

Committee: Environmental and Cultural Committee

Issue: The question of Geoengineering

Student Officer: Marita Hadjitheodorou

Position: Co-chair

Introduction

4.54 billion years ago a planet named Earth, also known as Gaia was formed. The first form of human beings inhabited the Blue Planet around 1.5 million years ago. Since then the constant development of agriculture and right after that, the creation of communities and civilization allowed humans to have an influence on the Earth as no other species has ever done before. After all these years humanity has now, in the 21st century, reached the limits of manipulation and influence on the world. Natural disasters follow one another and simultaneously our earth's climate is changing. Our species' future on Earth is questioned. We have interfered to such a tremendous level that our own planet turns against us and we ourselves that developed it in order to make it a more pleasant and appealing place to us are not able to control it anymore. Time for change has come in order to guarantee a future for generations to come.

While people have unintentionally been altering Earth's climate for centuries, scientists have begun to intentionally alter the planet. The most recent and efficient solution to the aforementioned problem is Geoengineering. Geoengineering also known as climate engineering or climate intervention. It is the process of intervening in the climatic system in order to control or limit climate change, particularly carbon dioxide and solar radiation. It is a process that has generated -especially over the last decades- a lot of controversy due to the fact that climate modification requires a large amount of chemicals. These chemicals could turn out to be saving the environment but that is not the case for human beings. Additionally, the lack of technocratic ways to make such projects cheaper and the catastrophic environmental impacts are other issues that hinder the proper commencement and installation of geoengineering. According to recent statistics 64% of the people worldwide support the idea that humans should not manipulate nature. This causes further issues and there is not broad support for geoengineering projects since most of the inhabitants of our planet are not directly affected by climate change yet. In fact there is skepticism even about further research in this particular area. However, climate change has started to become irreversible and immediate action is needed in order to prevent an

upcoming catastrophe of the blue planet.

Definition of key terms

Geoengineering

The deliberate intervention on Earth in order to limit climatic changes, which cause problems to humanity such as global warming. The term climate engineering contains two substantial processes: carbon dioxide removal and solar radiation management

Solar radiation management (SRM)

This strategy's aim is to reflect sunrays back into space in order to create a state of stable temperature on Earth. An increase in temperature is caused mainly by the amount of greenhouse gases in the atmosphere, which absorb solar energy and therefore raise the planet's temperature.

Carbon dioxide removal (CDR)

CDR techniques aim to limit or entirely remove carbon dioxide from the atmosphere. In comparison to SRM, CDR techniques have to be implemented on a global scale in order for them to have a significant impact.

Greenhouse gas (GHG)

A gas that absorbs and emits radiation within the atmosphere. The most important types of greenhouse gases are water vapor (water in gaseous state), carbon dioxide (CO₂), methane (CH₄) and ozone (O₃). Their effect on Earth leads to the so-called greenhouse effect.

Greenhouse effect

A process by which radiation from the atmosphere warms the surface of our planet to a temperature above the one that would be considered normal in the absolute absence of atmosphere.

Adaptation to global warming

Measures taken in order to reduce the vulnerability of social and biological systems and thus prevent the catastrophic impacts of global warming.

Climate change mitigation

Actions that are taken by individuals but enforced by governments mainly to limit the magnitude of long-term climate change. Climate change mitigation mainly refers to reduction of CO₂ emissions. There are several mitigation policies that can reduce human associated greenhouse gases.

Background Information

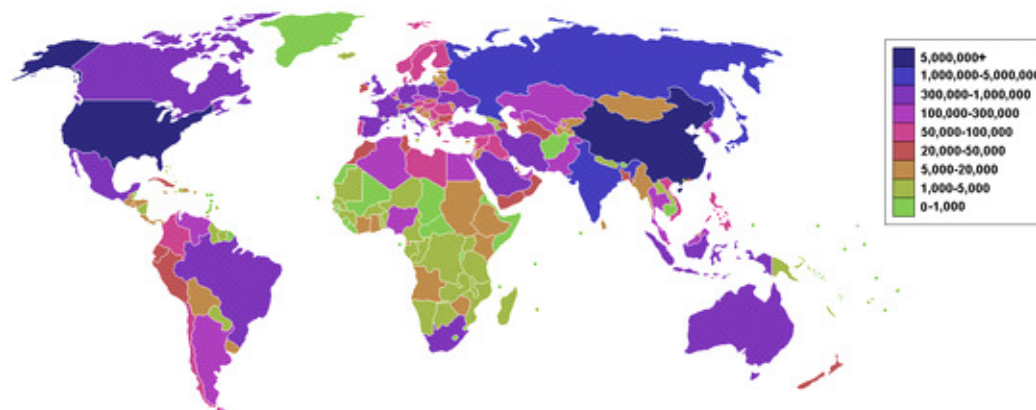
Introduction to the discussion of the issue

During the last decades there have been noted irreversible changes in several ecosystems and our Earth's climatic system. Ecosystems as the Amazon rainforest and the Arctic tundra are changing dramatically and rapidly through warming and drying. Mountain glaciers are in retreat and the world is running low on resources. Geoengineering poses nowadays the only drastic solution in order to avoid the upcoming catastrophe of our planet.

The basic idea is to artificially moderate the climatic system in order to avoid negative impacts of climate change on our earth. This is achieved through technology, which offers several methods. The first goal of geoengineering is to alter the amount of sunlight that our planet absorbs in order to retain a stable temperature. This process is known as solar radiation management. According to it the sunrays are being reflected away from the planet by a method which absorbs sunlight and afterwards radiates it away or by increasing the reflectivity - a process called albedo- out of the atmosphere. The advantage of SRM is that it deploys quicker when compared to other techniques. This occurs mainly by the spraying of stratospheric sulfur aerosols, which create a layer in the upper atmosphere. However, there is a great number of drawbacks to the "gas-the-planet" strategy as it is believed that dramatic weather changes might occur such as acid rain. Managing solar radiation using aerosols or cloud cover would affect plant life and solar energy. It is believed that the appearance of the sky would be affected by stratospheric aerosol injection projects as they might change the color of the sky, the sun and the clouds. The second one called carbon dioxide removal proposes the removal of greenhouse gases out of the atmosphere. There are methods that directly remove greenhouse gases while other indirect aim at the creation of natural processes to limit and control CO₂ emissions. Among such are bio-energy with carbon capture and storage, direct air capture and enhanced

weathering. As CDR removes carbon dioxide it also produces negative emissions, which counterbalance already existing emissions, and that way removes them completely from the Earth's atmosphere.

(Other SRM and CDR methods are listed and elaborated under "Previous attempts to solve the issue")



Countries listed by carbon dioxide emissions

In general geoengineering is considered to be a hugely controversial theory. Promoting manmade solutions to climate change causes a conflict with the efforts to reduce human impact on natural procedures. But the popularity of geoengineering is on the rise among a great number of scientists, researchers and organizations. Most experts advise against intervention on Earth as a simple solution to climate change due to the fact that there are uncertainties over effectiveness and side effects. However, geoengineering should be seen as a solution in the context of the risks of climate change. Interventions at a large scale may lead to a greater risk disrupting natural systems, but it could reduce political and public pressure for emissions reduction and other binding concepts within the legal framework. Apart from mitigation and adaptation more direct and practical measures should exist that could be implemented immediately. The idea of climate engineering that could substitute these is not generally accepted since geoengineering relies on short-term solutions that are mostly not legally binding.

Every kind of measure concerning climate change generates several issues of economic, political or physical nature since there is not much research done concerning the economic component of geoengineering as well as the possible risks to humanity which makes the proper investment in this particular sector unsure. The adequacy and feasibility of SRM and CDR techniques are constantly being tested but due to the fact that

governments prohibit the use of these methods, experimentation is still at an early stage and only small-scale tests are allowed by the law while some countries do not allow it at all.

For all the aforementioned reasons experts, organizations and governments remain still and do not take action while our planet's climate changes unstoppably and turns the case into a global emergency.

Advantages and Disadvantages of Geoengineering

Regarding geoengineering there are several aspects that should be considered. First of all and most importantly the possible risks that may accompany geoengineering. Secondly the costs and the funding of such actions. In addition to these religious and political obstacles, governance and predictability of problems should also be considered.

To start with, most methods of geoengineering are either theoretical or have been tried out at a small scale –as mentioned before. There are around 60 different geoengineering methods among which only a small amount is seriously considered as an efficient solution to climate change. Concerning the costs of climate engineering techniques a research suggests that well designed systems would be at a cost of a few hundred million dollars per year which in comparison to CO₂ emissions reduction techniques are much more affordable. In fact according to a report by the Royal Society afforestation and stratospheric sulfur aerosols are the most affordable and simultaneously effective methods. The only disadvantage is the fact that spraying contains several risks while afforestation even though it is safe is not as effective as aerosols. A governance issue is also raised while geoengineering projects should be controlled by the ensemble of countries because as mentioned further the whole world is affected by geoengineering even if only one single country enforces it within its legal framework. The resulting power of controlling geoengineering would be enormous and could not be entirely controlled by legal, political or regulatory systems. There are however significant incentives for states to cooperate in choosing a specific geoengineering policy.

As far as the moral and ethical side is concerned geoengineering raises the issue of whether human beings are allowed and qualified enough in order to intervene deliberately and inadvertently in the Earth. An important factor is religion. Different religious commitments and ethical views on the topic come into a conflict since the role of human beings is inferior to natural processes as nature is the creation of God. According to them, humans via geoengineering are intervening indirectly in the work of the Creator himself and attempt to turn themselves against Him and his work, denying simultaneously his power

and existence.

Apart from religion another factor that hinders the proper commencement of geoengineering projects is political viability. Practical difficulty has been noted in politicizing climate intervention, as there are several obstacles. There is no effective way to reduce carbon dioxide through mitigation and adaptation since they do not directly tackle the problem. They simply compose a system that monitors measures and compliance procedures within the legal framework. Governments should focus on more sustainable techniques that would not just be applicable over several years of application but would also upgrade through time. However, the problem is not geoengineering techniques themselves rather than their governance, monitoring and supervision. In order for feasible geoengineering solutions to be found, a regional variability is needed since while some countries might enjoy the benefits of geoengineering procedures, others might simultaneously experience massive damages instead of privileges. Although most of the proposed interventions in the climatic system are regional, such as albedo modification in the Arctic the nature of geoengineering may create a division between winners and losers. For instance through sulfur aerosols European countries would be benefitted while African countries would become more dry and experience longer heat waves than before. It could also weaken Indian monsoons and change completely the climate in several countries simply by blocking sun radiation through SRM in other countries. Unintended and unpredicted climatic consequences might exist such as changes to the hydrological cycle including droughts or floods. For the aforementioned reasons there have been criticisms by various individuals and organizations such as the ETC Group which have called for a moratorium of geoengineering

Another issue with geoengineering is that scientists are quite unsure about the impact of it on Earth. Their effectiveness is not guaranteed and will not get guaranteed unless they conduct tests. As mentioned before tests are prohibited in most countries or only small-scale techniques are being tried out without the expected result. Larger experiments are needed in order to get a clear image of the impact of geoengineering. In addition to that research has also been prohibited in some nations, which completely oppose the idea of intervening the climatic system. This actually summarizes the whole geoengineering problematic and contradicts the theories of scientists and experts. The side effects are mainly not foreseen or considered at all since climate-engineering techniques are not well understood at this point. A suitable example is termination shock. It might be simply a theory at the moment but in case of an abrupt termination of SRM techniques the world might experience the delayed heat wave it was attempting to avoid via geoengineering. Temperatures will rise globally even more than they would rise without the use of geoengineering models. The rapid rise may lead to more severe consequences than a

gradual rise of the same magnitude.

Another problematic issue when talking about geoengineering is the still theoretical issue of weaponizing the weather. Geoengineering could be used as a weapon by powerful countries in order to make weather more favorable for them and that way weakening other nations.

Major countries and organizations involved

The United States of America

The United States of America has stated continually its desire for geoengineering projects for strategic military purposes. The US military has stated its interest in climate engineering programs with the project "Owning The Weather By 2025". (<http://csat.au.af.mil/2025/volume3/vol3ch15.pdf>) Apart from that there have been reported several cases and there are suspicions of illegal spraying of aerosols by American aircrafts. The U.S. government also provides funding for studies on geoengineering technologies in order to provide an understanding of the state of the science of climate intervention. In the US, there have been several reports arguing for more research into geoengineering. Responsible to conduct further research in this particular field in the US are: the National Research Council, the House of Representatives' committee on science and technology, the Government Accountability Office and the National Academy of Sciences.

The National Academy of Sciences

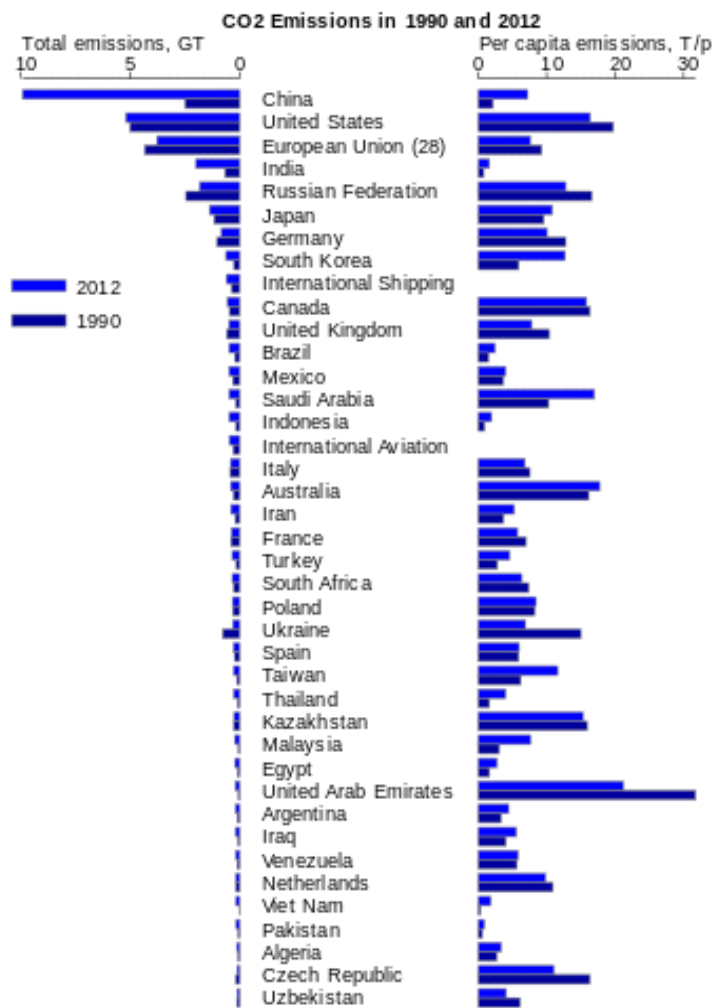
The National Academy of Sciences is a private, nonprofit institution which provides the government with scientific, technological and health policy advice. Through the National Research Council it possesses scientists, engineers and other experts in order to answer scientific and technical issues facing the United States. The Academy attempts to provide the world with a clear scientific understanding of geoengineering techniques as well as potential risks, side effects and possible consequences. It also ran a 21-month project, which studied how humans might influence weather and investigated possible national security implications and risks of geoengineering attempts.

Russian Federation

Russia started getting involved in geoengineering through a Russian scientist called Yuri A. Izrael. Izrael is a person with specific political views and an opposer of the Kyoto Protocol. According to paper reports Izrael is the first geoengineering field trial. With a board of scientists he launched aerosol generators on a helicopter and sprayed out particles from ground level until the height of 200 meters in the Earth's atmosphere. Through this experiment he attempted to measure how much sunlight had successfully been reflected away after the spraying. Observers have suggested that such actions be a violation of the UN moratorium on geoengineering projects.

During an Intergovernmental Panel on Climate Change, which took place in Stockholm in 2013, Russia suggested including "planet hacking" in its report and that is how the IPCC included indirectly geoengineering techniques for the first time in the report. Documents presented by the Guardian mention that Russia is asking for a conclusion of the report to say that a "possible solution of this [climate change] problem can be found in using of geoengineering methods to stabilize current climate."

Intergovernmental Panel on Climate Change



The Intergovernmental Panel on Climate Change is a scientific intergovernmental body of the United Nations. The IPCC produces reports that support the United Nations Framework Convention on Climate Change (UNFCCC), which is the main international treaty on climate change. It also evaluates the scientific, technical and socio-economic information relevant for the understanding of the risk of human intervention on climate change. It has conducted several expert meetings on Geoengineering like the one mentioned before.

People’s Republic of China

The political dilemma over geoengineering is very intense in China. China has clearly stated that geoengineering is among its Earth science research priorities. Due to its massive

and rapid economic growth a dramatic increase of greenhouse gases has been noticed in the atmosphere. Although the aforementioned escalation China possesses one of the most effective CO2 emissions reduction systems and China's Communist Party has enforced efficient measures in order to achieve this state (see diagram). In general there is a great deal of skepticism about geoengineering within China's scientific community and strong inclination towards research has been noted too.

Other organizations and institutions that are indirectly involved into geoengineering problems:

US Congress, the Royal Society, UK Parliament, Friends of the Earth, Action Group on Erosion, Technology and Concentration (ETC Group), National Oceanic and Atmospheric Administration (NOAA), National Aeronautic and Space Administration (NASA), Greenpeace

Timeline of events:

Date	Event	Additional Information
1976	U.N Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques	1) Prohibits weaponizing geoengineering techniques 2) Was signed by 85 countries
1992	United Nations Framework Convention on Climate Change (UNFCCC)	Ways to preserve and enhance the global environment
11 December 1997	Introduction of the Kyoto Protocol	Fight global warming by reducing greenhouse gas concentrations in the atmosphere to 'a level that would prevent dangerous anthropogenic interference with the climate system' (Art. 2).

16 February 2005	Kyoto Protocol enters into force	1) 192 parties 2) Commits state parties to reduce greenhouse gases emissions, based on the premise that (a) global warming exists and (b) man-made CO2 emissions have caused it
2007	Intergovernmental Panel on Climate Change (IPCC)	IPCC conducts research on geoengineering and publishes it
29 October 2010	United Nations Treaty to Protect the Diversity of Life on Earth	The 19 treaty partners agreed that "no climate-related geoengineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts."
2012	Doha Amendment to the Kyoto Protocol	Second commitment period of the Kyoto Protocol
2015	The United Nations Climate Change Conference	Goal: achieve a legally binding and universal agreement on climate from all the nations of the world

Relevant UN involvement: resolutions and treaties:

United Nations Framework Convention on Climate Change (UNFCCC)

Negotiations to create the United Nations Framework on Climate Change began in 1991 and in 1992 within the borders of the Earth Summit leaders and citizens of 176 countries from every corner of the world gathered in Rio de Janeiro, Brazil in order to sign

the aforementioned convention. It was ratified right after it entered into force by 50 countries in 1994. The main conclusion of the treaty was: “achieve ... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner”

The Kyoto Protocol

The Kyoto Protocol was firstly introduced on the 11th of December 1997 but it first entered into force on March of the year 2005. It is signed by 192 parties, which are committed to reduce through political actions greenhouse gases emissions such as CO₂ in order to fight global warming. The only conditions are that global warming exists and the fact that CO₂ emissions by human beings have caused it. The first commitment period ended in 2012 but it was expanded through the Doha amendment, which proposed a second commitment period to the Kyoto Protocol. However the treaty does not contain enforcement mechanisms so it is not considered as legally binding.

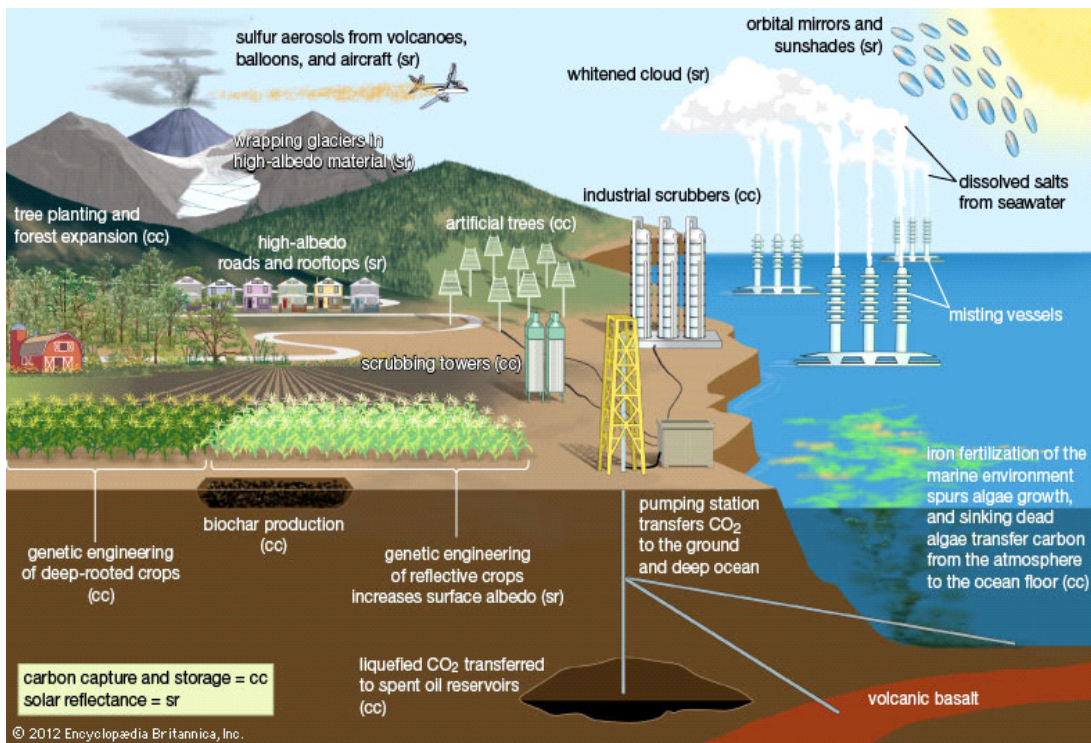
The Copenhagen Accord

The Copenhagen Accord drafted by the United States and the BASIC countries (China, India, South Africa, and Brazil) is a non-legally binding agreement, which was entertained at the UN Climate Change Conference in Copenhagen in December 2009. The main points of it regarding geoengineering is the continuation of the Kyoto Protocol as well as "the scientific view that the increase in global temperature should be below 2 degrees Celsius" in order to prevent dangerous anthropogenic interference within the climatic system.

Cancun Agreements

In December 2010, climate change talks in Cancún concluded in actions to help countries advance towards a low greenhouse gases emissions future. Known as the “Cancún Agreements,” the decisions include mitigation pledges and increased accountability for them as well as taking concrete action to protect the world's forests.

Previous attempts to solve the issue



As mentioned previously there were not many previous attempts, since there are various implementation issues. First of all only small-scale experimentation is allowed and that only in specific parts of the world while several firms, individuals and governments conduct such experiments illegally and unsupervised. However, small-scale tests do not represent impacts that correspond to the real geoengineering scales that are needed. Research into SRM and CDR has mainly consisted of computer modeling or laboratory tests. Costs for certain geoengineering projects make the whole issue more complex.

Below are listed the most common, sufficient and suitable to our Earth geoengineering methods:

Solar Radiation Management Techniques

- Surface-based (land or ocean albedo modification) e.g. cool roof (Painting roof materials in white or pale colors which reflect solar radiation)

- Troposphere-based, for example cloud whitening – using fine seawater spray to whiten clouds and increase cloud reflectivity
- Upper atmosphere-based: creating reflective aerosols, such as stratospheric sulfate aerosols, aluminum oxide particles, which will be sprayed in the upper atmosphere or designed self-levitating aerosols
- Space-based: space sunshade—obstructing solar radiation with space-based mirrors and asteroid dust

Carbon Dioxide Removal Techniques

- Creating biochar which produces negative carbon dioxide emissions that counterbalance already existing emissions
- Bio-energy with carbon capture and storage to sequester carbon and simultaneously provide energy
- Carbon air capture to remove carbon dioxide from ambient air
- Planting trees to offset carbon emissions
- Enhanced weathering involves land or ocean based techniques. e.g. ultramafic rock which stores CO2 emissions
- Ocean nourishment including iron fertilization of the oceans
- Scrubbing towers (see David Keith under Possible Solutions)
- Artificial Trees



Artificial trees

Possible solutions

First of all specific investment projects and related institutional and policy options for limiting greenhouse gas emissions should be found. These will strengthen national institutional capabilities to assess global implications of energy efficiency and other projects, which affect emission levels and radiation management. Further experiments should be conducted in order to demonstrate the operational viability of geoengineering technologies. However in order for those to be conducted properly a legal framework should be developed which would be applicable to every nation of the world in order to be able to make geoengineering legally binding. Geoengineering methods -that are listed under previous attempts to solve the issue- should be considered and discussed by the ensemble of countries in order to find the most suitable methods in regards to possible impacts on Earth and human beings. Governance issues should be solved by considering the capability of the governing nation/nations. The methods exist already. Their applications are hindered by other factors, which should be overcome. Further methods could also be found which would be more nature and human friendly. One project suggested by David Keith should be taken under consideration since it proposes a method that is both

applicable, at a low cost and theoretically also politically accepted. He proposes erecting vented building-size structures that contain grids coated with a chemical solution. As air flows through the vents, the solution would bind to the carbon-dioxide molecules and trap them. This way carbon would be captured in the structures, which could resemble industrial cooling towers and be controlled by central stations. Then carbon would be put back to the ground or deep into the oceans where it first originated as oil and find a way to make it remain underground. Given the uncertainties and the stakes involved, it is important that we conduct further research to determine if any of the proposed geoengineering techniques could be employed without generating side-effects and possible risks.

Further reading:

<http://www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>

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