

# Careers in Geoengineering

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In a recent report, the Copernicus Climate Change Service (C3S) confirmed that global temperatures in 2024 exceeded the critical threshold of 1.5°C above pre-industrial levels. Scientists of EU countries have also declared 2024 as the hottest year ever recorded. Experts warn that this alarming milestone may represent a point of no return in the fight against climate change.

As the world grapples with the devastating and intensifying impacts of global warming and climate change, the notion of geoengineering has emerged as a potential tool to mitigate the escalating impacts of global warming.

Geoengineering refers to large-scale interventions in the Earth's natural systems aimed at combating climate change. By directly altering Earth's environment, geoengineering seeks to mitigate or reverse the adverse effects of global warming. With the world facing unprecedented environmental crises, geoengineering careers are increasingly in demand, drawing professionals from various disciplines including engineering, environmental science, physics, and policy. In this article, we will explore the wide array of careers in geoengineering, highlighting key roles, educational pathways, skills required, and the impact of geoengineering on society and the environment.

## Understanding Geoengineering

The Cambridge dictionary defines geoengineering as "The use of scientific methods to artificially control the environment, particularly the world's temperature, in order to deal with the problem of climate change". In other words, geoengineering refers to the large-scale manip-



ulation of a particular process pivotal to regulating the climate of Earth for the purpose of acquiring a certain benefit. From among the various types of geoengineering, two types are most prominent:

**1. Solar Radiation Management (SRM):** This refers to a set of geoengineering techniques aimed at reducing the Earth's temperature by reflecting a portion of incoming sunlight back into space. This approach seeks to counteract the effects of global warming by mimicking the natural processes that regulate Earth's climate, such as volcanic eruptions that release aerosols into the atmosphere. One of the most commonly proposed methods is stratospheric aerosol injection, where reflective particles, such as sulphur dioxide, are dispersed into the stratosphere to create a cooling effect. Other techniques include marine cloud brightening, which involves spraying sea water into clouds to enhance their reflectivity, and the use of high albedo crops—plants engineered or selected for their ability to reflect more sun-

light. Another innovative idea is the creation of reflective surfaces or ocean mirrors on large stretches of ocean, which would increase the reflectivity of the Earth's surface and help cool the planet. While these strategies have the potential to lower global temperatures, they also come with significant uncertainties regarding their long-term environmental and geopolitical impacts.

**2. Carbon Dioxide Removal (CDR):** This incorporates a variety of methods focused on directly eliminating CO<sub>2</sub> from the atmosphere to alleviate the effects of climate change. Unlike SRM, whose objective is to reduce solar radiation, CDR targets the root cause of global warming—excess carbon dioxide (CO<sub>2</sub>). One of the most widely used methods is afforestation, which includes planting large-scale forests to capture CO<sub>2</sub> from the earth's atmosphere via natural processes. Additionally, reforestation and wetland restoration efforts aim to rehabilitate ecosystems that naturally sequester carbon dioxide. A more complicated technique is ocean farming (mariculture), which includes cultivation of seaweed or other aquatic plants that absorb CO<sub>2</sub> during growth, as well as promoting the rejuvenation of marine

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ecosystems like seagrass beds, which act as carbon sinks. The most technical and also uniquely controversial approach to CDR is Direct Air Carbon Capture and Storage (DACCS), where machines extract CO<sub>2</sub> directly from the earth's atmosphere and store it underground or use it in various industrial mechanisms. While CDR techniques hold the promise of reducing atmospheric CO<sub>2</sub> levels, they represent a significant financial burden, require unprecedented amounts of energy, and may have unanticipated ecological or societal consequences, particularly when scaled up.

While geoengineering holds potential for reversing climate change, it also presents ethical, ecological, geopolitical and social challenges. As a result, professionals working in the field must navigate complex scientific, political, and environmental considerations.

## Careers in Geoengineering

Geoengineering careers span various fields, each contributing a unique expertise to climate intervention strategies. Here are some of the key roles:

### 1. Climate Scientist / Atmospheric Scientist

**Role:** Climate Scientists study the Earth's climate systems to understand the causes and effects of climate change. They conduct research to develop models predicting the outcomes of different geoengineering interventions, such as aerosol injection or carbon capture. These scientists may also explore the long-term consequences of geoengineering efforts on global weather patterns, ecosystems, and human societies.

**Skills Required:** A deep understanding of atmospheric science, climate modelling, and data analysis. Familiarity with the use of supercomputers to simulate climate scenarios is essential.

**Education:** Typically requires a Ph.D. in atmospheric science, environmental science, or climate change. Some positions may accept candidates with a master's degree combined with significant research experience.

### 2. Environmental Engineer

**Role:** Environmental engineers in geoengineering focus on developing technologies that can mitigate the impact of climate change. They work on designing carbon capture systems, such as direct air capture facilities or Bioenergy with Carbon Capture and Storage (BECCS). Their role is to ensure that geoengineering technologies are both effective and environmentally sustainable.

**Skills Required:** Expertise in engineering principles, environmental systems, and renewable energy. Proficiency in designing large-scale infrastructure pro-

jects and conducting impact assessments.

**Education:** A bachelor's degree in environmental engineering, civil engineering, or mechanical engineering, with a master's or Ph.D. for specialized roles.

### 3. Geoengineering Researcher

**Role:** Researchers in geoengineering typically work within academic institutions, government agencies, or private companies to explore new geoengineering techniques or optimise existing ones. They engage in cutting-edge research to better understand the scientific, ethical, and technological aspects of geoengineering, often in a multidisciplinary team setting.

**Skills Required:** Strong analytical skills, expertise in climate modelling or experimental methods, and the ability to write research papers and reports. Researchers also need to stay up-to-date with the latest developments in the field.

**Education:** A Ph.D. in a relevant field such as environmental science, engineering, or physics. Researchers typically require a strong background in experimental or computational methods.

### 4. Climate Policy Analyst

**Role:** Climate Policy Analysts study the political, economic, and social aspects of climate change and geoengineering. They analyse the potential risks, benefits, and ethical implications of different geoengineering techniques and contribute to policy discussions at local, national, and international levels. These professionals play a critical role in shaping public perceptions and regulations regarding geoengineering.

**Skills Required:** A deep understanding of environmental law, political science, economics, and public policy. Analytical skills to assess the feasibility and implications of different geoengineering interventions are crucial.

**Education:** A master's or Ph.D. in public policy, environmental law, international relations, or economics. A background in environmental studies or political science is also valuable.

### 5. Ecologist / Environmental Biologist

**Role:** Ecologists and Environmental Biologists are concerned with understanding the effects of geoengineering interventions on ecosystems and biodiversity. They study how various geoengineering methods, such as large-scale carbon sequestration or aerosol injection, could impact natural habitats, plant and animal life, and ecological processes.

**Skills Required:** Knowledge of ecology, biology, and envi-

ronmental impact assessments. Familiarity with conducting field research, collecting data, and analysing the ecological consequences of environmental interventions.

**Education:** A bachelor's or master's degree in ecology, environmental biology, or a related field. A Ph.D. is typically required for higher-level research positions.

### 6. Geoengineering Technology Developer

**Role:** Geoengineering Technology Developers work on the creation, improvement, and commercialisation of geoengineering technologies. This could involve designing and building systems for carbon capture, solar radiation management, or other environmental interventions. Developers work with engineers and scientists to create scalable, economically viable technologies.

**Skills Required:** Expertise in technology development, innovation, and engineering. Knowledge of materials science, machine learning, and data-driven technologies can also be important, especially in the development of more precise geoengineering techniques.

**Education:** A degree in engineering, computer science, or a related field. Advanced degrees (Master's or Ph.D.) are required for specialised technology development positions.

### 7. Ethicist / Environmental Philosopher

**Role:** As geoengineering involves altering Earth's climate, it raises complex ethical questions, such as the moral implications of manipulating natural systems, the potential for unintended consequences, and the distribution of benefits and risks. Ethicists and Environmental Philosophers examine these questions, providing critical insights to guide decision-making in geoengineering.

**Skills Required:** Strong analytical skills and a deep understanding of ethical theories, environmental justice, and philosophy. The ability to engage with interdisciplinary teams of scientists, engineers, and policymakers is important.

**Education:** A Ph.D. in philosophy, with a focus on environmental ethics or political philosophy. A background in law or public policy is also helpful.

### 8. Project Manager in Geoengineering

**Role:** Geoengineering projects are typically large, complex, and multidisciplinary. Project Managers co-ordinate the efforts of diverse teams of scientists, engineers, policymakers, and other stakeholders. They oversee the planning, execution, and evaluation of geoengineering projects to ensure that objectives are met on time, within budget, and in accordance with ethical and environmental standards.

**Skills Required:** Strong leadership and communication skills,

knowledge of project management tools and methodologies, and the ability to balance technical, ethical, and logistical concerns.

**Education:** A degree in engineering, environmental science, or business management. A master's degree in project management or a related field is beneficial.

## Educational Pathways in Geo-engineering

To pursue a career in geoengineering, one needs a solid educational foundation in the sciences and engineering, with specialisation in climate-related fields. Here's a general pathway:

**Undergraduate Studies:** A bachelor's degree in environmental science, engineering, physics, or a related field is typically the first step. Many students also choose to pursue interdisciplinary programmes that integrate aspects of environmental studies, policy, and technology.

**Graduate Studies:** A master's degree or Ph.D. in a specialised area, such as climate science, environmental engineering, or geoengineering itself, is often required for higher-level research or technical roles. Graduate studies allow students to gain in-depth knowledge and hands-on experience in geoengineering technologies and climate solutions.

**Postdoctoral Research:** For those interested in research-oriented careers, pursuing postdoctoral work in geoengineering allows one to contribute to cutting-edge studies and refine technical skills.

**Certifications and Continuing Education:** As geoengineering is a rapidly developing field, professionals need to pursue additional certifications, attend conferences, and engage in ongoing education to stay current with the latest developments.

## Skills and Attributes for Success

While technical knowledge and educational qualifications are essential, a successful career in geoengineering also requires a range of soft skills and attributes:

**Interdisciplinary Collaboration:** Geoengineering often involves teams of scientists, engineers, policy experts, and ethicists. The ability to collaborate across disciplines and communicate complex ideas clearly is critical.

**Critical Thinking:** The ability to assess the effectiveness, risks, and ethical considerations of geoengineering techniques is essential. Professionals make data-driven decisions and to think critically about long-term environmental and societal impacts.

**Communication Skills:** A career in geoengineering involves navigating complex debates surrounding budgetary constraints, feasibility, and the ethical implications of implementing such technologies. Effective communication skills are essential in this field. Professionals must not only analyse the risks and benefits with precision but also articulate their findings clearly and persuasively to key stakeholders, ensuring informed and balanced decision-making.

**Problem-Solving:** Geoengineering is a solution-oriented field, so creativity and a strong problem-solving mindset are crucial to designing effective interventions and overcoming challenges.

**Ethical Awareness:** Understanding the potential unintended consequences of geoengineering is crucial, especially in roles that involve policy or environmental ethics. Geoengineers weigh the scientific potential against the moral and ethical implications of their actions.

## The Future of Geo-engineering Careers

The future of geoengineering careers looks promising, as the world continues to grapple with the reality of climate change. As governments, corporations, and research institutions invest in climate solutions, the demand for geoengineering professionals is expected to grow. Geoengineering will require diverse expertise, spanning science, engineering, policy, and ethics, making it an exciting and interdisciplinary field to work in.

However, geoengineering will remain a highly debated and controversial field, with concerns about environmental risks, social equity, and governance. As such, professionals working in this area must navigate not only technical challenges but also societal debates and ethical considerations.

## Conclusion

Geoengineering presents an array of career opportunities that span multiple disciplines, each offering a chance to contribute to the fight against climate change. Whether working as a scientist, engineer, ethicist, or policy expert, professionals in this field are tasked with solving some of the most urgent environmental challenges of our time. While geoengineering holds the potential for large-scale climate solutions, it also requires careful consideration of its risks and ethical implications. As such, the future of geoengineering will rely on the collaboration of diverse experts and the continued development of new, sustainable technologies.

(The author is a freelance writer on career related topics. Feedback can be sent to [feedback.employmentnews@gmail.com](mailto:feedback.employmentnews@gmail.com).)

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