Published online: www.iea.org, retrieved on 14.11.2017.

IEA, *Energy Security and Climate Policy*, p. 37, 2007, www.iea.org/publications/freepublications/publication/energy_security_climate_policy.pdf, retrieved on 11.11.2017.

IEA, *IEA finds CO₂ emissions flat for third straight year even as global economy grew in 2016*, 17 March 2017, <http://www.iea.org/newsroom/news/2017/march/iea-finds-CO2-emissions-flat-for-third-straight-year-even-as-global-economy-grew.html>, retrieved on 12.9.2017.

K.C., Samir, Lutz, W., *The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100*, Global Environmental Change Volume 42, January 2017, Pages 181-192.

Kenny, T., *What Are Green Bonds?*, <https://www.thebalance.com/what-are-green-bonds-417154>, retrieved on 12.9.2017.

Lee, J. C., Pearce, A., *How Trump Can Influence Climate Change*, The New York Times, 8.12.2016, <https://www.nytimes.com/interactive/2016/12/08/us/trump-climate-change.html>, retrieved on 28.7.2017.

Lee, J. C., Pearce, A., *The Stakes in the Paris Climate Deal: What Might Other Countries Do?*, The New York Times, 31.5.2017, https://www.nytimes.com/interactive/2017/05/31/climate/trump-climate-paris-agreement.html?smid=tw-nytimes&smtyp=cur&_r=2, retrieved on 28.7.2017.

NTV Haber, *Trump, ABD'nin Paris İklim Anlaşması'ndan çekileceğini açıkladı*, 2.6.2017, <http://www.ntv.com.tr/dunya/trump-abdnin-paris-iklim-anlasmasindan-cekilecegini-acikladi,zO2XzIDaP0KUGawf2pBbLA>, retrieved on 28.7.2017.

Nuccitelli, D., *Here's what happens when you try to replicate climate contrarian papers*, The Guardian, Tuesday 25 August 2015, <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/aug/25/heres-what-happens-when-you-try-to-replicate-climate-contrarian-papers>, retrieved on 22.5.2017.

Ryan, L., Convery, F., and Ferreira, S., *Stimulating the use of biofuels in the European Union: Implications for climate change policy*, Energy Policy Volume 34, Issue 17, November 2006, Pages 3184-3194.

The Economist, *The thawing Arctic threatens an environmental catastrophe*, Apr 29th 2017, <https://www.economist.com/news/briefing/21721364-commercial-opportunities-are-vastly-outweighed-damage-climate-thawing-arctic?fsrc=rss>, retrieved on 22.5.2017.

World Bank, *CO2 emissions (metric tons per capita)*, <http://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2013&start=2013&view=map>, retrieved on 12.9.2017.

Worrell, E., Bernstein, L., Roy, J. et al. *Energy Efficiency (2009) 2: 109*. <https://doi.org/10.1007/s12053-008-9032-8>.

Wright, P., *We Have 3 Years to Save the Planet From Climate Disaster, Experts Warn*, <https://weather.com/science/environment/news/climate-change-experts-3-years-global-warming>, retrieved on 12.9.2017.